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DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1910, 1915, 1917, 1918, 1926, and 1928

[Docket No. OSHA–2021–0009]

RIN 1218-AD39

Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings

AGENCY: Occupational Safety and Health Administration (OSHA), Labor.

ACTION: Notice of proposed rulemaking (NPRM); request for comments.

SUMMARY: OSHA is proposing to issue a new standard, titled *Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings*. The standard would apply to all employers conducting outdoor and indoor work in all general industry, construction, maritime, and agriculture sectors where OSHA has jurisdiction, with some exceptions. It would be a programmatic standard that would require employers to create a plan to evaluate and control heat hazards in their workplace. It would more clearly set forth employer obligations and the measures necessary to effectively protect employees from hazardous heat. OSHA requests comments on all aspects of the proposed rule.

DATES: Comments to this NPRM (including requests for a hearing) and other information must be submitted by [INSERT DATE 120 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

Informal public hearing: OSHA will schedule an informal public hearing on the proposed rule if requested during the comment period. If a hearing is requested, the location and date of the hearing, procedures for interested parties to notify the agency of their intention to participate, and procedures for participants to submit their testimony and documentary evidence will be announced in the *Federal Register*.

ADDRESSES:

Written comments: You may submit comments and attachments, identified by Docket No. OSHA–2021–0009, electronically at *https://www.regulations.gov*, which is the Federal e-Rulemaking Portal. Follow the instructions online for making electronic submissions. After accessing ‘‘all documents and comments’’ in the docket (Docket No. OSHA–2021–0009), check the “proposed rule” box in the column headed “Document Type,” find the document posted on the date of publication of this document, and click the “Comment Now” link. When uploading multiple attachments to regulations.gov, please number all of your attachments because regulations.gov will not automatically number the attachments. This will be very useful in identifying all attachments. For example, Attachment 1—title of your document, Attachment 2—title of your document, Attachment 3—title of your document. For assistance with commenting and uploading documents, please see the Frequently Asked Questions on regulations.gov.

Instructions: All submissions must include the agency’s name and the docket number for this rulemaking (Docket No. OSHA–2021–0009). All comments, including any personal information you provide, are placed in the public docket without change and may be made available online at *https://www.regulations.gov*. Therefore, OSHA cautions commenters about submitting information they do not want made available to the public, or submitting materials that contain personal information (either about themselves or others), such as Social Security Numbers and birthdates.

Docket citations: This *Federal Register* document references material in Docket No. OSHA–2021–0009, which is the docket for this rulemaking.

Citations to documents: The docket referenced most frequently in this document is the docket for this rulemaking, docket number OSHA–2021–0009, cited as Document ID OSHA–2021–0009. Documents in the docket get an individual document identification number, for example ‘‘OSHA–2021–0009–0047.’’ Because this is the most

frequently cited docket, the citation is shortened to indicate only the document number. The example is cited in the NPRM as ‘‘Document ID 0047.’’

Documents cited in this NPRM are available in the rulemaking docket (Docket ID OSHA–2021–0009). They are available to read and download by searching the docket number or document ID number at *https://www.regulations.gov*. Each docket index lists all documents in that docket, including public comments, supporting materials, meeting transcripts, and other documents. However, some documents (e.g., copyrighted material) in the dockets are not available to read or download from that website. All documents in the dockets are available for inspection at the OSHA Docket Office. This information can be used to search for a supporting document in the docket at *www.regulations.gov*. Contact the OSHA Docket Office at (202) 693–2350 (TTY number: 877–889–5627) for assistance in locating docket submissions.

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Copies of this Federal Register notice: Electronic copies are available at *https://www.regulations.gov*. This *Federal Register* notice, as well as news releases and other relevant information, also are available at OSHA’s webpage at *https://www.osha.gov*.

The docket is available at *https://www.regulations.gov*, the Federal eRulemaking Portal. A “100-word summary” is also available on *https://www.regulations.gov*. For additional information on submitting items to, or accessing items in, the docket, please

refer to the **"ADDRESSES"** section of this NPRM. Most exhibits are available at *https://www.regulations.gov*; some exhibits (e.g., copyrighted material) are not available to download from that webpage. However, all materials in the dockets are available for inspection and copying at the OSHA Docket Office.

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I. Executive Summary

Heat is the leading cause of death among all weather-related phenomena in the United States. Excessive heat in the workplace can cause a number of adverse health effects, including heat stroke and even death, if not treated properly. Yet, there is currently no Federal OSHA standard that regulates heat stress hazards in the workplace. Although several governmental and non-governmental organizations have published regulations and guidance to help protect workers from heat hazards, OSHA believes that a mandatory Federal standard specific to heat-related injury and illness prevention is

necessary to address the hazards posed by occupational heat exposure. OSHA has preliminarily determined that this proposed rule would substantially reduce the risk posed by occupational exposure to hazardous heat by clearly setting forth employer obligations and the measures necessary to effectively protect exposed workers.

OSHA is proposing this standard pursuant to the Occupational Safety and Health Act of 1970, 29 U.S.C. 651 et seq. (OSH Act or Act). The Act authorizes the agency to issue safety or health standards that are "reasonably necessary or appropriate" to provide safe or healthful employment and places of employment (29 U.S.C. 652(8)). A standard is reasonably necessary or appropriate when a significant risk of material harm exists in the workplace and the standard would substantially reduce or eliminate that workplace risk. Applicable legal requirements are more fully discussed in Section II., Pertinent Legal Authority.

Workers in both outdoor and indoor work settings without adequate climate controls are at risk of hazardous heat exposure. Certain heat-generating processes, machinery, and equipment (e.g., hot tar ovens, furnaces) can also cause heat hazards when cooling measures are not in place. Based on the best available evidence, as discussed in this preamble, OSHA has preliminarily determined that exposure to hazardous heat in the workplace poses a significant risk of serious injury and illness. This finding of a significant risk of material harm is based on the health consequences associated with exposure to heat (see Section IV., Health Effects) as well as the risk assessment (see Section V., Risk Assessment and Section VI., Significance of Risk). In Section V.C., Risk Reduction, OSHA demonstrates the efficacy of the controls relied on in this proposed rule to reduce the risk of heat-related injury and illness in the workplace. Employees working in workplaces without these controls are at higher risk of severe health outcomes from exposure to hazardous heat.

On October 27, 2021, OSHA published in the *Federal Register* an advance notice of proposed rulemaking (ANPRM) for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings (86 FR 59309). The ANPRM outlined key issues and challenges in occupational heat-related injury and illness prevention and aimed to collect evidence, data, and information critical to informing how OSHA proceeds in the rulemaking process. The ANPRM included background information on injuries, illnesses, and fatalities due to heat, underreporting, scope, geographic region, and inequality in exposures and outcomes. The ANPRM also covered existing heat injury and illness prevention efforts including OSHA's efforts, the National Institute for Occupational Safety and Health (NIOSH) criteria documents, State standards, and other standards.

OSHA received 965 unique public comments, which largely supported the need for continued rulemaking. The agency then worked with the National Advisory Committee on Occupational Safety and Health (NACOSH) to assemble a Heat Injury and Illness Prevention Work Group. The Work Group was tasked with evaluating stakeholder input to the ANPRM and developing recommendations on potential elements of a proposed heat injury and illness prevention standard. The Work Group presented its recommendations on potential elements of a proposed heat injury and illness prevention standard for consideration by the full NACOSH committee. On May 31, 2023, NACOSH amended the report to ask OSHA to include a model written plan and then unanimously voted to submit the Work Group's recommendations to the Secretary of Labor.

In accordance with the requirements of the Small Business Regulatory Enforcement Fairness Act (SBREFA), OSHA next convened a Small Business Advocacy Review (SBAR) Panel in August 2023. The Panel, comprised of members from the Small Business Administration's (SBA) Office of Advocacy, OSHA, and OMB's Office of Information and Regulatory Affairs, heard comments directly from Small Entity Representatives (SERs) on the potential impacts of a heat-specific standard. The Panel

received advice and recommendations from the SERs and reported its findings and recommendations to OSHA. OSHA has taken the SER's comments and the Panel's findings and recommendations into consideration in the development of this proposed rule (see Section VIII.F., Initial Regulatory Flexibility Analysis).

In accordance with 29 CFR parts 1911 and 1912, OSHA also consulted with and considered feedback from the Advisory Committee on Construction Safety and Health (ACCSH). On April 24, 2024, the Committee unanimously passed a motion recommending that OSHA proceed expeditiously with proposing a standard on heat injury and illness prevention. In addition, in accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 65 FR 67249 (Nov. 6, 2000), OSHA held a listening session on May 15, 2024, with Tribal representatives regarding this Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings rulemaking and provided an opportunity for the representatives to offer feedback.

The proposed rule is a programmatic standard that requires employers to create a heat injury and illness prevention plan to evaluate and control heat hazards in their workplace. It establishes requirements for identifying heat hazards, implementing engineering and work practice control measures at or above two heat trigger levels (i.e., an initial heat trigger and a high heat trigger), developing and implementing a heat illness and emergency response plan, providing training to employees and supervisors, and retaining records. The proposed rule would apply to all employers conducting outdoor and indoor work in all general industry, construction, maritime, and agriculture sectors, with some exceptions (see Section VII.A., Paragraph (a) Scope and Application). Throughout this document, OSHA seeks input on alternatives and potential exclusions.

Organizations affected by heat hazards vary significantly in size and workplace activities. Accordingly, many of the provisions of the proposed standard provide flexibility for affected employers to choose the control measures most suited to their

workplace. The flexible nature of the proposed rule may be particularly beneficial to small organizations with limited resources.

Additionally, to determine whether the proposed rule is feasible for affected employers, and in accordance with Executive Orders 12866 and 13563, the Regulatory Flexibility Act (RFA), and the Unfunded Mandates Reform Act (2 U.S.C 1501 et seq.), OSHA has prepared a Preliminary Economic Analysis (PEA), including an Initial Regulatory Flexibility Analysis (see Section VIII., Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis). Supporting materials prepared by OSHA are available in the public docket for this rulemaking, Document ID OSHA-2021-0009, through regulations.gov.

II. Pertinent Legal Authority

A. Introduction.

In the Occupational Safety and Health Act, 29 U.S.C. 651 et seq., Congress authorized the Secretary of Labor ("the Secretary") "to set mandatory occupational safety and health standards applicable to businesses affecting interstate commerce" (29 U.S.C. 651(b)(3); see *Nat'l Fed'n of Indep. Bus. v. Dep't of Labor*, 595 U.S. 109, 117 (2022) (per curiam); see also 29 U.S.C. 654(a)(2) (requiring employers to comply with OSHA standards)). Section 6(b) of the Act authorizes the promulgation, modification or revocation of occupational safety or health standards pursuant to detailed notice and comment procedures (29 U.S.C. 655(b)).

Section 3(8) of the Act defines a safety or health standard as a standard which requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes "reasonably necessary or appropriate" to provide safe or healthful employment and places of employment (29 U.S.C. 652(8)). A standard is reasonably necessary or appropriate within the meaning of section 3(8) when a significant risk of material harm exists in the workplace and the standard would substantially reduce

or eliminate that workplace risk (see *Indus. Union Dep't, AFL-CIO v. Am. Petroleum Inst.,* 448 U.S. 607 (1980) ("*Benzene*")). OSHA's authority extends to, for example, removing workers from environments where workplace hazards exist (see, e.g., *United Steelworkers of America v. Marshall*, 647 F.2d 1189, 1228-38 (D.C. Cir. 1981); 29 CFR 1910.1028(i)(8); 29 CFR 1910.1024(l); cf. *Whirlpool Corp. v. Marshall*, 445 U.S. 1, 12 (1980) (upholding regulation allowing employees to refuse dangerous work in certain circumstances because "[t]he Act does not wait for an employee to die or become injured.").

In addition to the requirement that each standard address a significant risk, standards must also be technologically feasible (see *UAW v. OSHA*, 37 F.3d 665, 668 (D.C. Cir. 1994)). A standard is technologically feasible when the protective measures it requires already exist, when available technology can bring the protective measures into existence, or when that technology is reasonably likely to develop (see *Am. Iron and Steel Inst. v. OSHA*, 939 F.2d 975, 980 (D.C. Cir. 1991)).

Finally, a standard must be economically feasible (see *Forging Indus. Ass'n v. Secretary of Labor*, 773 F.2d 1436, 1453 (4th Cir. 1985)). A standard is economically feasible if industry can absorb or pass on the costs of compliance without threatening its long-term profitability or competitive structure (see *American Textile Mfrs. Inst., Inc.*, 452 U.S. 490, 530 n.55 ("*Cotton Dust*")). Each of these requirements is discussed further below.

B. Significant Risk.

As noted above, OSHA's workplace safety and health standards must address a significant risk of material harm that exists in the workplace (see *Benzene,* 448 U.S. at 614-15). The agency's risk assessments are based on the best available evidence, and its final conclusions are made only after considering all information in the rulemaking record. Reviewing courts have upheld the Secretary's significant risk determinations

where supported by substantial evidence and "a reasoned explanation for [their] policy assumptions and conclusions" (*Bldg & Constr. Trades Dep't v. Brock*, 838 F.2d 1258, 1266 (D.C. Cir. 1988) ("*Asbestos II*")).

The Supreme Court in *Benzene* explained that "[i]t is the agency's responsibility to determine, in the first instance, what it considers to be a 'significant' risk" (*Benzene*, 448 U.S. at 655). The Court declined to "express any opinion on the . . . difficult question of what factual determinations would warrant a conclusion that significant risks are present which make promulgation of a new standard reasonably necessary or appropriate" (*Benzene*, 448 U.S. at 659). The Court stated, however, that the substantial evidence standard applicable to OSHA's significant risk determination (see 29 U.S.C. 655(b)(f)) does not require the agency "to support its finding that a significant risk exists with anything approaching scientific certainty" (*Benzene*, 448 U.S. at 656). Rather, OSHA may rely on "a body of reputable scientific thought" to which "conservative assumptions in interpreting the data" may be applied, "risking error on the side of overprotection" (*Benzene*, 448 U.S. at 656). The D.C. Circuit has further explained that OSHA may thus act with a pronounced bias towards worker safety in making its risk determinations (*Asbestos II*, 838 F.2d at 1266). The Supreme Court also recognized that the determination of what constitutes "significant risk" is "not a mathematical straitjacket" and will be "based largely on policy considerations" (*Benzene*, 448 U.S. at 655 & n.62).

Once OSHA makes its significant risk finding, the standard it promulgates must be "reasonably necessary or appropriate" to reduce or eliminate that risk (29 U.S.C. 652(8)). In choosing among regulatory alternatives, however, "[t]he determination that [one standard] is appropriate, as opposed to a marginally [more or less protective] standard, is a technical decision entrusted to the expertise of the agency" (*Nat'l Mining Ass'n v. Mine Safety and Health Admin.*, 116 F.3d 520, 528 (D.C. Cir. 1997) (analyzing a

Mine Safety and Health Administration standard under the *Benzene* significant risk standard)).

C. Feasibility.

The statutory mandate to consider the feasibility of the standard encompasses both technological and economic feasibility; OSHA has performed these analyses primarily on an industry-by-industry basis (*United Steelworkers of Am., AFL-CIO-CLC v. Marshall*, 647 F.2d 1189, 1264, 1301 (D.C. Cir. 1980) ("*Lead I*")). The agency has also used application groups, defined by common tasks, as the structure for its feasibility analyses (*Pub. Citizen Health Research Grp. v. OSHA*, 557 F.3d 165, 177-79 (3d Cir. 2009)). The Supreme Court has broadly defined feasible as "capable of being done" (*Cotton Dust*, 452 U.S. at 509-10).

I. Technological Feasibility.

A standard is technologically feasible if the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be expected to be developed (*Lead I*, 647 F.2d at 1272; *Amer. Iron & Steel Inst. v. OSHA*, 939 F.2d 975, 980 (D.C. Cir. 1991) ("*Lead II*")). Courts have also interpreted technological feasibility to mean that a typical firm in each affected industry or application group will reasonably be able to implement the requirements of the standard in most operations most of the time (see *Public Citizen v. OSHA*, 557 F.3d 165, 170-71 (3d Cir. 2009); *Lead I*, 647 F.2d at 1272; *Lead II*, 939 F.2d at 990)). OSHA's standards may be "technology forcing," so long as the agency gives an industry a reasonable amount of time to develop new technologies to comply with the standard. Thus, OSHA is not bound by the "technological status quo" (*Lead I*, 647 F.2d at 1264).

II. Economic Feasibility.

In addition to technological feasibility, OSHA is required to demonstrate that its standards are economically feasible. A reviewing court will examine the cost of compliance with an OSHA standard "in relation to the financial health and profitability of the industry and the likely effect of such costs on unit consumer prices" (*Lead I*, 647 F.2d at 1265 (citation omitted)). As articulated by the D.C. Circuit in *Lead I*, "OSHA must construct a reasonable estimate of compliance costs and demonstrate a reasonable likelihood that these costs will not threaten the existence or competitive structure of an industry, even if it does portend disaster for some marginal firms" (*Lead I*, 647 F.2d at 1272). A reasonable estimate entails assessing "the likely range of costs and the likely effects of those costs on the industry" (*Lead I*, 647 F.2d at 1266). As with OSHA's consideration of scientific data and control technology, however, the estimates need not be precise (*Cotton Dust*, 452 U.S. at 528-29 & n.54), as long as they are adequately explained.

OSHA standards satisfy the economic feasibility criterion even if they impose significant costs on regulated industries so long as they do not cause massive economic dislocations within a particular industry or imperil the very existence of the industry (*Lead II*, 939 F.2d at 980; see also *Lead I*, 647 F.2d at 1272; *Asbestos I*, 499 F.2d. at 478). As with its other legal findings, OSHA "is not required to prove economic feasibility with certainty, but is required to use the best available evidence and to support its conclusions with substantial evidence" (*Lead II*, 939 F.2d at 980-81 (citing *Lead I*, 647 F.2d at 1267)).

In addition to determining economic feasibility, OSHA estimates the costs and benefits of its proposed and final rules to ensure compliance with other requirements such as those in Executive Orders 12866 and 13563.

D. High Degree of Employee Protection.

Safety standards must provide a high degree of employee protection to be consistent with the purpose of the Act (see Control of Hazardous Energy Sources (Lockout/Tagout) Final Rule, Supplemental Statement of Reasons, 58 FR 16612, 16614-15 (March 30, 1993)). OSHA has preliminarily determined that this proposed standard is a safety standard because the health effects associated with exposure to occupational heat are generally acute. As explained in Section IV., Health Effects, the proposed standard aims to address the numerous acute health effects of occupational exposure to hazardous heat. These include, among other things, heat stroke, heat exhaustion, heat syncope, and physical injuries (e.g., falls) due to fatigue or other heat-related impairments. These harms occur after relatively short-term exposures to hazardous heat and are typically apparent at the time of the exposure or shortly thereafter. Consequently, the link between these harms and heat exposures is also often apparent and they do not implicate the concerns about latent, hidden harms that underly health standards (see *Benzene*, 448 U.S. at 649 n. 54; *UAW v. OSHA*, 938 F.2d 1310, 1313 (D.C. Cir. 1991) ("*Lockout/Tagout I*"); *National Grain & Feed Ass'n v. OSHA*, 866 F.2d 717, 733 (5th Cir. 1989) ("*Grain Dust*")).

Finally, although OSHA acknowledges that there is growing evidence occupational exposure to hazardous heat may lead to some chronic adverse health outcomes like chronic kidney disease, much of the science in this area is still developing (see Section IV., Health Effects). In any event, the agency expects that addressing the acute hazards posed by heat would also protect workers from potential chronic health outcomes by reducing workers' overall heat strain.

III. Background

A. Introduction.

The Occupational Safety and Health Administration (OSHA) is proposing a new standard to protect outdoor and indoor workers from hazardous heat in the workplace.

OSHA promulgates and enforces occupational safety and health standards under authority granted by the Occupational Safety and Health (OSH) Act of 1970 (29 U.S.C. 651 et seq.).

In the absence of a Federal occupational heat standard, five States have issued heat injury and illness prevention regulations to protect employees exposed to heat hazards in the workplace: Minnesota (Minn. R. 5205.0110 (1997)); California (Cal. Code of Regs. tit. 8, section 3395 (2005)); Oregon (Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)); Colorado (7 Colo. Code Regs. section 1103-15 (2022)); and Washington (Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)). Although Minnesota was the first State to adopt a standard covering employees exposed to indoor environmental heat conditions, California was the first State to adopt a standard covering employees exposed to outdoor environmental heat conditions. Washington, Oregon, and Colorado have since enacted similar regulations to California's, requiring employers to implement controls and monitor for signs and symptoms of heat-related injury or illness, among other requirements. In 2023, California proposed a new standard that would cover indoor work environments (California, 2023). In 2024, Maryland published a proposed standard that would cover both outdoor and indoor work environments (Maryland, 2024).

Workers in many industries are at risk for heat-related injury and illness stemming from hazardous heat exposure (see Section V.A., Risk Assessment). While the general population may be able to avoid and limit prolonged heat exposure, workers across a wide range of indoor and outdoor settings often are required to work through shifts with prolonged heat exposure. Some workplaces have heat generation from industrial processes and expose workers to sources of radiant heat, such as ovens and furnaces. Additionally, employers may not take adequate steps to protect their employees from exposure to hazardous heat (e.g., not providing rest breaks in cool areas). Many work

operations also require the use of personal protective equipment (PPE) that can reduce the worker's heat tolerance because it can decrease the body's ability to cool down. Workers may also face pressure, or incentivization through pay structures, to push through and continue working despite high heat exposure, which can increase the risk of heat-related injury and illness (Billikopf and Norton, 1992; Johansson et al., 2010; Spector et al., 2015; Pan et al., 2021).

OSHA uses several terms related to excessive heat exposure throughout this proposal. Heat stress is the combined load of heat that a person experiences from sources of heat (i.e., metabolic heat and the environment) and heat retention (e.g., from clothing or personal protective equipment). Heat strain refers to the body's response to heat stress (American Conference of Governmental Industrial Hygienists (ACGIH), 2023). Heat-related illness means adverse clinical health outcomes that occur due to heat exposure, such as heat exhaustion or heat stroke. Heat-related injury means an injury linked to heat exposure, such as a fall or cut. OSHA sometimes refers to these collectively as "heat-related injuries and illnesses."

B. Need for Proposal.

Occupational heat exposure affects millions of workers in the United States. Each year, thousands of workers experience heat-related injuries and illnesses, and some of these cases result in fatalities (BLS, 2023b; BLS, 2024c). OSHA has relied on the General Duty Clause of the OSH Act (discussed further below), as well as enforcement emphasis programs and hazard alerts and other guidance, to protect workers and inform employers of their legal obligations. However, a standard specific to heat-related injury and illness prevention would more clearly set forth enforceable employer obligations and the measures necessary to effectively protect employees from hazardous heat.

Workers in both outdoor and indoor work settings without adequate climate controls are at risk of hazardous heat exposure. In addition to weather-related heat,

certain heat-generating processes, machinery, and equipment (e.g., hot tar ovens, furnaces) can cause hazardous heat exposure when cooling measures are not in place. An evaluation of 66 heat-related illness enforcement investigations from 2011–2016 found heat-related injuries and illnesses, including fatalities, occurring in both outdoor (n=34) and indoor (n=29) work environments (Tustin et al., 2018a). Excessive heat exacerbates existing health conditions like asthma, diabetes, kidney failure, and heart disease, and can cause heat stroke and death if not treated properly and promptly. Some groups may be more likely to experience adverse health effects from heat, such as pregnant workers (NIOSH, 2024), while others are disproportionately exposed to hazardous levels of heat, such as workers of color in essential jobs, who are more often employed in work settings with a high risk of hazardous heat exposure (Gubernot et al., 2015).

The Bureau of Labor Statistics (BLS), in its Census of Fatal Occupational Injuries, documented 1,042 U.S. worker deaths due to occupational exposure to environmental heat from 1992–2022, with an average of 34 fatalities per year during that period (BLS, 2024c). In 2022 alone, BLS reported 43 work-related deaths due to environmental heat exposure (BLS, 2024c). The BLS Annual Survey of Occupational Injuries and Illnesses (SOII) estimates 33,890 work-related heat injuries and illnesses involving days away from work from 2011–2020, which is an average of 3,389 injuries and illnesses occurring each year during this period (BLS, 2023b).

Workers across hundreds of industries are at risk for hazardous heat exposure and resulting heat-related injuries and illnesses. From January 1, 2017, to December 31, 2022, 1,054 heat-related injuries, illnesses, and fatalities were reported to and investigated by OSHA, including 625 heat-related hospitalizations and 211 heat-related fatalities, as well as 218 heat-related injuries and illnesses that did not result in hospitalization. During this time, hospitalizations occurred most frequently in construction, manufacturing, and postal and delivery service. Fatalities were most frequently reported in construction,

landscaping, agriculture, manufacturing, and postal and delivery service (as identified by 2-digit NAICS codes).

However, as explained in Section V.A., Risk Assessment, these statistics likely do not capture the true magnitude and prevalence of heat-related injuries, illnesses, and fatalities. Recent studies demonstrate significant undercounting of occupational injuries and illnesses by both the BLS SOII and OSHA's enforcement data. One reason for this undercounting is that the BLS SOII only reports the number of heat-related injuries and illnesses involving days away from work and thus does not capture the full picture of heat-related injuries and illnesses. An examination of workers' compensation claims in California, which include more than only cases involving days away from work, identified 3 to 6 times the number of annual heat-related illness and injury cases than reported by BLS SOII (Heinzerling et al., 2020). In addition, evidence has shown significant underreporting as employers and employees are disincentivized from reporting injuries and illnesses due to several factors, including potential increases in workers' compensation costs or impacts on the employer's reputation, or an employee's fear of retaliation or lack of awareness of their right to speak out about workplace conditions (BLS, 2020b).

Heat-related injuries and illnesses may present unique challenges to surveillance efforts. As the nature of heat-related symptoms (e.g., headache, fatigue) vary, some cases may be attributed to other illnesses rather than heat (as discussed in Section IV., Health Effects). Furthermore, heat is not always identified as a contributing factor to fatality, as heat exposure may exacerbate existing medical conditions and medical professionals may not witness the symptoms and events preceding death (Luber et al., 2006).

Finally, exposure to heat can interfere with routine occupational tasks and impact workers' psychomotor and mental performance, which can lead to workplace injuries. Particularly, heat can impair performance of job tasks related to complex cognitive

function (Hancock and Vasmatzidis, 2003; Piil et al., 2017) and reduce decision making abilities (Ramsey et al., 1983; Xiang et al., 2014a) and productivity (Foster et al., 2021). A growing body of evidence has demonstrated that heat-induced impairments may result in significant occupational injuries that are not currently factored into official statistics for heat-related cases (Spector et al., 2016; Calkins et al., 2019; Dillender, 2021; Park et al., 2021). See Section V.A., Risk Assessment, for further discussion on underreporting of heat-related injuries, illnesses, and fatalities.

While a significant percentage of heat-related incidents are unreported, OSHA's investigations of reported heat-related fatalities point to many gaps in employee protections. OSHA has identified the following circumstances in its review of 211 heat-related fatality investigations from 2017-2022: employees left alone by employers after symptoms started; employers not providing adequate medical attention to employees with symptoms; employers preventing employees from taking rest breaks; employers not providing water on-site; employers not providing on-site access to shade; employers not providing cooling measures on-site; and employers not having programs to acclimatize employees to hot work environments (*https://www.osha.gov/fatalities*). OSHA has relied on multiple mechanisms to protect employees from hazardous heat, however, OSHA's efforts to prevent the aforementioned circumstances have been met with challenges without a heat-specific standard (as discussed in Section III.C.III., OSHA's Heat-Related Enforcement).

Many U.S. States run their own OSHA-approved State Plans (e.g., State heat standards, voluntary consensus standards) (see Section III.D., Other Standards), however OSHA has preliminarily determined that this standard is still needed to protect workers from the persistent and serious hazards posed by occupational heat exposure. As explained in Section VI., Significance of Risk, OSHA has preliminarily determined that a significant risk of material harm from occupational exposure to hazardous heat exists,

and issuance of this standard would substantially reduce that risk. Therefore, to more clearly set forth employer obligations and the measures necessary to more effectively protect employees from hazardous heat, and reduce the number and frequency of occupational injuries, illness, and fatalities caused by exposure to hazardous heat, OSHA is proposing a Federal standard for Heat Injury and Illness Prevention for Outdoor and Indoor Work Settings.

C. Events Leading to the Proposal.

I. History of Heat as a Recognized Occupational Hazard.

Heat exposure has long been recognized as an occupational hazard. For example, in the United States, the occupational hazards associated with the construction of the Hoover Dam between 1931 and 1935 brought attention to the effects of heat on worker health. The Bureau of Reclamation reported that 14 dam workers and two others residing in the work area died from "heat prostration" in 1931 (Bureau of Reclamation, 2015). According to a local newspaper, temperatures at the dam site that summer reached 140°F in the sun and 120°F in the shade (Turk, 2018; Rogers, 2012). In response to the extreme heat of the summer and other unsafe working conditions, the Industrial Workers of the World convinced Hoover Dam workers to strike over safety concerns (Turk, 2018; Rogers, 2012). Six Companies, the conglomerate of companies hired by the Bureau of Reclamation to construct most of the dam, was forced to make concessions, including protections against HRI such as providing potable water in dormitories, bringing ice water to workers at their work sites, and adding first aid stations closer to the job site (Rogers, 2012). The heat-related deaths that occurred during 1931 also prompted Harvard University researchers from the Harvard Fatigue Laboratory to travel to the Hoover Dam and study the relationship between hot, dry temperatures, physical performance, and heart rate (Turk, 2018).

Heat-related illnesses were identified as a major concern for the U.S. military in the 1940s and 1950s. Between 1942 and 1944, 198 soldiers died of heat stroke at U.S.-based training camps, 157 of which did not have a known history of cardiac diseases or other conditions that may predispose them to heat illness (Schickele, 1947, p. 236). This led to investigations of the environmental conditions at the time of these deaths, and eventually to the development of wet bulb globe temperature (WBGT) to measure heat stress (Yaglou and Minard, 1957; Minard, 1961; Department of the Army, 2022; Department of the Navy, 2023).

Research on the effects of occupational heat exposure continued in the 1960s, as researchers conducted trials examining the physiological effects of work at various temperatures (e.g., Lind, 1963). Findings from these trials would eventually underpin the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), as well as the National Institute of Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) (Dukes-Dobos and Henschel, 1973). ACGIH first proposed guidelines for a TLV in 1971, which were later adopted in 1974.

Heat was recognized as a preventable workplace hazard in the legislative history of the OSH Act. Senator Edmund Muskie submitted a letter in support of the OSH Act into the Congressional record on behalf of "a distinguished group of citizens, including a former Secretary of Labor and several noted scientists." (Senate Debate on S. 2193, Nov. 16, 1970), *reprinted in* Legislative History of the Occupational Safety and Health Act of 1970, pp. 513-14 (1971) (Committee Print) ("Leg. Hist."). The letter states, "Most industrial diseases and accidents are preventable. Modern technological and medical sciences are capable of solving the problems of noise, dust, heat, fumes, and toxic substances in the plants. However, existing legislation in this area does not begin to meet the problems" (Leg. Hist., pp. 513-14).

In 1972, just two years after promulgation of the OSH Act, NIOSH first recommended a potential OSHA heat standard in its *Criteria for a Recommended Standard* (NIOSH, 1972). This criteria document, issued under the authority of section 20(a) of the OSH Act, recommended an OSHA standard based on a critical review of scientific and technical information. In response, an OSHA Standards Advisory Committee on Heat Stress was appointed in 1973 and presented recommendations for a standard for work in hot environments in 1974. At the time, 12 of 15 members of the advisory committee agreed that occupational heat stress warranted a standard (Ramsey, 1975).

NIOSH's criteria document for a recommended standard has since been updated in 1986 (NIOSH, 1986) and again in 2016 (NIOSH, 2016). The 2016 criteria document recommends various provisions to protect workers from heat stress, including rest breaks, hydration, shade, acclimatization plans, and worker training (NIOSH, 2016). The 2016 criteria document also recommends that no worker be "exposed to combinations of metabolic and environmental heat greater than" the recommended alert limit (RAL) for unacclimatized workers or the recommended exposure limit (REL) for acclimatized workers). The document recommends that environmental heat be assessed with measurements of WBGT (NIOSH, 2016).

A detailed report of the history of heat as a recognized occupational hazard is available in the docket (ERG, 2024a). The report summarizes historical documentation of occupational heat-related illness beginning in ancient times and from the eighteenth century through the regulatory interest in the twentieth century.

II. OSHA's Heat Injury and Illness Prevention Efforts.

In 2011, OSHA issued a memorandum to inform regional administrators and State Plan designees of inspection guidance for heat-related illnesses (OSHA, 2011). That same year, OSHA launched the Heat Illness Prevention Campaign

(*https://www.osha.gov/heat*) to build awareness of prevention strategies and tools for employers and workers to reduce occupational heat-related illness. In its original form, the Campaign delivered a message of "Water. Rest. Shade." The agency updated Campaign materials in 2021 to recognize both indoor and outdoor heat hazards, as well as the importance of protecting new and returning workers from hazardous heat with an acclimatization period.

In addition, OSHA maintains on its website a Heat Topics page on workplace heat exposure (*https://www.osha.gov/heat-exposure/*), which provides additional information and resources. The page provides information on planning and supervision in hot work environments, identification of heat-related illness and first aid, information on prevention such as training, calculating heat stress and controls, personal risk factors, descriptions of other heat standards and case study examples of situations where workers developed heat-related illness. OSHA and NIOSH also co-developed a Heat Safety Tool Smartphone App for both Android and iPhone devices (see *www.osha.gov/heat/heat-app*). The app provides outdoor, location-specific temperature, humidity, and heat index (HI) readings. Measurements for indoor work sites must be collected and manually entered into the app by the user for accurate calculations. The app also provides relevant information on identifying signs and symptoms of heat-related illness and steps to prevent heat-related injuries and illnesses. Despite the strengths and reach of the Campaign, Heat Topics page, and Heat Safety Tool App, these guidance and communication materials are not legally enforceable requirements.

III. OSHA's Heat-Related Enforcement.

Without a specific standard governing hazardous heat conditions at workplaces, the agency currently enforces section 5(a)(1) (the General Duty Clause) of the OSH Act against employers that expose their workers to this recognized hazard. Section 5(a)(1) states that employers have a general duty to furnish to each of their employees

"employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm" to employees (29 U.S.C. 654(a)(1)). To prove a violation of the General Duty Clause, OSHA must establish—in each individual case—that: (1) the employer failed to keep the workplace free of a hazard to which its employees were exposed; (2) the hazard was recognized; (3) the hazard was causing or likely to cause death or serious injury; and (4) a feasible means to eliminate or materially reduce the hazard existed (see, e.g., A.H. Sturgill Roofing, Inc., 2019 O.S.H. Dec. (CCH) ¶ 33712, 2019 WL 1099857 (No. 13-0224, 2019)).

OSHA has relied on the General Duty Clause to cite employers for heat-related hazards for decades (see, e.g., Duriron Co., 11 BNA OSHC 1405, 1983 WL 23869 (No. 77-2847, 1983), aff'd, 750 F.2d 28 (6th Cir. 1984)). According to available OSHA enforcement data, between 1986 and 2023, Federal OSHA issued at least 348 hazardous heat-related citations under the General Duty Clause. Of these citations, 85 were issued between 1986-2000 (OSHA, 2024b). Citations were identified using multiple queries of OSHA enforcement data and then manually reviewed to ensure the inclusion of only citations due to heat exposure and no other exposures (e.g., burns or explosions). Several keywords were utilized to filter the data for inclusion (e.g., "heat," "heat stress," "heat illness," "WBGT") and exclusion (e.g., "explosion," "flash," "electrical burn," "fire"). Due to limitations of the data set on which OSHA relied, OSHA did not have access to violation text descriptions of citations issued before the mid-1980s and thus did not determine how many are related to heat exposure prior to this time period. Additionally, over half of the citations from 1986-1989 are missing violation text descriptions, which likely resulted in an undercount of heat-related citations.

OSHA has used its general inspection authority (29 U.S.C. 657) to target heat-related injuries and illnesses in various Regional Emphasis Programs (REPs). OSHA enforcement emphasis programs focus the agency's resources on particular hazards or

high-hazard industries (see Marshall v. Barlow's, Inc., 436 U.S. 307, 321 (1978) (affirming OSHA's use of an administrative plan containing specific neutral criteria to focus inspections)). OSHA's Region VI regional office, located in Dallas, TX, has a heat-related special REP (OSHA, 2019). This region covers Texas, New Mexico, Oklahoma, Arkansas, and Louisiana. OSHA's Region IX regional office, located in San Francisco, CA, also has a heat-related REP (OSHA, 2022). This region covers American Samoa, Arizona, California, Guam, Hawaii, Nevada, and the Northern Mariana Islands. These REPs allow field staff to conduct heat illness inspections of outdoor work activities on days when the high temperature is forecasted to be above 80°F.

On September 1, 2021, OSHA issued updated Inspection Guidance for Heat-Related Hazards, which established a new enforcement initiative to protect employees from heat-related injuries and illnesses while working in hazardous hot indoor and outdoor environments (OSHA, 2021). The guidance provided that days when the heat index exceeds 80°F would be considered heat priority days. It announced that enforcement efforts would be increased on heat priority days for a variety of indoor and outdoor industries, with the aim of identifying and mitigating potential hazards and preventing heat-illnesses before they occur.

In April 2022, OSHA launched a National Emphasis Program (NEP) to protect employees from heat-related hazards and resulting injuries and illnesses in outdoor and indoor workplaces. The NEP expanded the agency's ongoing heat-related injury and illness prevention initiatives and campaign by setting forth a targeted enforcement component and reiterating its compliance assistance and outreach efforts. The NEP targets specific industries expected to have the highest exposures to heat-related hazards and resulting illnesses and deaths. This approach is intended to encourage early interventions by employers to prevent illnesses and deaths among workers during high heat conditions (CPL 03-00-024). As of June 26, 2024, OSHA has conducted 5,038 Heat

NEP Federal inspections. More than 1,229 of these were initiated by complaints and 117 were due to the occurrence of a fatality or catastrophe. As a result of these inspections, OSHA issued 56 General Duty Clause citations and 736 Hazard Alert Letters (HALs). Inspections occurred across various industries (as identified by 2-digit NAICS codes) including construction, which had the highest number of inspections, as well as manufacturing, maritime, agriculture, transportation, warehousing, food services, waste management, and remediation services.

On July 27, 2023, OSHA issued a heat hazard alert to remind employers of their obligation to protect workers against heat injury and illness in outdoor and indoor workplaces. The alert highlights what employers can and should be doing to protect employees. It also serves to remind employees of their rights, including protections against retaliation. In addition, the alert highlights steps OSHA is currently taking to protect workers and directs employers, employees, and the public to OSHA resources, including guidance and fact sheets on heat.

OSHA's efforts to protect employees from hazardous heat conditions using the General Duty Clause, although important, have limitations leaving many workers vulnerable to heat-related hazards. For example, the Commission has struggled to determine exactly what conditions create a recognized heat hazard under the General Duty Clause, and has therefore suggested the necessity of a standard (see, A.H. Sturgill Roofing, Inc., 2019 OSHD (CCH) ¶ 33712, 2019 WL 1099857, at *2-5 and n.8 (No. 13-0224, 2019) ("The Secretary's failure to establish the existence of an excessive heat hazard here illustrates the difficulty in addressing this issue in the absence of an OSHA standard."); U.S. Postal Service, 2023 OSHD (CCH) ¶ 33908, 2023 WL 2263313, at *3 n.7 (Nos. 16-1713, 16-1872, 17-0023,17-0279, 2023) (noting Commissioner Laihow's opinion that "A myriad of factors, such as the geographical area where the work is being

performed and the nature of the tasks involved, can impact" whether excessive heat is present, and indicating that a standard is therefore necessary to define the hazard).

Under the General Duty Clause, OSHA cannot require abatement before proving in an enforcement proceeding that specific workplace conditions are hazardous; whereas a standard would establish the existence of the hazard at the rulemaking stage, thus allowing OSHA to identify and require specific abatement measures without having to prove the existence of a hazard in each case (see Sanderson Farms, Inc. v. Perez, 811 F.3d 730, 735 (5th Cir. 2016) ("Since OSHA is required to determine that there is a hazard before issuing a standard, the Secretary is not ordinarily required to prove the existence of a hazard each time a standard is enforced.")). Given OSHA's burden under the General Duty Clause, it is currently difficult for OSHA to ensure necessary abatement before employee lives and health are unnecessarily endangered. Further, under the General Duty Clause OSHA must largely rely on expert witness testimony to prove both the existence of a hazard and the availability of feasible abatement measures that will materially reduce or eliminate the hazard in each individual case (see, e.g., Industrial Glass, 15 BNA OSHC 1594, 1992 WL 88787, at *4-7 (No. 88-348, 1992)).

Moreover, as OSHA has noted in similar contexts, standards have the advantage of providing greater clarity to employers and employees of the measures required to protect employees and are developed with the benefit of information gathered in the notice and comment process (see 86 FR 32376, 32418 (Jun. 21, 2021) (COVID-19 Healthcare ETS); 56 FR 64004, 64007 (Dec. 6, 1991) (Bloodborne Pathogens Standard)).

OSHA currently has other existing standards that, while applicable to some issues related to hazardous heat, have not proven to be adequate in protecting workers from exposure to hazardous heat. For example, OSHA's Recordkeeping standard (29 CFR 1904.7) requires employers to record and report injuries and illnesses that meet recording criteria. Additionally, the agency's Sanitation standards (29 CFR 1910.141, 1915.88,

1917.127, 1926.51, and 1928.110) require employers to provide potable water readily accessible to workers. While these standards require that drinking water be made available in "sufficient amounts," they do not specify quantities, and employers are not required to encourage workers to frequently hydrate on hot days.

OSHA's Safety Training and Education standard (29 CFR 1926.21) requires employers in the construction industry to train employees in the recognition, avoidance, and prevention of unsafe conditions in their workplaces. OSHA's PPE standards (29 CFR 1910.132, 1915.152, 1917.95, and 1926.28) require employers to conduct a hazard assessment to determine the appropriate PPE to be used to protect employees from the hazards identified in the assessment. However, hazardous heat is not specifically identified as a hazard for which workers need training or PPE, complicating the application of these requirements to hazardous heat.

IV. Rulemaking Activities Leading to this Proposal.

OSHA has received multiple petitions to promulgate a heat injury and illness prevention standard, including in 2018 from Public Citizen, on behalf of approximately 130 organizations (Public Citizen et al., 2018). OSHA has also been urged by members of Congress to initiate rulemaking for a Federal heat standard, as well as by the Attorneys General of several States in 2023.

On October 27, 2021, OSHA published an advance notice of proposed rulemaking (ANPRM) for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings in the *Federal Register* (86 FR 59309) (referred to as "the ANPRM" hereafter). The ANPRM outlined key issues and challenges in occupational heat-related injury and illness prevention and aimed to collect evidence, data, and information critical to informing how OSHA proceeds in the rulemaking process. The ANPRM included background information on injuries, illnesses, and fatalities due to heat, underreporting, scope, geographic region, and inequality in exposures and outcomes. The ANPRM also

covered existing heat injury and illness prevention efforts, including OSHA's efforts, the NIOSH criteria documents, State standards, and other standards. The initial public comment period was extended and closed on January 26, 2022. In response to the ANPRM, OSHA received 965 unique comments. The comments covered several topics, including the scope of a standard, heat stress thresholds for workers across various industries, heat acclimatization planning, and heat exposure monitoring, as well as the nature, types, and effectiveness of controls that may be required as part of a standard.

Following the publication of the ANPRM, OSHA presented topics from the ANPRM and updates on the heat rulemaking to several stakeholders, including several trade associations, the Office of Advocacy of the Small Business Administration's (SBA's Office of Advocacy) Labor Safety Roundtable (November 19, 2021), and NIOSH National Occupational Research Agenda (NORA) councils, including the Construction Sector Council (November 17, 2021), Landscaping Safety Workgroup (January 12, 2022), and Oil and Gas Extraction Sector (April 7, 2022).

On May 3, 2022, OSHA held a virtual public stakeholder meeting on the agency's "Initiatives to Protect Workers from Heat-Related Hazards." A total of over 1,300 people attended the virtual meeting, and the recorded video has been viewed over 3,500 times (see *www.youtube.com/watch?v=Ud29WsnsOw8*) as of June 2024. The six-hour meeting provided stakeholders an opportunity to learn about and comment on efforts OSHA is taking to protect workers from heat-related hazards and ways the public can participate in the agency's rulemaking process.

OSHA also established a Heat Injury and Illness Prevention Work Group of the National Advisory Committee on Occupational Safety and Health (NACOSH) to support the agency's rulemaking and outreach efforts. The Work Group was tasked with reviewing and developing recommendations on OSHA's heat illness prevention guidance materials, evaluating stakeholder input, and developing recommendations on potential

elements of any proposed heat injury and illness prevention standard. On May 31, 2023, the Work Group presented its recommendations on potential elements of a proposed heat injury and illness prevention standard for consideration by the full NACOSH committee. The Work Group recommended that any proposed heat injury and illness prevention standard include: a written exposure control plan/heat illness prevention plan; training; environmental monitoring; workplace control measures; acclimatization; worker participation; and emergency response (Document ID OSHA-2023-0003-0007). After deliberations, NACOSH amended the report to ask OSHA to include a model written plan and then submitted its recommendations to the Secretary of Labor (Document ID OSHA-2023-0003-0012).

As an initial rulemaking step, OSHA convened a Small Business Advocacy Review Panel (SBAR Panel) on August 25, 2023, in accordance with the Regulatory Flexibility Act (RFA) (5 U.S.C. 601 et seq.), as amended by the Small Business Regulatory Enforcement Act (SBREFA) of 1996. This SBAR Panel consisted of members from OSHA, SBA's Office of Advocacy, and the Office of Information and Regulatory Affairs (OIRA) in the White House Office of Management and Budget (OMB). The SBAR Panel identifies individual representatives of affected small entities, termed small entity representatives (SERs), which includes small businesses, small local government entities, and non-profits. This process enabled OSHA, with the assistance of SBA's Office of Advocacy and OIRA, to obtain advice and recommendations from SERs about the potential impacts of the regulatory options outlined in the regulatory framework and about additional options or alternatives to the regulatory framework that may alleviate those impacts while still meeting the objectives and requirements of the OSH Act.

The SBAR Panel hosted six online meetings on September 9, 12, 13, 14, 18, and 19, 2023, with participation from a total of 82 SERs from a wide range of industries. A

final report containing the findings, advice, and recommendations of the SBAR Panel was submitted to the Assistant Secretary of Labor for Occupational Safety and Health on November 3, 2023, to help inform the agency's decision making with respect to this rulemaking (Document ID OSHA-2021-0009-1059).

In accordance with 29 CFR parts 1911 and 1912, OSHA presented to the Advisory Committee on Construction Safety and Health (ACCSH) on its framework for a proposed rule for heat injury and illness prevention in outdoor and indoor work settings on April 24, 2024. The Committee then passed unanimously a motion recommending that OSHA proceed expeditiously with proposing a standard on heat injury and illness prevention. The Committee also recommended that OSHA consider the feedback and questions discussed by Committee members during the meeting in formulating the proposed rule (see the minutes from the meeting, Docket No. 2024-0002). OSHA has considered the Committee's feedback in the development of this proposal.

In accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 65 FR 67249 (Nov. 6, 2000), OSHA held a listening session with Tribal representatives regarding this Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings rulemaking on May 15, 2024. OSHA provided an overview of the rulemaking effort and sought comment on what, if any, tribal implications would result from the rulemaking. A summary of the meeting and list of attendees can be viewed in the docket (DOL, 2024a).

D. Other Standards.

Various other organizations have also either identified the need for standards to prevent occupational heat-related injury and illness or published their own standards. In 2024, the American National Standards Institute/American Society of Safety Professionals A10 Committee (ANSI/ASSP) published a consensus standard on heat stress management in construction and demolition operations. The International

Organization for Standardization (ISO) also has a standard for evaluating heat stress: ISO 7243: Ergonomics of the thermal environments – Assessment of heat stress using the WBGT (wet bulb globe temperature) index (ISO, 2017). ISO 7243 uses WBGT values, along with metabolic rate, to assess hot environments, similar to ACGIH and NIOSH recommendations. Additional ISO standards address predicting sweat rate and core temperature (ISO 7933), and determining metabolic rate (ISO 8996), physiological strain (ISO 9886), and thermal characteristics for clothing (ISO 9920). In 2021, the American Society for Testing and Materials (ASTM) finalized its Standard Guide for Managing Heat Stress and Heat Strain in Foundries (E3279-21) which establishes "best practices for recognizing and managing occupational heat stress and heat strain in foundry environments." The standard outlines employer responsibilities and recommends elements for a "Heat Stress and Heat Strain Management Program" (ASTM, 2021).

ACGIH has identified TLVs for heat stress (ACGIH, 2023). The TLVs utilize WBGT and take into consideration metabolic rate or workload categories. Additionally, ACGIH provides clothing adjustment factors which are added to the measured WBGT for certain types of work clothing to account for the impaired thermal regulation.

The U.S. Armed Forces has developed extensive heat-related illness prevention and management strategies. The Warrior Heat and Exertion Related Events Collaborative is a tri-service group of military leaders focused on clinical, educational, and research efforts related to exercise and exertional heat-related illnesses and medical emergencies (HPRC, 2023). The U.S. Army has a Heat Center at Fort Benning which focuses on management, research, and prevention of heat-related illness and death (Galer, 2019). In 2023, the U.S. Army updated its Training and Doctrine Command (TRADOC) Regulation 350-29 addressing heat and cold casualties. The regulation includes requirements for rest and water consumption according to specific WBGT levels and work intensity (Department of the Army, 2023). The U.S. Navy has developed

Physiological Heat Exposure Limit curves that are based on metabolic and environmental heat loads and represent the maximum allowable heat exposure limits, which were most recently updated in 2023. The Navy monitors WBGT and has guidelines based on these measurements, with physical training diminishing as WBGTs increase and all nonessential outdoor activity stopped when WBGTs exceed 90 °F (Department of the Navy, 2023). The U.S. Marine Corps follows the Navy's guidelines for implementation of the Marine Corps Heat Injury Prevention Program (Commandant of the Marine Corps, 2002). In 2022, the U.S. Army and U.S. Air Force issued an update to their technical heat stress bulletin, which outlines measures to prevent indoor and outdoor heat-related illness in soldiers. The bulletin includes recommended acclimatization planning, work-rest cycles, fluid and electrolyte replacement, and limitations on work based on WBGT (Department of the Army, 2022).

As of April 2024, five States have promulgated heat standards requiring employers in various industries and workplace settings to implement protections to reduce the risk of heat-related injuries and illnesses for their employees: California, Minnesota, Oregon, Washington, and Colorado. In addition, Maryland and California are currently engaged in rulemaking. State standards differ in the scope of coverage (see tables III-1 and 2). For example, Minnesota's standard covers only indoor workplaces. California and Washington standards cover only outdoor workplaces, although California’s proposal would include coverage of indoor workplaces. Oregon's rule covers both indoor and outdoor workplaces. State rules also differ in the methods used for triggering protections against hazardous heat. Minnesota's standard considers the type of work being performed (light, moderate, or heavy) and provides WBGT trigger levels based on the type of work activity. California's heat-illness prevention protections go into effect at an ambient temperature of 80 °F. Washington's rule also relies on ambient

temperature readings combined with considerations for the breathability of workers' clothing. Oregon's rule uses a heat index 80 °F as a trigger.

California, Washington, Colorado, and Oregon all have additional protections that are triggered by high heat. However, they differ as to the trigger for these additional protections. In California, high heat protections are triggered at an ambient temperature reading of 95 °F (and only apply in certain industries). In Washington, high heat protections are triggered at an ambient temperature reading of 90 °F. In Colorado, additional protections are triggered at an ambient temperature reading of 95 °F or by other factors such as unhealthy air quality, length of workday, heaviness of clothing or gear, and acclimatization status. These additional protections only apply to the agricultural industry. Finally, in Oregon, high heat protections are triggered at a heat index of 90 °F.

All the State standards require training for employees and supervisors. All the State standards, except for Minnesota, require employers to provide at least one quart of water per hour for each employee, require some form of emergency response plan, include provisions related to acclimatization for workers, and require access to shaded break areas. Washington and Oregon require that employers provide training in a language that the workers understand. Similarly, California's standard requires that employers create a written heat-illness prevention plan in English as well as in whatever other language is understood by the majority of workers at a given workplace. California also requires close monitoring of new employees for the first fourteen days and monitoring of all employees during a heat wave. Table III-1 below provides an overview of the provisions included in the existing and proposed State standards on heat injury and illness prevention. Table III-2 provides an overview of the additional provisions required when the high heat trigger is met or exceeded.

Table III-1 Initial heat triggers and provisions in State heat standards

			General							
		Threshold	Provision of water	Shade or cool-down means	Rest breaks if needed	Emergency response	Acclimatization	Training	Heat Illness Prevention Plan	Observation /supervision
California	Outdoor	80°F (Ambient)[1]	•	•	•	•	•	•	•	
Washington	Outdoor	80°F (Ambient), All other clothing; 52°F, Non-breathable clothes	•	•	•	•	•	•	• (accident prevention)	
Colorado	Agriculture	80°F (Ambient)	•	•	•	•	•	•		•
California (proposal)	Indoor	82°F (Ambient)	•	•	•	•	•	•	•	
Maryland (proposal)	Indoor & Outdoor	80°F (Heat Index)	•	•		•	•	•	•	
Minnesota[2]	Indoor	86°F (WBGT), Light work; 80°F, Moderate work; 77°F, Heavy work						•		
Oregon	Indoor & Outdoor	80°F (Heat Index)	•	•		•	•	•	•	

[1] Some provisions, including water, emergency response, training, and heat illness prevention plan, apply to covered employers regardless of the temperature threshold.

[2] Minnesota uses a 2-hour time-weighted average permissible exposure limit rather than a trigger.

Table III-2 High heat triggers and additional provisions in State heat standards

		Additional High Heat Provisions				
		Threshold	Work-rest schedule	Observation/supervision	Pre-shift meetings	Assessment and control measures[1]
California	Outdoor[2]	95°F (Ambient)	• (only agriculture)	•	•	
Washington	Outdoor	90°F (Ambient)	•	•		
Colorado	Agriculture	95°F (Ambient) or other conditions[3]	•	covered in general provisions above	•	
California (proposal)	Indoor	87°F (Ambient or Heat Index) or other conditions[4]				•
Maryland (proposal)	Indoor & Outdoor	90°F (Heat Index)	•	•		
Oregon	Indoor & Outdoor	90°F (Heat Index)	•	•		

[1] Assessment and control measures include measuring temperature and heat index, identifying and evaluating all other environmental risk factors for heat illness, and using specified control measures to minimize the risk of heat illness.

[2] High heat procedures apply in agriculture; construction; landscaping; oil and gas extraction; transportation or delivery of agricultural products, construction materials or other heavy materials, except for employment that consists of operating an air-conditioned vehicle and does not include loading or unloading.

[3] Other conditions include unhealthy air quality, shifts over 12 hours, heavy clothing or gear required, or the employee is new or returning from absence.

[4] Other conditions include wearing clothing that restricts heat removal, or working in a high radiant heat area, when the ambient temperature is at or above 82°F.

IV. Health Effects

A. Introduction.

I. Health Effects of Occupational Heat Exposure.

Exposure to workplace heat can be seriously detrimental to workers' health and safety and, in some cases, can be fatal. Workplace heat contributes to heat stress, which is a person's total heat load (NIOSH, 2016) from the following sources combined: 1) heat from the environment, including heat generated by equipment or machinery; 2) metabolic heat generated through body movement, which is proportional to one's relative level of exertion (Sawka et al., 1993; Astrand 1960); and 3) heat retained due to clothing or personal protective equipment (PPE), which is highly dependent on the breathability of the clothing and PPE worn (Bernard et al., 2017). Heat is routinely an occupation-specific risk because, for example, workers may experience greater heat stress than non-workers, particularly when they are required to work through shifts with prolonged heat exposure, complete tasks that require physical exertion, and/or their employers do not take adequate steps to protect them from exposure to hazardous heat. In addition, many work operations require the use of PPE. PPE can increase heat stress and can reduce workers' heat tolerance by decreasing the body's ability to cool down. Workers may also face pressure, or incentivization through pay structures (e.g., piece-rate, bonuses), to work through hazardous heat. Pressure to produce results and be seen as a good worker can have a direct impact on worker self-care choices that impact health (Wadsworth et al., 2019). Pay structures and production quotas intended to motivate workers may also compromise worker safety (Iglesias-Rios et al., 2023). These pressures can increase their risk of heat-related injury and illness (Billikopf and Norton, 1992; Johansson et al., 2010; Spector et al., 2015; Pan et al., 2021). The body's response to heat stress is called heat strain (NIOSH, 2016). As the heat stress a person experiences increases, the body attempts to cool itself by releasing heat into the surrounding environment. If the body begins to

acquire heat faster than it can release it, the body will store heat. As stored heat accumulates, the body can show signs of excessive heat strain, such as increased core temperature and heart rate, as well as symptoms of heat strain, such as sweating, dizziness, or nausea.

Two large meta-analyses (n=2,409 and n=11,582)[1] have confirmed that occupational heat exposure is associated with both signs and symptoms of heat strain (Ioannou et al., 2022; Flouris et al., 2018). In one, the authors found a high prevalence of heat strain (35%) among workers in hot conditions, defined by the authors as WBGT greater than 26°C (78.8°F); they also found that workers in hot conditions were four times more likely to experience signs and symptoms of heat strain than workers in more moderate conditions (Flouris et al., 2018).

II. Literature Review for Health Effects Section.

OSHA conducted a non-systematic review of the medical and scientific literature to identify evidence on the relationship between heat exposure and illnesses and death. OSHA's literature review focused on meta-analyses, systematic reviews, and studies cited in NIOSH's *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments*, published in 2016. OSHA separately searched for additional meta-analyses and systematic reviews that were not cited in the NIOSH Criteria document, including those that were published after the document was released (i.e., 2016 and on).

OSHA also reviewed sentinel epidemiological evidence including observational, experimental, and randomized controlled studies. OSHA primarily reviewed epidemiological studies focusing on worker populations, athletes, and military members,

[1] In the Health Effects section, OSHA refers to statistics that were reported by authors when describing results from their research studies. These include the sample size (n), the odds ratio (OR), the confidence interval (CI), and the p-value (p). These statistics provide information about effect size, error, and statistical significance.

but also included studies in non-worker populations where appropriate. For example, when there was limited occupation-specific research or data for some heat-related health effects, OSHA sometimes considered general population studies as they relate to understanding physiological mechanisms of heat-related illness, severity of an illness, and prognosis. In addition to the evidence of heat-related illnesses and deaths, OSHA reviewed a large body of evidence that evaluated the association of occupational heat exposure with workplace injuries such as falls, collisions, and other accidents. OSHA also reviewed evidence regarding individual factors such as age, medication use, and certain medical conditions that may affect one's risk for heat-related health effects.

III. Summary.

The best available evidence in the scientific and medical literature, as summarized in this Health Effects section, demonstrates that occupational heat exposure can result in death; illnesses, including heat stroke, heat exhaustion, heat syncope, rhabdomyolysis, heat cramps, hyponatremia, heat edema, and heat rash; and heat-related injuries, including falls, collisions, and other workplace accidents.

B. General Mechanisms of Heat-Related Health Effects.

This section briefly describes the mechanisms of heat-related health effects, i.e., how the body's physiological responses to heat exposure can lead to the heat-related health effects identified in OSHA's literature review. More detailed information about the mechanisms underpinning each specific heat-related health effect is described in the relevant subsections that follow.

As explained above, occupational heat exposure contributes to heat stress. The resulting bodily responses are collectively referred to as heat strain (Cramer and Jay, 2016). The bodily responses included in heat strain serve to decrease stored heat by increasing heat loss to the environment to maintain a stable body temperature (NIOSH, 2016). When the brain recognizes that the body is storing heat, it activates the autonomic

nervous system to initiate cooling (Kellogg et al., 1995; Wyss et al., 1974). Blood is shunted towards the skin and vasodilation begins, meaning that the blood vessels near the skin's surface become wider, thereby increasing blood flow near the surface of the skin (Kamijo et al., 2005; Hough and Ballantyne, 1899). The autonomic nervous system also triggers the body's sweat response, in which sweat glands release water to wet the skin (Roddie et al., 1957; Grant and Holling, 1938). These processes allow the body to cool in four ways: 1) radiation, i.e., when heat is released directly into the surrounding air; 2) convection, i.e., when there is air movement that moves heat away from the body; 3) evaporation, i.e., when sweat on the skin diffuses into surrounding air (as clothing/PPE permits) and 4) conduction, i.e., when heat is directly transferred through contact with a cooler surface (e.g., wearing an ice-containing vest (Cramer and Jay, 2016; Leon and Kenefick, 2012)).

Importantly, the extent of heat release through radiation, convection, and evaporation depends on environmental conditions such as the speed of air flow, temperature, and relative humidity (Clifford et al., 1959; Brebner et al., 1958). For example, when relative humidity is high, sweat is less likely to evaporate off the skin, which significantly reduces the cooling effect of evaporation. Additionally, when sweat remains on the skin and irritates the sweat glands, it can cause a condition known as heat rash, whereby itchy red clusters of pimples or blisters develop on the skin (DiBeneditto and Worobec, 1985; Sulzberger and Griffin, 1968).

While the purpose of the sweat response is to cool the body, in doing so, it can deplete the body's stores of water and electrolytes (e.g., sodium [Na], potassium [K], chloride [Cl], calcium [Ca], and magnesium [Mg]) that are essential for normal bodily function (Shirreffs and Maughan, 1997). The condition resulting from abnormally low sodium levels is known as hyponatremia. When stores of electrolytes are depleted, painful muscle spasms known as heat cramps can occur (Kamijo and Nose, 2006).

Additionally, depletion of the body's stored water causes dehydration, which is known to reduce the body's circulating blood volume (Trangmar and Gonzalez-Alonso, 2017; Dill and Costill, 1974).

During vasodilation that happens as the body attempts to cool, blood can pool in areas of the body that are most subject to gravity, and fluid can seep from blood vessels causing noticeable swelling under the skin (known as heat edema). Upright standing would further encourage blood to pool in the legs, and thus, the heart has an even lower blood volume available for circulation (Smit et al., 1999). A large reduction in circulating blood volume will lead to 1) a continued rise in core body temperature, and 2) reduced blood flow to the brain, muscles, and organs. A rise in core body temperature and reduced blood flow to the brain can cause neurological disturbances, such as loss of consciousness, which are characteristic of heat stroke and heat syncope (Wilson et al., 2006; Van Lieshout et al., 2003). A rise in core body temperature and reduced blood flow to muscles can also cause extreme muscle fatigue (to the point of collapse) and muscle cell damage during exertion, which are characteristic of heat exhaustion and rhabdomyolysis, respectively (Torres et al., 2015; Nybo et al., 2014). Finally, a rise in core body temperature and reduced blood flow to organs can damage multiple vital organs (such as the heart, liver, and kidneys), which is often observed in heat stroke (Crandall et al., 2008; O'Donnell and Clowes, 1972). Heat stroke and rhabdomyolysis can lead to death if not treated properly and promptly.

C. Identifying Cases of Heat-Related Health Effects.

In its review of the scientific and medical literature on the health effects of occupational heat exposure, OSHA found several studies that relied upon coding systems, in which medical providers or other public health professionals identify fatalities and non-fatal cases of various illnesses and injuries, including heat-related illnesses and injuries (HRIs). The medical and scientific communities use data from these coding

systems to study the incidence and prevalence of illnesses and injuries, including HRIs. In both this Health Effects section and Section V., Risk Assessment, OSHA relied on several studies that make use of data from these coding systems. A brief summary of each of the major coding systems is provided below.

I. International Statistical Classification of Diseases and Related Health Problems (ICD) Codes.

The International Statistical Classification of Diseases and Related Health Problems (ICD) System is under the purview of the World Health Organization (WHO), an international agency that, as the leading authority on health and disease, regularly publishes evidence-based guidelines to advance clinical practice and public health policy. The ICD System harmonizes the diagnosis of disease across many countries, and ICD codes are used routinely in the U.S. healthcare system by medical personnel to record diagnoses in patients' medical records, as well as to identify cause of death. These codes are utilized as part of a standardized system for recording diagnoses, as well as organizing and collecting data into public health surveillance systems. Each ICD code is a series of letters and/or numbers that corresponds to a highly specific medical diagnosis. Healthcare providers may record multiple ICD codes if an individual presents with multiple diagnoses. The ICD system has multiple codes that medical personnel can use when diagnosing HRIs.

The ICD system was first developed in the 18th century and was adopted under the purview of the World Health Organization (WHO) in 1948 (Hirsch et al., 2016). Since then, the ICD system has been revised 11 times—ICD-11 was released in 2022. However, because the ICD-11 system has not yet been implemented in the United States, many of the epidemiological studies cited throughout this Health Effects section used the ICD-9 and ICD-10 systems to survey heat-related deaths and HRIs. Table IV-1 provides a list of heat-related ICD-9 and ICD-10 codes.

Table IV-1 ICD-9 and ICD-10 Codes for Heat-Related Health Effects*

ICD-9 Code	ICD-10 Code Equivalent
992 *Effects of heat and light*	T67 *Effects of heat and light*
992.0 *Heatstroke and sunstroke*	T67.0 *Heatstroke and sunstroke*
992.1 *Heat syncope*	T67.1 *Heat syncope*
992.2 *Heat cramps*	T67.2 *Heat cramp*
992.3 *Heat exhaustion, anhydrotic*	T67.3 *Heat exhaustion, anhydrotic*
992.4 *Heat exhaustion due to salt depletion*	T67.4 *Heat exhaustion due to salt depletion*
992.5 *Heat exhaustion, unspecified*	T67.5 *Heat exhaustion, unspecified*
992.6 *Heat fatigue, transient*	T67.6 *Heat fatigue, transient*
992.7 *Heat edema*	T67.7 *Heat edema*
992.8 *Other effects of heat and light*	T67.8 *Other effects of heat and light*
992.9 *Effects of heat and light, unspecified*	T67.9 *Effects of heat and light, unspecified*
E900 *Accident caused by excessive heat*	NA
E900.0 *Accident caused by excessive heat due to weather conditions*	X30 *Exposure to excessive natural heat*
E900.1 *Accidents due to excessive heat of man-made origin*	W92 *Exposure to excessive heat of man-made origin*
E900.9 *Accidents due to excessive heat of unspecified origin*	X30 *Exposure to excessive natural heat*

Note: The above heat-related codes exclude X32 *Exposure to sunlight* and W89 *Exposure to man-made radiation*, among others.
*These ICD codes are specific to heat as indicated by the names of the codes. There are additional codes that can be associated with diagnosed heat illness but may not be specific to heat-related illness which are not included here but may be included in text where relevant (e.g., *M62.82* for rhabdomyolysis and E87.1 for hypo-osmolality and hyponatremia).

Various surveillance systems exist to track documentation of ICD codes. For example, the CDC leverages ICD-10 codes to collect nearly real-time data on heat-related deaths and HRIs through the National Syndromic Surveillance System (NSSP). The CDC also uses ICD-10 codes to collect annual data on heat-related deaths and HRIs, then reports these data via the National Vital Statistics System (NVSS) and National Center for Health Statistics (NCHS). Additionally, all branches of the U.S. Armed Forces (i.e., Army, Navy, Air Force, and Marine Corps) use ICD-10 codes to document HRIs among service members in the Defense Medical Surveillance System (DMSS). The US Army also uses ICD-10 codes to document HRIs in the Total Army Injury and Health Outcomes Database (TAIHOD) (Bell et al., 2004).

II. Occupational Illness and Injury Classification System (OIICS) Codes.

The U.S. Bureau of Labor Statistics (BLS) is a Federal agency, housed in the Department of Labor, that collects and analyzes data on the U.S. economy and workforce. In 1992, BLS developed the Occupational Illness and Injury Classification System (OIICS) to harmonize reporting of injuries and illnesses that affect U.S. workers. The OIICS is similar to the ICD system. Each OIICS code is a series of numbers that specifies a diagnosis (referred to as the nature of an illness or injury, or a "nature code") and event(s) leading to an illness or injury (referred to as an "event code"). OIICS was updated in 2010 (Version 2.0), and again in 2022 (Version 3.0); Version 3.0 is the most up to date version (*https://www.bls.gov/iif/definitions/occupational-injuries-and-illnesses-classification-manual.htm;* BLS, 2023e). The OIICS system has multiple codes that can be used when identifying occupational HRIs. Table IV-2 provides a list of heat-related OIICS codes (nature and event codes).

Table IV-2 OIICS Codes (Version 3.0) for Heat-Related Health Effects †

Nature Codes
172 *Effects of heat and light*
1720 *Effects of heat – unspecified*
1721 *Heat stroke, syncope*
1722 *Heat exhaustion, fatigue*
1729 *Effects of heat – not elsewhere classified*
2893 *Prickly heat, heat rash, and other disorders of the sweat glands including "miliaria rubra"*
Event Codes
53 *Exposure to temperature extremes*
530 *Exposure to temperature extremes – unspecified*
531 *Exposure to environmental heat*
5310 *Exposure to environmental heat – unspecified*
5311 *Exposure to environmental heat – indoor*
5312 *Exposure to environmental heat – outdoor*

† Some of the data OSHA relies on uses older versions of OIICS codes (Versions 1 and 2) but the major categories for heat-related incidents did not change significantly between versions.

Through a combination of survey staff and a specialized automated coding system, BLS applies OIICS codes to data collected through their worker safety and health surveillance systems, the Census of Fatal Occupational Injuries (CFOI) and the Survey of

Occupational Injuries and Illnesses (SOII), to identify and document occupational heat-related deaths and occupational HRIs, respectively. Researchers have also relied on this system for identifying occupational HRIs (e.g., Spector et al., 2016). However, BLS data does not currently specify discrete codes for all HRIs described in this health effects section. The CFOI is a cooperative program between the Federal Government and the States that relies on various administrative records, including death certificates, to accurately produce counts of fatal work injuries (BLS, 2012). The CFOI examines all cases marked "At work" on the death certificate, and the CFOI database relies on the death certificate (among other sources) to ascertain the cause(s) of death. Further details about BLS reporting using OIICS codes, as well as rates of HRIs, can be found in Section V., Risk Assessment.

III. Limitations.

A limitation to relying on these coding systems to identify heat-related fatalities and HRIs is underreporting. Numerous studies have found that HRIs are likely vastly underreported (see Section V., Risk Assessment). Reasons for the likely underreporting include underreporting of illness and injuries by workers to their employers (Kyung et al., 2023), underreporting of injuries and illnesses by employers to BLS and OSHA (Wuellner and Phipps, 2018; Fagan and Hodgson, 2017), underutilization of workers' compensation insurance (Fan et al., 2006; Bonauto et al., 2010), influence of structural factors and work culture on workers perceptions about seeking help (Wadsworth et al., 2019; Iglesias-Rios, 2023), and difficulties with determining heat-related causes of death (e.g., Luber et al., 2006; Pradhan et al., 2019). As a result, there are likely many heat-related fatalities and cases of HRIs that are not captured in these coding systems. For a more detailed discussion of underreporting, see Section V., Risk Assessment.

IV. Summary.

As demonstrated by these coding systems, in which medical providers or other public health professionals assign one or more codes to identify a heat-related fatality or HRI, it is well accepted in the medical and scientific communities that heat exposure, including occupational heat exposure, can result in death and HRIs. Indeed, in its review of the best available scientific and medical literature on the health effects of occupational heat exposure, OSHA identified several studies that relied upon data from these coding systems to determine the incidence or prevalence of heat-related deaths and HRIs in workers. OSHA relies on these studies in both this Health Effects section and Section V., Risk Assessment, of this preamble to the proposed rule.

D. Heat-Related Deaths.

I. Introduction.

Heat is the deadliest weather phenomenon in the United States (NWS, 2022). Heat as a cause of death is widely recognized in the medical and scientific communities. Studies investigating relationships between heat and mortality have long demonstrated positive associations between heat exposure and increased all-cause mortality (e.g., Weinberger et al., 2020; Basu and Samet, 2002; Whitman et al., 1997). As explained below, the connection between heat exposure, the body's physiological responses, and death (i.e., heat-related death mechanisms) is clearly established. Exposure to occupational heat can be fatal. According to BLS's CFOI, occupational heat exposure has killed 1,042 U.S. workers between 1992-2022 (BLS, 2024c).

II. Physiological Mechanisms.

Death caused by exposure to heat can occur in occupational settings if the worker's body is not able to adequately cool in response to heat exposure or if treatment for symptoms of heat-related illness is not provided promptly. Nearly all body systems can be negatively affected by heat exposure. Mora et al. (2017) systematically reviewed mechanistic studies on heat-related deaths and identified five harmful physiological

mechanisms triggered by heat exposure that can lead to death: ischemia (inadequate blood flow), heat cytotoxicity (damage to and breakdown of cells), inflammatory response (inflammation that disrupts cell and organ function), disseminated intravascular coagulation (widespread dysfunction of blood clotting mechanisms), and rhabdomyolysis (breakdown of muscle tissue). These mechanisms, with the exception of rhabdomyolysis, are associated with the development of heat stroke. Rhabdomyolysis, which is a potentially fatal illness resulting from the breakdown of muscle tissue, can also occur in conjunction with or in the absence of heat stroke. For a more detailed discussion on rhabdomyolysis, see Section IV.H., Rhabdomyolysis. Mora et al. (2017) also identified seven vital organs that can be critically impacted by heat exposure—the brain, heart, kidneys, lungs, pancreas, intestines, and liver. Across the five identified mechanisms and seven vital organs, Mora et al. (2017) found medical evidence for twenty-seven pathways whereby physiological mechanisms triggered by heat exposure could lead to organ failure and fatality.

The most common cause of heat-related occupational deaths is heat stroke. Heat stroke is a potentially fatal dysregulation of multiple physiological processes and organ systems resulting in widespread organ damage. Heat stroke is typically marked by significant elevation in core body temperature and cognitive impairment due to central nervous system damage. The physiological mechanisms involved in the development and progression of heat stroke are discussed in more detail in Section IV.E., Heat Stroke.

III. Determining Heat as a Cause of Death.

The identification of deaths caused by heat exposure can take place in a few different ways. Healthcare professionals may identify heat-related deaths in medical settings. For example, a heat-related death may be identified if an individual experiencing heat stroke presents to an emergency room and then later dies. The heat-related nature of the death should be documented by the healthcare professional in the chief complaint

field during medical history taking and selection of relevant ICD diagnosis codes. The ICD system allows for identification of heat as either an underlying cause of death or a significant contributing condition. The ICD-10 instruction manual defines underlying cause as "(a) the disease or injury which initiated the train of morbid events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury" (WHO, 2016, p. 31). A significant contributing condition is defined as a condition that "contributed to the fatal outcome, but was not related to the disease or condition directly causing death" (WHO, 2004, p. 24).

Medical examiners or coroners can also identify heat as a cause of death or significant condition contributing to death during death investigations, which should be noted on the deceased individual's death certificate. The National Association of Medical Examiners (NAME), a professional organization for medical examiners, forensic pathologists, and medicolegal affiliates and administrators, defines "heat-related death" as "a death in which exposure to high ambient temperature either caused the death or significantly contributed to it" (Donoghue et al., 1997). This definition was developed in an effort to standardize the way in which heat-related deaths were identified and documented on death certificates. According to the NAME definition, cause is ascertained based on circumstances of the death, investigative reports of high environmental temperature (e.g., a known heat wave), or a pre-death temperature ≥105°F. Cause is also indicated in cases where the person may have a lower body temperature due to attempted cooling measures, but where the individual had a history of mental status changes and specific toxicological findings of elevated muscle and liver enzymes. Heat may be designated as a "significant contributing condition" if: 1) "antemortem body temperature cannot be established but the environmental temperature at the time of collapse was high"; and/or 2) heat stress exacerbated a pre-existing disease, in which case heat and the pre-existing disease would be listed as the cause and significant contributing

condition, respectively, or vice versa. Importantly, Donoghue et al. note "The diagnosis of heat-related death is based principally on investigative information; autopsy findings are nonspecific." (Donoghue et al., 1997). While this definition is the official definition of this professional organization, other definitions or processes for determining whether or not a death is heat-related may be used.

Additionally, there are processes in place to identify and document deaths that are work-related. Death certificates include a field that can be checked for "injury at work" (Russell and Conroy, 1991). Further, work-related fatalities due to heat are identified and documented through the CFOI (for more details, see Section IV.C., Overview of ICD and OIICS Codes for Heat-Related Health Effects).

IV. Occupational Heat-Related Deaths.

Occupational heat exposure has led to worker fatalities in both indoor and outdoor work settings and across a variety of industries, occupations, and job tasks (Petitti et al., 2013; Arbury et al., 2014; Gubernot et al., 2015; NIOSH, 2016; Harduar Morano and Watkins, 2017). BLS's CFOI identified 1,042 U.S. worker deaths due to heat exposure between 1992 and 2022, with an average of 34 fatalities per year during that period (BLS, 2024c). Between 2011 and 2022, BLS reports 479 worker deaths (BLS, 2024c). During the latest three years for which BLS reports data (2020-2022), there was an average of 45 work-related deaths due to exposure to environmental heat per year (BLS, 2024c). However, for the reasons explained in Section V., Risk Assessment, these statistics likely do not capture the true magnitude and prevalence of heat-related fatalities because of underreporting.

There are numerous case studies documenting the circumstances under which occupational heat exposure led to death among workers. For example, in three NIOSH Fatality Assessment and Control Evaluations (FACE) investigations of worker fatalities, workers died of heat stroke after not receiving prompt treatment upon symptom onset

(NIOSH, 2004; NIOSH, 2007; NIOSH, 2015). Another case report of a farmworker who died due to heat stroke indicates that confusion the worker experienced as a result of heat exposure may have played a role in his ability to seek help (Luginbuhl et al., 2008). Additional case reports show workers have collapsed and later died while working alone, such as in mail delivery (Shaikh, 2023), and that worker distress has been interpreted as drug use as opposed to symptoms of heat illness (Alsharif, 2023).

V. Summary.

OSHA's review of the scientific and medical literature indicates that occupational heat exposure can and does cause death. The physiological mechanisms by which heat exposure can result in death are clearly established in the literature, and heat exposure being a cause of death is widely recognized in the medical and scientific communities. Indeed, occupational surveillance data demonstrates that numerous work-related deaths from occupational heat exposure occur every year.

E. Heat Stroke.

I. Introduction.

Among HRIs, the most serious and deadly illness from occupational heat exposure is heat stroke. NIOSH (2016) defines heat stroke as "an acute medical emergency caused by exposure to heat from an excessive rise in body temperature [above 41.1°C (106°F)] and failure of the [body's] temperature-regulating mechanism." When this happens, an individual's central nervous system is affected, which can result in a sudden and sustained loss of consciousness preceded by symptoms including vertigo, nausea, headache, cerebral dysfunction, bizarre behavior, and excessive body temperature (NIOSH 2016).

Because progression of symptoms varies and involves central nervous system function, it may be difficult for individuals, or those they are with, to know when they are experiencing serious heat illness or to understand that they need urgent medical care

(Alsharif, 2023). If not treated promptly, early symptoms of heat stroke may progress to seizures, coma, and death (Bouchama et al., 2022). Thus, heat stroke is often referred to as a life-threatening form of hyperthermia (i.e., elevated core body temperature) because it can cause damage to multiple organs such as the liver and kidneys. Of note, the term "stroke" in "heat stroke" is a misnomer in that it does not involve a blockage or hemorrhage of blood flow to the brain.

There are two types of heat stroke: classic heat stroke (CHS) and exertional heat stroke (EHS). CHS can occur without any activity or physical exertion, whereas EHS occurs as a result of physical activity. CHS typically occurs in environmental conditions where ambient temperature and humidity are high and is most often reported during heat waves (Bouchama et al., 2022). It is most likely to affect young children and the elderly (Laitano et al., 2019). Studies have found that EHS can occur with any amount of physical exertion, even within the first 60 minutes of exertion (Epstein and Yanovich, 2019; Garcia et al., 2022). Additionally, EHS can occur in healthy individuals who would otherwise be considered low risk performing physical activity, regardless of hot or cool environmental conditions (Periard et al., 2022; Epstein et al., 1999).

Cases of heat stroke can be identified in a few ways. Medical personnel who make a formal diagnosis of heat stroke record the corresponding ICD code in the patient's medical record. Medical examiners also identify heat stroke as a cause of death or significant condition contributing to death and note it on the deceased individual's death certificate.

II. Physiological Mechanisms.

Heat stroke happens when the body is under severe heat stress and is unable to dissipate excessive heat to keep the body temperature at 37°C (98.6°F), resulting in an elevated core body temperature (Epstein and Yanovich, 2019). The hallmark characteristics of heat stroke are: 1) central nervous system (CNS) dysfunction, including

encephalopathy (i.e., brain dysfunction manifesting as irrational behavior, confusion, coma, or convulsions); and 2) damage to multiple organs, including the kidneys, liver, heart, pancreas, gastrointestinal tract, as well as the circulatory system. There are three accepted mechanisms through which heat exposure can cause CNS dysfunction and/or multi-organ damage (Bouchama et al., 2022; Garcia et al., 2022; Iba et al., 2022). All three mechanisms share a common origin: heat exposure contributes to excessive heat stress, which results in hyperthermia.

One mechanism of heat stroke is reduced cerebral blood velocity (CBV) (an indicator of blood flow to the brain) that results in orthostatic intolerance (i.e., the inability to remain upright without symptoms) (Wilson et al., 2006). As individuals experience whole body heating, CBV is reduced and cerebral vascular resistance (the ratio of carbon dioxide stimulus to cerebral blood flow) increases. These changes ultimately contribute to reduced cerebral perfusion (flow of blood from the circulatory system to cerebral tissue) and blood flow, as well as orthostatic intolerance (Wilson et al., 2006).

Another mechanism is damage to the vascular endothelium. Hyperthermia can damage or kill cells in the lining of blood vessels, known as the vascular endothelium. The body responds to vascular endothelium damage through a process called disseminated intravascular coagulation (DIC). DIC is characterized by two processes: 1) tiny clots form in the tissues of multiple organs, and 2) bleeding occurs at the sites of those tiny clots. DIC is extremely damaging and results in injury to organs (Bouchama and Knochel, 2002). Namely, DIC limits the delivery of oxygen and nutrients to several organs including the brain, heart, kidneys, and liver. Thus, DIC can result in both CNS dysfunction and multi-organ damage. Additionally, damage to the vascular endothelium makes it more permeable and creates an imbalance in the substances that control blood

clotting, which promotes abnormal and increased blood clotting (Bouchama and Knochel, 2002; Wang et al., 2022).

A third mechanism is damage to the cells in the lining of the gut, known as the gut epithelium. Hyperthermia can alter the cell membranes' permeability (Roti Roti et al., 2008), or directly cause cells to die (Bynum et al., 1978). In either case, cells in the gut epithelium will leak endotoxins into the blood, a process known as endotoxemia. When these endotoxins circulate throughout the body, the immune system aggressively responds by activating cells to fight infection and inflammation, known as systemic inflammatory response syndrome (SIRS) (Leon and Helwig, 2010). The presence of endotoxins, as well as the body's aggressive immune response, can cause serious multi-organ damage (Epstein and Yanovich, 2019; Wang et al., 2022). In particular, the liver is usually one of the first organs to be damaged and is often what causes a heat stroke death (Wang et al., 2022).

III. Occupational Heat Stroke.

Heat stroke is life-threatening and can severely impair workers' safety and health (Lucas et al., 2014). A study of work-related HRIs in Florida using hospital data reported that, during the warm seasons from May through October between 2005 through 2012, heat stroke was the primary diagnosis in 91% (21 of 23) of deaths. In total, they reported 160 cases of work-related heat stroke (Harduar Morano and Watkins, 2017). Analyses of heat stroke among military members indicate that roughly 73% of EHS patients require hospitalization for at least two days (Carter et al., 2007).

IV. Treatment and Recovery.

Heat stroke is a serious medical emergency that requires immediate rest, cooling, and usually hospitalization. Prognosis for heat stroke is highly dependent on how quickly heat stroke is recognized and how quickly an affected worker can be cooled. When an affected person can be diagnosed early and cooled rapidly, the prognosis is generally

good. For example, rapid cooling within one hour of presentation of symptoms of CHS was found to reduce the mortality rate from 33% to 15% (Vicario et al., 1986). For EHS, cooling the body below 104°F within 30 minutes of collapse is associated with very good outcomes (Casa et al., 2012; Casa et al., 2015). The authors also reported that they were unaware of any cases of fatalities among EHS victims where it was recorded that the body was cooled below 104°F within 30 minutes of collapse (Casa et al., 2012).

Comparably, others have found that the risk of morbidity and mortality from heat stroke increases as treatment is delayed (Demartini et al., 2015; Schlader et al., 2022). Schlader et al. (2022) found that a delay in cooling can result in tissue damage, multi-organ dysfunction, and eventually death. Similarly, Zeller et al. (2011) found in their retrospective cohort study that patients who did not receive early or immediate cooling had worse outcomes, such as more severe forms of disease or death, although their study design does not allow for conclusions regarding causality (Zeller et al., 2011). Khogali and Weiner's (1980) case study report on 18 cases of heat stroke found that 72% of the patients took between 30-90 minutes to cool, whereas the other 28% were resistant to cooling, taking two to five hours to reach 38°C (100.4°F). This means that there is variation in how individuals respond to heat stroke treatment and that some individuals will respond quicker to treatment than others. Prompt treatment is likely even more critical for the individuals who take longer to cool.

Data from the general population also demonstrate the serious nature of heat stroke. One analysis of nationwide data estimated that nearly 55% of emergency department visits for heat stroke required hospitalization and roughly 3.5% of patients died in the emergency department or at the hospital (Wu et al., 2014). This study also found that heat stroke medical emergencies are more severe than other non-heat-related emergencies, with a 2.6-fold increase in admission rate and a 4.8-fold increase in case fatality compared to those other conditions (Wu et al., 2014).

Complete recovery for individuals who are affected by heat stroke may require time away from work. Some research suggests the length of recovery time and the need for time away from work is based on how long a person was at or above the critical core body temperature of 41°C (105.8°F), and how long it takes for biomarkers in blood to normalize (McDermott et al., 2007). Relevant biomarkers include those for acute liver dysfunction, myolysis (the breakdown of muscle tissue), and other organ system biomarkers (Ward et al., 2020; Schlader et al., 2022).

Guidelines for military personnel and athletes suggest that it may be weeks or months before a worker who has suffered heat stroke can safely return to work or perform the same level of work they did before suffering heat stroke. U.S. military members have clear return-to-work protocols post-heat stroke where members are assigned grades of functional capacity in six areas: physical capacity or stamina, upper extremities, lower extremities, hearing and ears, eyes, and psychiatric functioning (O'Connor et al., 2007). For example, when a soldier/airman experiences heat stroke, they automatically receive a reduced function capacity grade status in physical capacity. This also results in an automatic referral to a medical examination board. Soldiers and airmen are not cleared to return to duty until their laboratory results normalize, and even then, their status remains a trial of duty. If the individual has not exhibited any heat intolerance after three months, they are returned to a normal work schedule. However, maximal exertion and significant heat exposure remains prohibited for these individuals. If a military member experiences any heat intolerance during the period of restriction, or subsequent resumption to normal duty, a referral to the physical examination board for a hearing regarding their health status is required (O'Connor et al., 2007).

The U.S. Navy has its own set of guidelines, which does not distinguish between heat exhaustion and heat stroke, but uses laboratory tests, especially liver function tests, to determine when sailors are allowed to return to duty. For those who have suffered heat

stroke, full return to duty is usually not granted until somewhere between two days to three weeks later (O'Connor et al., 2007).

In 2023, the American College of Sports Medicine (ACSM) published their consensus statement which provides evidence-based strategies to reduce and eliminate HRIs, including a return to activity protocol for athletes recovering from EHS (Roberts et al., 2023). Of note, ACSM names athletes (whether elite, recreational, or tactical) and occupational laborers as groups who are active and regularly perform exertional activities that could lead to EHS. Specifically, ACSM recommendations include refraining from exercise for at least seven days following release from the initial medical care for EHS treatment. Once all laboratory results and vital signs have normalized, ACSM recommends an individual can exercise in cool environments and gradually increase duration, intensity, and heat exposure over a two to four-week period to initiate environmental acclimatization (Roberts et al., 2023). If the affected athlete does not return to pre-EHS activity levels within four to six weeks, further medical evaluation is needed. ACSM recommends a full return to activity between two to four weeks after the individual has demonstrated exercise acclimatization and heat tolerance with no abnormal symptoms or test results during the re-acclimatization period (Roberts et al., 2023). Similarly, the National Athletic Trainer's Association proposes that individuals who experience EHS should complete a 7 to 21-day rest period, be asymptomatic, have normal blood-work values, and obtain a physician's clearance prior to beginning a gradual return to activity (Casa et al., 2015).

In the military setting it is accepted that returning to work too early and/or without adequate work restrictions can result in incomplete recovery from heat stroke, which may necessitate a prolonged restricted work status (McDermott et al., 2007). About 10-20% of people who have had heat stroke have been shown to experience heat intolerance roughly two months after having the heat stroke (Binkley et al., 2002). In some instances, this has

lasted for five years and has increased the risk for another heat stroke (Binkley et al., 2002; McDermott et al., 2007). Similarly, a case study report of EHS cases amongst the U.S. Army found that in one of the ten cases examined, the person was heat intolerant for 11.5 months post-EHS (Armstrong et al., 1989).

Only a limited number of studies have focused on the long-term effects of heat stroke. This includes research by Wallace et al. (2007), whose retrospective review of military service members found that those who suffered an EHS event earlier in life were more likely to die due to cardiovascular disease and ischemic heart disease. Similarly, Wang et al. (2019) report that prior exertional heat illness was associated with a higher prevalence of acute ischemic stroke, acute myocardial infarction, and an almost three-fold higher prevalence of chronic kidney disease. Other research in mice support these claims and indicate that epigenetic effects post-EHS result in immunosuppression and an altered heat shock protein response as well as development of metabolic disorders that could negatively impact long-term cardiovascular health (Murray et al., 2020; Laitano et al., 2020).

V. Summary.

OSHA's review of the scientific and medical literature indicates that occupational heat exposure can cause heat stroke, a medical emergency. The physiological mechanisms by which heat exposure can result in heat stroke are well-established in the literature, and heat exposure as a cause of heat stroke is well-recognized in the medical and scientific communities. The best available research demonstrates that heat stroke must be treated as soon as possible and that prolonged time between experiencing heat stroke and seeking treatment increases the likelihood of death and may result in long-term health effects.

F. Heat Exhaustion.

I. Introduction.

NIOSH defines heat exhaustion as "[a] heat-related illness characterized by elevation of core body temperature above 38°C (100.4°F) and abnormal performance of one or more organ systems, without injury to the central nervous system" (NIOSH, 2016). Heat exhaustion can progress to heat stroke if not treated properly and promptly, and may require time away from work for a full recovery.

Signs and symptoms of heat exhaustion typically include profuse sweating, changes in mental status, dizziness, nausea, headache, irritability, weakness, decreased urine output and elevated core body temperature up to 40°C (104°F) (NIOSH, 2016; Kenny et al., 2018). Collapse may or may not occur. Significant injury to the central nervous system, and significant inflammatory response do not occur during heat exhaustion. However, there appears to be a fine line between heat exhaustion and heat stroke. Kenny et al. 2018 state that it can be difficult to clinically differentiate between heat exhaustion and early heat stroke. NIOSH also states that heat exhaustion "may signal impending heat stroke" (NIOSH, 2016). Armstrong et al. (2007) recommend that rectal temperature be taken to distinguish between heat exhaustion and heat stroke.

II. Physiological Mechanisms.

Heat exhaustion occurs when heat stress results in elevated body temperature between 98.6°F and 104°F (37°C and 40°C) and physiological changes occur (Kenny et al., 2018). Under these significant heat stress conditions, heavy sweating occurs, tissue perfusion is reduced, and inflammatory mediators are released. Electrolyte imbalances can occur due to fluid and electrolyte losses through sweating paired with inadequate replenishment. Voluntary and involuntary dehydration can exacerbate this process (Hendrie et al., 1997; Brake and Bates, 2003). "Voluntary dehydration," as used by Brake and Bates, refers to the circumstance where a dehydrated worker does not adequately rehydrate, despite the availability of water. Upon review of several studies, Kenny et al. (2018) report that dehydration among workers is common, even when water is readily

available. There is also evidence that even when water intake increases, as sweat rate and dehydration increase, intake may not be adequate to fully replace losses (Hendrie et al., 1997).

Brake and Bates (2003) summarized various hypothesized reasons for voluntary and involuntary dehydration. One hypothesized reason for voluntary dehydration is a delayed or decreased thirst response (Brake and Bates, 2003). Other reasons include mechanisms that affect fluid retention, such as the dependence of fluid retention on solutes such as sodium, which may be in imbalance under heat stress (Brake and Bates, 2003). Lack of adequate hydration could also be due to workplace pressures or concerns about sanitation (Rao, 2007; Iglesias-Rios, 2023).

The combination of heat stress, upright posture, and low vascular fluid volume (hypovolemia) can further dysregulate the circulatory system and affect clotting mechanisms (Kenny et al., 2018). Heat stress reduces blood flow to the abdominal organs, kidneys, muscles, and brain and increases blood flow to the skin to aid in cooling. These changes in the circulatory system and blood flow to the brain can potentially lead to dizziness or faintness upon standing (orthostatic intolerance), or collapse. Other factors that affect the development of heat exhaustion include individual health status, preparedness (such as acclimatization level), individual characteristics, knowledge, access to fluids, environmental factors, personal protective equipment use and work pacing and intensity (Kenny, 2018).

III. Occupational Heat Exhaustion.

Heat exhaustion is one of the more common heat-related illnesses (Armstrong et al., 2007; Harduar Morano and Watkins, 2017; Lewandowski and Shaman, 2022). In their study of heat-illness hospitalizations in Florida during May to October from 2005-2012, Harduar Morano and Watkins (2017) reported that there were 2,659 cases of work-related heat exhaustion that resulted in emergency department visits or hospitalization,

versus 181 cases of work-related heat stroke that resulted in emergency department visits, hospitalization, or death. Similar results have been reported in studies of heat-related illness among the United States Armed Forces and miners showing the frequency of heat exhaustion (Dickinson, 1994; Armed Forces Health Surveillance Division, 2022b; Lewandowski and Shaman, 2022; Donoghue et al., 2000; Donoghue, 2004). While in some studies heat exhaustion is not specifically diagnosed, several qualitative studies describe self-reported symptoms in workers that may be indicative of heat exhaustion (e.g., Mirabelli et al., 2010; Fleischer et al., 2013; Kearney et al., 2016; Mutic et al., 2018). These symptoms included headache, nausea, vomiting, feeling faint, and heavy sweating.

IV. Treatment and Recovery.

Heat exhaustion may require treatment beyond basic first aid to prevent progression to heat stroke (Kenny et al., 2018). In cases where the degree of severity of heat illness is unclear, the individual should be treated as if they have heat stroke (Armstrong, 1989). For a worker experiencing heat exhaustion, NIOSH recommends the following steps to ensure the worker receives proper and adequate treatment: "Take worker to a clinic or emergency room for medical evaluation and treatment; If medical care is unavailable, call 911; Someone should stay with worker until help arrives; Remove worker from hot area and give liquids to drink; Remove unnecessary clothing, including shoes and socks; Cool the worker with cold compresses or have the worker wash head, face, and neck with cold water; Encourage frequent sips of cool water" (NIOSH, 2016).

Complete recovery from heat exhaustion may require a restricted work status (or limited work duties). Donoghue et al. (2000) reported that following heat exhaustion, 29% (22 of 77) of miners included in the study required a restricted work status for at least one shift. The military has specific protocols for return to duty following heat

exhaustion. For example, the U.S. Army and Air Force follow the protocol outlines in AR 40-501 (O'Connor et al., 2007). Three instances of heat exhaustion in less than 24 months can result in referral to a Medical Evaluation Board before a full return to service. Some military units have additional or more specific guidelines. For example, one military unit, at Womack Army Medical Center in North Carolina, has guidelines that allow individuals who are considered to have mild illness, fully recovered in the emergency room, and have no abnormal laboratory findings to return to light duty the following day and limited duty the day after that. However, they also indicate that some effects of heat illness may be subtle or delayed and recommend individuals avoid strenuous exercise for several days and remain under observation (O'Connor et al., 2007).

V. Summary.

The scientific and medical literature presented here clearly demonstrate that heat exhaustion is a recognized health effect of occupational heat exposure. The best available evidence on the symptoms, treatment, and recovery of heat exhaustion demonstrates that heat exhaustion can progress to heat stroke, a medical emergency, if not treated promptly and that heat exhaustion may require time away from work for a full recovery.

G. Heat Syncope.

I. Introduction.

Occupational heat exposure can result in heat syncope. Syncope is the medical term for "fainting," and heat syncope is defined as "fainting, dizziness, or light-headedness after standing or suddenly rising from a sitting/lying position" due to heat exposure (NIOSH, 2023a). Heat syncope may sometimes be referred to as "exercise-associated collapse" (EAC), but heat syncope can happen without significant levels of exertion (Asplund et al., 2011; Pearson et al., 2014). As explained below, heat syncope is an acknowledged and documented health effect of occupational heat exposure.

II. Physiological Mechanisms.

There are two mechanisms for how heat exposure can cause heat syncope (Schlader et al., 2016; Jimenez et al., 1999). One mechanism for heat syncope is reduced blood flow to the brain. Elevated core temperature induces vasodilation, sweating, and may result in blood pooling in certain areas of the body (see Section IV.B., General Mechanisms of Heat-Related Health Effects). Thus, there is a lower circulating blood volume, which can reduce blood flow to the brain and cause loss of consciousness (Wilson et al., 2006; Van Lieshout et al., 2003).

A second mechanism for heat syncope is reduced cerebral blood velocity (CBV) (indicative of reduced blood flow to the brain) that results in orthostatic intolerance (the inability to remain upright without symptoms) during a heat stress episode (Wilson et al., 2006). As individuals experience whole body heating, CBV is reduced and cerebral vascular resistance (the ratio of carbon dioxide stimulus to cerebral blood flow) increases. These changes ultimately contribute to reduced cerebral perfusion and blood flow, as well as orthostatic intolerance (Wilson et al., 2006). The orthostatic response to heat stress during "rest" (i.e., standing/sitting) is essentially equivalent to the orthostatic response to heat stress after exercise if skin temperature is similarly elevated (Pearson et al., 2014). While core temperature is not always elevated in cases of heat syncope, skin temperature typically is (Department of the Army, 2022; Noakes et al., 2008).

Differentiating between heat syncope, heat exhaustion, and heat stroke is a critical step in proper diagnosis (Santelli et al., 2014; Coris et al., 2004). As stated above, heat syncope always involves loss of consciousness, but it does not require elevated core body temperature (Santelli et al., 2014; Holtzhausen et al., 1994). Conversely, heat exhaustion and stroke do not require loss of consciousness. Though central nervous system (CNS) disturbances are possible in heat stroke and heat stroke is always characterized by significantly elevated core temperature. Further, recovery of mental

status is faster in heat syncope than in exhaustion and heat stroke, since cooling may not be required for treatment of heat syncope (Howe and Boden, 2007).

III. Occupational Heat Syncope.

Workers have experienced heat syncope when exposed to heat. A survey-based study in southern Georgia found that 4% of 405 farmworkers experienced fainting within the previous week (Fleischer et al., 2013). Another survey-based study in North Carolina asked 281 farmworkers if they had ever experienced heat-related illness and found that 3% of workers had fainted (Mirabelli et al., 2010). While these cases were not formally diagnosed as heat syncope, Fleischer reported temperatures ranging from 34-40°C (94-104°F) and a heat index of 37-42°C (100-108°F) at the time workers fainted, and Mirabelli described the working conditions at the time of fainting as being in “extreme heat.”

IV. Treatment and Recovery.

NIOSH recommends treating heat syncope by having the worker sit down in a cool environment and hydrate with either water, juice, or a sports drink (NIOSH, 2016). The Department of the Army recommends that "victims of heat/parade syncope will recover rapidly once they sit or lay supine, though complete recovery of stable blood pressure and heart rate (resolution of orthostasis or ability to stand without fainting) in some individuals may take 1 to 2 hours” (Department of the Army, 2022). Treatment recommendations for athletes consist of moving the athlete to a cool area and laying them supine with elevated legs to assist in venous return, possibly with oral or intravenous rehydration (Peterkin et al., 2016; Howe and Boden, 2007; Seto et al., 2005; Lugo-Amador et al., 2004).

An episode of heat syncope may require time away from work for a thorough evaluation to ascertain one’s risk for recurrent/future episodes of heat syncope. No studies have evaluated recurring episodes of syncope among workers specifically, but a

study found that, for the general population, 1-year syncope recurrence (any type) was 14% in working-age people (18-65 years) (Barbic et al., 2019). The U.S. Army has a requirement to "obtain a complete history to rule out other causes of syncope, including an exertional heat illness or other medical diagnosis (for example, cardiac disorder)" (Department of the Army, 2022). Recommendations for athletes include thorough evaluation "for injury resulting from a fall, and all cardiac, neurologic, or other potentially serious causes for syncope" (Howe and Boden, 2007; Lugo-Amador et al., 2004; Binkley et al., 2002). Indeed, if an injury (e.g., fall, collision) is sustained because of heat syncope, treatment beyond first aid (including hospitalization) may be necessary. Supporting this point, more general syncope has been linked to occupational accidents requiring hospitalizations (Nume et al., 2017).

V. Summary.

The scientific and medical literature presented in this section demonstrate that heat syncope is a recognized health effect of occupational heat exposure. Studies suggest that heat syncope may require time away from work for further evaluation. Additionally, heat syncope can lead to injuries (e.g., injury from a fall), some of which may require hospitalization.

H. Rhabdomyolysis.

I. Introduction.

Rhabdomyolysis is a life-threatening illness that can affect workers exposed to occupational heat. NIOSH defines rhabdomyolysis as "a medical condition associated with heat stress and prolonged physical exertion, resulting in the rapid breakdown of muscle and the rupture and necrosis of the affected muscles" (NIOSH, 2016). This definition is specific to exertional rhabdomyolysis. Another form of rhabdomyolysis, called traumatic rhabdomyolysis, is caused by direct muscle trauma (e.g., from a fall or crush injury). Workers can experience such injuries, and consequently suffer from

traumatic rhabdomyolysis, because of occupational heat exposure (see Section IV.P., Heat-Related Injuries). However, this section will focus only on exertional rhabdomyolysis. Unless otherwise specified, all references to rhabdomyolysis are shorthand for exertional rhabdomyolysis.

Signs and symptoms of rhabdomyolysis include myalgia (muscle pain), muscle weakness, muscle tenderness, muscle swelling, and/or dark-colored urine (Armed Forces Health Surveillance Division, 2023b; Dantas et al., 2022; O'Connor et al., 2008; Cervellin et al., 2010). Notably, the onset of these symptoms may be delayed by 24-72 hours (Kim et al., 2016). Rhabdomyolysis commonly affects individuals who are exposed to heat during physical exertion. For example, the Centers for Disease Control and Prevention (CDC) investigated an incident in which an entire cohort of 50 police trainees were diagnosed with rhabdomyolysis after the first 3 days of a 14-week training program; the trainees had engaged in heavy physical exertion outdoors with limited access to water. The CDC concluded that adequate hydration is particularly important when the HI approaches 80°F (Goodman et al., 1990).

Rhabdomyolysis has long been recognized as a heat-related illness by NIOSH, the U.S. Armed Forces, and national athletic organizations such as the American College of Sports Medicine (Armstrong et al., 2007). Specifically, NIOSH lists rhabdomyolysis as an "acute heat disorder" in its *Criteria for a Recommended Standard* (2016) and provides detailed recommendations for recognition and treatment of rhabdomyolysis. NIOSH also conducted case studies and retrospective analyses to identify cases of rhabdomyolysis among workers exposed to heat, including firefighter cadets and instructors, as well as park rangers (Eisenberg et al., 2019; Eisenberg J et al., 2015; Eisenberg and Methner, 2014).

Similarly, the U.S. Armed Forces developed a case definition that specifies rhabdomyolysis can be heat-related (Armed Forces Health Surveillance Board, 2017),

and this definition is applied in their annual surveillance reports of HRIs. From 2018 to 2022, most rhabdomyolysis cases (75.9%) occurred during warmer months (i.e., May to October) (Armed Forces Health Surveillance Division, 2023b). In a retrospective study of hospital admissions for rhabdomyolysis in military members (2010-2013), 60.1% (193 out of 321) cases were deemed to be associated with exertion and exposure to heat (Oh et al., 2022).

Many studies have also found that rhabdomyolysis often coincides with exertional heat stroke and other HRIs such as heat exhaustion, heat cramps, hyponatremia, and dehydration. The frequent co-occurrence of rhabdomyolysis and other HRIs has been reported among workers, including police and firefighters (Eisenberg et al., 2019; Goodman et al., 1990), workers included in OSHA enforcement investigations (Tustin et al., 2018a), military members (Oh et al., 2022; Carter et al., 2005), athletes (Thompson et al., 2018), and in the general population (Thongprayoon et al., 2020).

II. Physiological Mechanisms.

Studies have identified two interrelated mechanisms through which heat exposure, combined with exertion, can cause rhabdomyolysis. Both mechanisms share a common origin: occupational heat exposure and exertion both contribute to excessive heat stress, which in turn causes an elevated core temperature. Both mechanisms also share a common outcome: the breakdown and death of muscle tissue, which is the hallmark characteristic of rhabdomyolysis. The first mechanism is thermal injury to muscle cells. When the body's core temperature is elevated, it creates a toxic environment that can directly injure or kill muscle cells. The temperature at which this occurs, known as the thermal maximum, is estimated to be about 107.6 °F (42°C) (Bynum et al., 1978). At the thermal maximum, the structural components of the cells' membranes are liquified and the membrane breaks down. Proteins in the cells' mitochondria, which are key to energy production, change shape and no longer function properly. Calcium, which is normally

maintained at a low level inside muscle cells, will rush into the cells and activate inflammatory processes that accelerate the death of those cells (Torres et al., 2015; Khan, 2009).

The second mechanism is lack of oxygen to muscle cells. When the body attempts to cool itself, it can lose high volumes of sweat. Sweat loss can deplete the body's stores of water and electrolytes, leading to low blood volume (see Section IV.B., General Mechanisms of Heat-Related Health Effects). Low blood volume, and low potassium in the blood (known as hypokalemia), can both contribute to muscle cell death. An adequate supply of blood is necessary to deliver oxygen to muscles, and an adequate supply of potassium is needed to support vasodilation (to support increased blood flow to the muscles during exertion). When neither blood volume nor potassium are sufficient, the muscle cells do not receive enough oxygen (known as ischemia). When this occurs, the muscle cells produce less energy and eventually will die if exertion continues (Knochel and Schlein, 1972).

III. Occupational Rhabdomyolysis.

While OSHA is not aware of surveillance data on the incidence of rhabdomyolysis in the worker population in the United States, there are surveillance data on the incidence of rhabdomyolysis among active military members in the Army, Navy, Air Force, and Marine Corps. These data have been reported for the U.S. Army from 2004 to 2006 (Hill et al., 2012) and for all military branches from 2008 through 2022 (Armed Forces Health Surveillance Division, 2023b; Armed Forces Health Surveillance Division, 2018; U.S. Armed Forces, 2013). These surveillance data and the studies described above by NIOSH and others indicate that workers performing strenuous tasks in the heat are at risk of developing rhabdomyolysis. The U.S. Armed Forces has successfully identified many cases of heat-related rhabdomyolysis by searching medical records for the presence of either the ICD-10 code for rhabdomyolysis and/or the ICD-10

code for myoglobinuria, along with any other heat-related codes (table IV-1) (Armed Forces Health Surveillance Division, 2023b; Oh et al., 2022).

IV. Treatment and Recovery.

Rhabdomyolysis is a serious heat-related illness that can cause life-threatening complications. Many cases of rhabdomyolysis may require hospitalization. For example, A CDC investigation into a police training program in Massachusetts found that 26% of police trainees (13 out of 50) were hospitalized for rhabdomyolysis only three days into their training (Goodman et al., 1990). The mean length of hospitalization was 6 days, with a range of 1 to 20 days (Goodman et al., 1990). Similarly, a military surveillance study identified 473 rhabdomyolysis cases among military members in 2022, with 35.3% of cases (167 out of 473) requiring hospitalization (Armed Forces Health Surveillance Division, 2023b). In a retrospective study of 193 military trainees hospitalized for rhabdomyolysis, the mean length of hospitalization was 2.6 days, with a range of 0 to 25 days (Oh et al., 2022).

The focus of treatment for rhabdomyolysis during hospitalization is to reduce levels of creatine kinase (CK) and myoglobin in the blood, as well as correct electrolyte imbalances, through aggressive administration of intravenous fluids (generally normal saline) (O'Connor et al., 2020; Luetmer et al., 2020; Manspeaker et al., 2016; Torres et al., 2015). Monitoring is used to repeatedly measure CK levels until a peak concentration is reached (often within 1-3 days), and then to ensure that CK levels are consistently trending downwards before discharge from the hospital (Kodadek et al., 2022; Oh et al., 2022).

Complications of rhabdomyolysis are also possible. When muscle cells die, they release several electrolytes and proteins into the bloodstream that can cause severe health complications. For example, the release of potassium from muscle cells can cause hyperkalemia (high level of potassium in the blood), which then leads to heart

arrhythmias (abnormal heart rhythms) (Mora et al., 2017; Sauret et al., 2002). Also, the release of myoglobin into the bloodstream can be toxic for the kidneys. When blood is filtered by nephrons (functional units of the kidneys) to produce urine, the presence of even small amounts of myoglobin can obstruct and damage the nephrons (Mora et al., 2017; Sauret et al., 2002). In some cases, these complications from rhabdomyolysis can be life-threatening (Wesdock and Donoghue, 2019) and in fact fatalities have been reported (Gardner and Kark, 1994; Goodman et al., 1990). A more detailed discussion of how rhabdomyolysis can cause acute kidney injury or other kidney damage can be found in Section IV.M., Kidney Health Effects.

Guidelines for return to work among workers diagnosed with rhabdomyolysis are limited. In the U.S. military, soldiers deemed to be at low risk for recurrence of rhabdomyolysis are restricted to light, indoor duty and encouraged to rehydrate for at least 72 hours to allow for normalization of CK levels. If CK levels do not normalize, they must continue indoor, light duty; if CK levels do normalize, they can proceed to light, outdoor duty for at least 1 week and must show no return of clinical symptoms before they can gradually return to full duty. In contrast, soldiers deemed to be at high risk for recurrence of rhabdomyolysis must undergo additional diagnostic tests, with consultation from experts, and can be given an individualized, restricted exercise program while they await clearance for full return to duty (O'Connor et al., 2020; O'Connor et al., 2008). These guidelines have been adopted by the Armed Forces and restated in their surveillance reports of rhabdomyolysis (Armed Forces Health Surveillance Division, 2023b).

V. Summary.

The available scientific literature indicates that rhabdomyolysis can result from physical exertion in the heat. Based on plausible mechanistic data, studies by NIOSH and others, and surveillance data indicating incidence of rhabdomyolysis among active

military members, OSHA preliminarily determines that workers performing strenuous tasks in the heat are at risk of rhabdomyolysis.

I. Hyponatremia.

I. Introduction.

Workers in hot environments may experience hyponatremia, a condition that occurs when the level of sodium in the blood falls below normal levels (<135 milliequivalents per liter (mEq/L)) (NIOSH, 2016). Hyponatremia is often caused by drinking too much water or hypotonic fluids, such as sports drinks, over a prolonged period of time. Without sodium replacement, the high water intake can result in losses of sodium in the blood as more sodium is lost due to increased sweating from heat exposure and urination (Korey Stringer Institute (KSI), n.d.). Mild forms of hyponatremia may not produce any signs or symptoms, or may present with symptoms including muscle weakness and/or twitching, dizziness, lightheadedness, headache, nausea and/or vomiting, weight gain, and swelling of the hands or feet (KSI, n.d.; NIOSH, 2016). In severe cases, hyponatremia may cause altered mental status, seizures, cerebral edema, pulmonary edema, and coma, which may be fatal (KSI, n.d.; NIOSH, 2016; Rosner and Kirven, 2007). NIOSH and the U.S. Army classify hyponatremia as a heat-related illness (NIOSH, 2016; Department of the Army, 2022).

II. Physiological Mechanisms.

When exposed to heat, the autonomic nervous system triggers the body's sweat response, in which sweat glands release water to wet the skin (Roddie et al., 1957; Grant and Holling, 1938). The purpose of the sweat response is to cool the body. However, in doing so, it can deplete the body's stores of water and electrolytes (e.g., sodium, potassium, chloride, calcium, and magnesium) that are essential for normal bodily function (Shirreffs and Maughan, 1997). As the body's store of sodium is lessening and high quantities of water are consumed, hyponatremia may develop as sodium in the blood

becomes diluted (<135 mEq/L). In some cases, this dilution may cause an osmotic disequilibrium—an imbalance in the amount of sodium inside and outside the cell resulting in cellular swelling—which can lead to the serious and fatal health outcomes discussed above.

III. Occupational Hyponatremia.

Surveillance of hyponatremia among workers is limited. However, a recent case study demonstrates the potential severity and life-threatening nature of hyponatremia. After a seven-day planned absence from work, a 34-year-old male process control operator in an aluminum smelter pot room was hospitalized due to a variety of HRI symptoms including hyponatremia, with serum (the liquid portion of blood collected without clotting factors) sodium level of 114 millimoles per liter (mmol/L) (reference range: 136-145 mmol/L) (Wesdock and Donoghue, 2019). After 13 days in the hospital, the patient was discharged with a diagnosis of "severe hyponatremia likely triggered by heat exposure" (Wesdock and Donoghue, 2019). The patient was still out of work 32 weeks after the incident. While no temperature data for the pot room were available, an exposure assessment used outdoor temperatures that day and pot room temperatures from the literature to estimate that the WBGT could have been as high as 33°C, which the authors state exceeds the ACGIH TLV for light work for acclimatized workers (Wesdock and Donoghue, 2019).

The relationship of heat exposure and hyponatremia was examined among male dockyard workers in Dubai, United Arab Emirates (Holmes et al., 2011). This population performed long periods of manual work in the heat and consumed a diet low in sodium. A first round of plasma (i.e., the liquid part of blood collected that contains water, nutrients and clotting factors) samples were taken at the end of the summer (n=44), with a second round taken at the end of the winter among volunteers still willing to participate (n=38). In the summer, 55% of participants were found to be hyponatremic (<135

millimolar (mM)), whereas only 8% were hyponatremic in the winter. Although ambient temperature conditions were not reported, the authors indicate that hyponatremia was highest during the summer because of sodium losses through sweat and inadequate sodium replacement (Holmes et al., 2011).

Hyponatremia among the military population has been well documented by the Annual Armed Forces Health Surveillance Division, which releases annual reports on exertional hyponatremia among active duty component services members, each with surveillance data for the previous 15 years (e.g., Armed Forces Health Surveillance Division, 2023a; Armed Forces Health Surveillance Division, 2022a; Armed Forces Health Surveillance Division, 2021; Armed Forces Health Surveillance Division, 2020). Cases come from the Defense Medical Surveillance System and include both ambulatory medical visits and hospitalizations in both military and civilian facilities. During the period of 2004 through 2022, the number of cases of hyponatremia among U.S. Armed Forces peaked in 2010 with 180 cases. The lowest number during that time period was 2013, when 72 cases were reported. During the last 15 years in which data were reported (2007-2022), 1,690 cases of hyponatremia occurred. Of these 1,690 cases, 86.8% (1,467) were diagnosed and treated during an ambulatory care visit (Armed Forces Health Surveillance Division, 2023a). As the diagnostic code for hyponatremia may include cases that are not heat-related, these data may be overestimates. However, such overestimation is reduced in this study as the authors controlled for many other related diagnoses (e.g., kidney diseases, endocrine disorders, alcohol/illicit drug abuse), which can cause hyponatremia.

IV. Treatment and Recovery.

Treatment and recovery for hyponatremia can vary depending on severity and symptoms. Workers presenting with mild symptoms should increase salt intake by consuming salty foods or oral hypertonic saline and restrict fluid until symptoms resolve

or sodium levels return to within normal limits (KSI, n.d.). Medical attention may be required in severe cases, which may be life-threating, and may be sought to address symptoms and personal risk factors (e.g., history of heart conditions, on a low sodium diet) (NIOSH, 2016).

V. Summary.

The available evidence in the scientific literature indicates that hyponatremia can result from occupational heat exposure. The evidence on treatment and recovery demonstrates that hyponatremia can require medical attention and, in some cases, may be life-threatening.

J. Heat Cramps.

I. Introduction.

Workers exposed to environmental or radiant heat can experience sudden muscle cramps known as "heat cramps." NIOSH defines heat cramps as "a heat-related illness characterized by spastic contractions of the voluntary muscles (mainly arms, hands, legs, and feet), usually associated with restricted salt intake and profuse sweating without significant body dehydration" (NIOSH, 2016). Someone can experience heat cramps even if they are frequently hydrating with water, but they are not replenishing electrolytes. Heat cramps are recognized as a "heat-related illness" by numerous organizations, including NIOSH, U.S. Army, U.S. Navy, National Athletic Trainers' Association (NATA), American College of Sports Medicine (ACSM), and World Medicine (formerly known as IAAF).

II. Physiological Mechanisms.

It is recognized in the medical and scientific communities that heat cramps result from heat exposure. However, the exact physiological mechanism is not known. In an early study of heat cramps, investigators included the following as the diagnostic criteria for heat cramps: exposure to high temperatures at work; painful muscle cramps; rapid

loss of salt in the sweat that is not replaced (which may cause hyponatremia); diminished concentration of chloride in the blood and in the body tissues (also known as hypochloremia); and rapid amelioration of symptoms after appropriate treatment (Talbott and Michelsen, 1933).

The following mechanism has been proposed for the development of heat cramps: profuse sweating can deplete electrolyte stores (e.g., sodium (Na), potassium (K), calcium (Ca)), which exacerbates muscle fatigue and can cause heat cramps (Bergeron, 2003; Horswill et al., 2009; Schallig et al., 2017; Derrick, 1934). The U.S. Army further posits that "intracellular calcium is increased via a reduction in the sodium concentration gradient across the cell membrane. The increased intracellular calcium accumulation then stimulates actin-myosin interactions (that is, filaments propelling muscle filaments) causing the muscle contractions" (Department of the Army, 2022). Heat cramps are sometimes referred to, more broadly, as exercise-associated muscle cramps (EAMCs) (Bergeron et al., 2008). However, heat cramps are distinct in that they only occur in hot conditions, which exacerbate electrolyte depletion, and may or may not be associated with exercise.

III. Occupational Heat Cramps.

Surveillance data and survey study data demonstrate that workers exposed to environmental or radiant heat frequently experience heat cramps in the United States. In a study of heat-related illness hospitalizations and deaths for the U.S. Army from 1980-2002, 8% of heat-related illness hospitalizations recorded were due to heat cramps (Carter et al., 2005). Similarly, in studies of self-reported heat-related illness, workers frequently cite heat cramps as a common symptom of heat exposure. Specifically, in several studies of self-reported heat-related symptoms among farmworkers in multiple States, participants reported experiencing sudden muscle cramps in the prior week in Georgia (33.7% of 405 respondents) (Fleischer et al., 2013), North Carolina (35.7% of

158 respondents) (Kearney et al., 2016), and Florida (30% of 198 respondents) (Mutic et al., 2018). In another study of self-reported symptoms among 60 migrant farmworkers in Georgia, heat-related muscle cramps were reported by 25% of participants, the second most frequently reported HRI symptom (Smith et al., 2021). In a study examining exertional heat illness and corresponding wet bulb globe temperatures in football players at five southeastern U.S. colleges from August to October 2003, the authors found that the highest incidences of exertional heat illness (EHI) occurred in August (88%, EHI rate= 8.95/1000 athlete-exposures (Aes)) and consisted of 70% heat cramps (6.13/1000 Aes) (Cooper et al., 2016).

IV. Treatment and Recovery.

Treatment for heat cramps includes electrolyte-containing fluid replacement (also known as isotonic fluid replacement), stretching, and massage (Gauer and Meyers, 2019; Peterkin et al., 2016). In some cases, sodium replacement may be a treatment for heat cramps (Talbott and Michelsen, 1933; Sandor, 1997; Jansen et al., 2002). In severe cases, it is recommended that magnesium levels of the patient are obtained and if necessary, magnesium replacement through IV therapy is provided (O'Brien et al., 2012). The ACSM recommends rest, prolonged stretching in targeted muscle groups, oral sodium chloride ingestion in fluids or foods, or intravenous normal saline fluids in severe cases (ACSM, 2007). NIOSH recommends that medical attention is needed if the worker has heart problems, is on a low sodium diet, or if cramps do not subside within 1 hour (NIOSH, 2016). If treated early and effectively, individuals may return to activity after heat cramps have subsided (Bergeron, 2007; Savioli et al., 2022; Gauer and Meyers, 2019). However, severe heat cramps may require an emergency department visit or hospitalization (Harduar Morano and Waller, 2017; Carter et al., 2005). While most cases of heat cramps do not require restricted work status or time away from work, guidelines for military personnel suggest some cases may require light workload the next day and

limited workload the following day, with observation of the affected patient because some additional deficits may be delayed or subtle (O'Connor et al., 2007). In addition, guidelines for military personnel advise that strenuous exercise be avoided for several days in some cases of heat cramps (O'Connor et al., 2007). Severe heat cramps may also elicit soreness for several days which can lead to a longer recovery period (Casa et al., 2015).

V. Summary.

OSHA's review of the scientific and medical literature indicates that heat cramps are a recognized health effect of occupational heat exposure. Indeed, several studies of self-reported symptoms of HRI among farmworkers in multiple States have indicated that heat cramps are quite common. The best available evidence on treatment and recovery indicates that heat cramps can, in some cases, require medical attention and may require time away from work or an adjusted workload.

K. Heat Rash.

I. Introduction.

Workers in hot environments may experience heat rash. Heat rash is defined by NIOSH as "a skin irritation caused by excessive sweating during hot, humid weather" (NIOSH, 2022). NIOSH, the U.S. Army, and the U.S. Navy classify heat rash as a heat-related illness (NIOSH, 2016; Department of the Army, 2022; Department of the Navy, 2023). Also known as miliaria rubra or prickly heat, workers with heat rash develop red clusters of pimples or small blisters, which can produce itchy or prickly sensations that become more irritating as sweating persists in the affected area. Heat rash can last for several days and tends to form in areas where clothing is restrictive and rubs against the skin, most commonly on the neck, upper chest, groin, under the breasts, and in elbow creases (OSHA, 2011; NIOSH, 2022; OSHA, 2024a). If left untreated, heat rash can become infected, and more severe cases can lead to high fevers and heat exhaustion

(Wenzel and Horn, 1998). In some cases, heat rash can lead to hypohidrosis (i.e., the reduced ability to sweat) in the affected area, even weeks after the heat rash is no longer visible, which impairs thermoregulation and can cause predisposition for heat stress (Sulzberger and Griffin, 1969; Pandolf et al., 1980; DiBeneditto and Worobec, 1985). This can impair an employee's ability to work and prevent resumption of normal work activities in hot environments to allow for the area to heal, which in some cases can take 3-4 weeks for heat intolerance to subside (Pandolf et al., 1980).

II. Physiological Mechanisms.

The development of heat rash has been studied for centuries (Renbourn, 1958). While working in hot environments with a high relative humidity, the body's ability to cool itself is greatly reduced, as sweat is less likely to evaporate from the skin (Sulzberger and Griffin, 1969; DiBeneditto and Worobec, 1985). Heat rash occurs when sweat remains on the skin and causes a blockage of sweat (eccrine) glands and ducts (Wenzel and Horn, 1998). Since the sweat ducts are blocked, sweat secretions can leak and accumulate beneath the skin, causing an inflammatory response and resulting in clusters of red bumps or pimples (Dibeneditto and Worobec, 1985). If left untreated, heat rash may become infected (Holzle and Kligman, 1978). Depending on the level of blockage, this can manifest as various types of miliaria, with miliaria rubra being the most common form of heat rash (Wenzel and Horn, 1998).

III. Occupational Heat Rash.

Surveillance of heat rash in worker populations is limited. However, farmworkers have reported cases of skin rash or skin bumps while working in summer months (Bethel and Harger, 2014; Kearney et al., 2016; Luque et al., 2020). From these studies, the percentage of participants surveyed or interviewed that report experiencing skin rash or skin bumps in the previous week were 10% (n=100, Beth and Harger, 2014), 12.1% (n=158, Kearney et al., 2016) and 5% (n=101, Luque et al., 2020). Although these studies

do not purport a diagnosis, presentation of skin rash or skin bumps while working in hot environments with reported average high temperatures ranging to the mid-90s°F indicates respondents may have developed heat rash.

Similar findings with diagnosis of heat rash or related symptoms have been recorded outside of the U.S. among workers in the following professions: 17% of indoor electronics store employees in air-conditioned (4%) and non-air-conditioned (13%) areas in Singapore (n=52, Koh, 1995); 2% of underground miners at a site in Australia (n=1,252, Donoghue and Sinclair, 2000); 34% of maize farmers in Nigeria (n=396, Sadiq et al., 2019); 68% of sugarcane cutters and 23% of sugarcane factory workers in Thailand (n=183, Boonruksa et al., 2020); 41% of sugarcane farmers in Thailand (n=200, Kiatkitroj et al., 2021); 17% of autorickshaw drivers (n=78), 23% of outdoor street vendors (n=75), 16% of street sweepers (n=75) in India (n=228, Barthwal et al., 2022); and 13% of underground and open pit miners across Australia (n=515, Taggart et al., 2024). Although these studies illustrate the prevalence of heat rash in various worker populations, OSHA notes that differences in study methodologies and the populations studied mean that the results of these studies are not necessarily directly comparable to each other or to similar industries or worker populations in the United States.

The type of clothing worn may also contribute to formation of heat rash while working in higher temperatures. Heat rash was formally diagnosed among U.S. military personnel wearing flame resistant army combat uniforms in hot and arid environments (102.2°F to 122°F (39°C to 50°C), 5% to 25% relative humidity) (Carter et al., 2011). In this case series, 18 patients with heat rash presented with moderate to severe skin irritation, which was worsened by reactions to chemical additives not removed from the laundering process and increased heat retention from sweat-soaked clothing, as well as the friction from the fabric and the occlusive effect of the clothing, which allowed sweat to accumulate on the skin despite the lower humidity (Carter et al., 2011). This study

calls attention to the effect of clothing on the development of heat rash and factors that may influence its severity.

IV. Treatment and Recovery.

Although most cases of heat rash can be self-treated without seeking medical attention, symptoms typically last for several days (Wenzel and Horn, 1998). It is important that heat rash is kept dry and cool to avoid possible infection. Workers experiencing heat rash should move to a cooler and less humid work environment and avoid tight-fitting clothing, when possible (NIOSH, 2022). The affected area should be kept dry, and ointments and creams, especially if oil-based, should not be used (NIOSH, 2022). However, powder may be used for relief.

V. Summary.

The available evidence in the scientific literature indicates that heat rash can result from occupational heat exposure. Although heat rash usually resolves on its own without medical attention, symptoms often persist for several days and more severe cases can impair an employee's ability to work and lead to infection if left untreated.

L. Heat Edema.

I. Introduction.

Workers in hot environments may experience heat edema. Heat edema is the swelling of soft tissues, typically in the lower extremities (feet, ankles, and legs) and hands, and may be accompanied by facial flushing (Gauer and Meyers, 2019). Surveillance systems and the U.S. Army classify heat edema as a heat-related illness (Department of the Army, 2022). Workers who are sitting or standing for prolonged periods may be at higher risk for heat edema (Barrow and Clark, 1998). Workers who are not fully acclimatized to the work site may be more prone to developing heat edema as the body adjusts to hotter temperatures (Howe and Boden, 2007).

II. Physiological Mechanism.

When exposed to heat, the body increases blood flow and induces vasodilation to cool itself and thermoregulate. This means, as blood is shunted towards the skin and vasodilation begins, the blood vessels near the skin's surface become wider (Hough and Ballantyne, 1899; Kamijo et al., 2005). However, blood can pool in areas of the body that are most subject to gravity (e.g., legs), and fluid can seep from blood vessels causing noticeable swelling under the skin – this is known as heat edema (Gauer and Meyers, 2019).

III. Occupational Heat Edema.

Surveillance of heat edema is limited. Many studies include heat edema as one of many HRIs that contributed to an aggregate measure of HRI in worker, military, or general populations, but very few were found to quantify heat edema alone.

Multiple studies outside of the U.S. have examined HRIs among farm and factory workers in the sugarcane industry through surveys and interviews (Crowe et al., 2015; Boonruksa et al., 2020; Kiatkitroj et al., 2021; Debela et al., 2023). Respondents in the studies were asked if they experienced swelling of the feet or hands (with varying degrees of frequency) during periods of heat exposure, which could indicate presentation of heat edema. In different samples of sugarcane workers in two provinces of Thailand, two studies found incidence of swelling of the hands and feet. Among sugarcane cutters, 16.7% self-reported ever experiencing swelling of the hands or feet and 5.6% self-reported experiencing these symptoms (mean 30.6°C WBGT) (n=90, Boonruksa et al., 2020). In another province, 10.5% self-reported swelling of the hands/feet while working one summer (n=200, Kiatkitroj et al., 2021).

While comparing HRI symptoms among sugarcane harvesters and non-harvesters in Costa Rica, 15.1% of harvesters (n=106) and 7.9% of non-harvesters (n=63) self-reported having ever experienced swelling of hands/feet (p=0.173) (n=169, Crowe et al., 2015). While 7.5% of harvesters, who worked outdoors in the field, self-reported

experiencing this symptom at least once per week, no non-harvesters self-reported swelling with this level of frequency (p=0.026) (Crowe et al., 2015). The sample of non-harvesters included both workers that were intermediately exposed to heat (e.g., in the processing plant or machinery shop) and workers not exposed to heat (e.g., in offices).

In a sample of sugarcane factory workers (n=1,524) in Ethiopia, 72.4% (1,104) were considered exposed to heat defined as conditions exceeding the ACGIH's TLV (Debela et al., 2023). Of the total sample (including workers considered exposed to heat and not), 78% (1,189) self-reported having experienced swelling of hands and feet at least once per week, which was the most commonly reported HRI symptom (Debela et al., 2023). Although these studies do not purport a diagnosis, presentation of swelling of the hands and feet while working in hot environments suggests respondents may have developed heat edema.

IV. Treatment and Recovery.

Although most cases of heat edema can be self-treated without seeking medical attention, symptoms can last for days and reoccurrence is less likely if individuals are properly acclimatized (Howe and Boden, 2007; Department of the Army, 2023). It is important that the affected individual moves out of the heat and elevates the swollen area. Diuretics are not typically recommended for treatment (Howe and Boden, 2007; Gauer and Meyers, 2019; CDC, 2024a).

V. Summary.

The available evidence in the scientific literature indicates that heat edema can result from occupational heat exposure, causing swelling of the lower extremities (feet, ankles, and legs) and hands. It may be difficult to move swollen body parts, thereby impeding an employee's ability to perform their job. The need for medical attention can typically be avoided if the condition is properly treated.

M. Kidney Health Effects.

I. Introduction.

The kidneys perform many functions in the body, including filtering toxins out of the blood and balancing the body's water and electrolyte levels (NIDDK, 2018). Working in the heat places a lot of demand on the kidneys to conserve water and regulate electrolytes, like sodium, lost through sweat. A growing body of experimental and observational literature suggests that intense heat strain can cause damage to the kidneys in the form of acute kidney injury (AKI), even independent of conditions like heat stroke and rhabdomyolysis. An epidemic of chronic kidney disease in Central America and other regions around the world has placed additional attention on the potential of recurrent heat stress-related AKI to cause chronic kidney disease (CKD) over time (Johnson et al., 2019; Schlader et al., 2019). Working in the heat has also been associated with the development of kidney stones among workers outside the U.S., likely a result of decreased urine volume leading to increased concentration of minerals in the urine that crystallize into stones.

Each kidney is comprised of hundreds of thousands of functional units called nephrons. Each nephron has multiple parts, including the glomerulus (a cluster of blood vessels that conduct the initial filtering of large molecules) and the tubules (tubes that reabsorb needed water and minerals and secrete waste products). The fluid that remains after traveling through the glomeruli and tubules becomes urine and is eliminated from the body (NIDDK, 2018).

This section will discuss three kidney-related health effects associated with heat exposure: kidney stones, AKI, and CKD.

II. Kidney Stones.

A. Introduction.

Kidney stones are hard objects that form in the kidney from the accumulation of minerals. They range in size from a grain of sand to a pea (NIDDK, 2017a). Symptoms

include sharp pain in the back, side, lower abdomen, or groin; pink, red, or brown blood in the urine; a constant need to urinate; pain while urinating; inability to urinate or only able to urinate a small amount; and cloudy or foul-smelling urine (NIDDK, 2017b). Nausea, vomiting, fever, and chills are also possible, and symptoms may be brief, prolonged, or come in waves (NIDDK, 2017b). In rare cases or when medical care is delayed, kidney stones can lead to complications including severe pain, urinary tract infections (UTI), and loss of kidney function (NIDDK, 2017a). Risk factors for kidney stones include being male, a family history of kidney stones, having previously had kidney stones, not drinking enough liquids, other medical conditions (e.g., chronic inflammation of the bowel, digestive problems, hyperparathyroidism, recurrent UTIs), drinking sugary beverages, and working in the heat, especially if unacclimatized (NIDDK, 2017a; Maline and Goldfarb, 2024). NIOSH has also cautioned workers that experiencing chronic dehydration can increase the risk of developing kidney stones (NIOSH, 2017a).

B. Physiological Mechanisms.

Kidney stones form when concentrations of minerals are high enough to the point of forming crystals, which then aggregate into a stone in either the renal tubular or interstitial fluid (Ratkalkar and Kleinman, 2011). Reduced urine volume, altered urine pH, diet, genetics, or many other factors may cause this concentration of minerals (Ratkalker and Kleinman, 2011). Heat exposure has the potential to cause kidney stones through heat-induced sweating and dehydration. Loss of extracellular fluid increases osmolality (i.e., increased concentration of solutes, like sodium and glucose) which leads to increased secretion of vasopressin, an antidiuretic hormone. Vasopressin signals to the kidneys to conserve water by reducing urine volume, leading to increased concentration of relatively insoluble salts, like calcium oxalate, in the urine. These salts can eventually form crystals which can develop into stones (Fakheri and Goldfarb, 2011).

C. Occupational Heat Exposure and Kidney Stones.

Epidemiological studies conducted outside the U.S. have documented the association between working in heat and developing kidney stones. One of the earliest publications on occupational heat and kidney stones was a small study of beach lifeguards in Israel (Better et al., 1980). Eleven of 45 randomly selected lifeguards (24%) were found to have had kidney stones, which Better et al. noted was approximately 20 times the incidence rate of the general Israeli population at the time. The authors attributed this finding to low urine output due to dehydration, hyperuricemia (elevated levels of uric acid in the blood), and absorptive hypercalciuria (elevated levels of calcium in the urine), among other factors. In 1992, Pin et al. compared outdoor workers exposed to hot environmental conditions to indoor workers exposed to cooler conditions (Pin et al., 1992). This study of 406 men in Taiwan included quarry, postal, and hospital engineering support workers. The prevalence of kidney stones was found to be significantly higher in the outdoor workers than the indoor workers (5.2% versus 0.85%, $p<0.05$). The authors posited that chronic dehydration from working outdoors in a tropical environment might explain the higher prevalence of kidney stones among outdoor workers (Pin et al., 1992).

Several studies have also considered occupational exposure to indoor heat sources. Borghi et al. studied machinists who had been working in the blast furnaces of a glass plant in Parma, Italy for five or more years, excluding those who had kidney stones before working at the plant (Borghi et al., 1993). The prevalence of kidney stones was significantly higher among machinists exposed to heat (n=236) than among those working in cooler temperatures (n=165) (8.5% vs. 2.4%, p=0.03) (Borghi et al., 1993). An analysis of risk factors revealed that workers in the heat lost substantially more water to sweat and that their urine had higher concentrations of uric acid, higher specific gravity, and lower pH than workers in normal temperatures (Borghi et al., 1993).

In a large study in Brazil, the prevalence of at least one episode of kidney stones was 8.0% among the 1,289 workers in hot areas, which was significantly higher than the 1.75% prevalence found among the 9,037 people working in room temperature conditions ($p<0.001$) (Atan et al., 2005). An analysis of a subset of workers demonstrated that workers in hot temperatures had significantly less citrate in their urine ($p=0.03$) and lower urinary volume ($p=0.01$) compared to room-temperature workers.

Venugopal et al. studied 340 steel workers in southern India engaged in moderate to heavy labor with three or more years of heat exposure (Venugopal et al., 2020). Of the 340 participants, 91 workers without other risk factors for kidney disease, but who had reported a symptom of kidney or urethral issues, underwent renal ultrasounds, which revealed that 27% had kidney stones. 84% of the participants with kidney stones were occupationally exposed to heat, as defined as working in conditions above the ACGIH TLV. Having five or more years of heat exposure was significantly associated with risk of kidney stones, while controlling for smoking (OR: 3.6, 95% CI: 1.2, 10.7).

Most recently, Lu et al. studied 1,681 steel workers in Taiwan, 12% of whom had kidney stones, compared to the age-adjusted prevalence among men in Taiwan of 9% (Lu et al., 2022). Heat exposure was found to be positively associated with prevalence of stones, particularly among workers ≤ 35 years old (OR: 2.7, 95% CI: 1.2, 6.0) (Lu et al., 2022).

Overall, the peer-reviewed literature supports occupational heat exposure as a risk factor for kidney stones, in both indoor and outdoor environments, across multiple countries, and in several industries.

D. Treatment and Recovery.

Treatment of kidney stones depends on their size, location, and type. Someone with a small kidney stone may be able to pass it by drinking plenty of water and taking pain medications as prescribed by a doctor (NIDDK, 2017c). Larger kidney stones can

block the urinary tract, cause intense pain, and may require medical intervention such as shock wave lithotripsy, cystoscopy, ureteroscopy, or percutaneous nephrolithotomy to remove or break up the stone (NIDDK, 2017c). Percutaneous nephrolithotomy, whereby kidney stones are removed through a surgical incision in the skin, requires several days of hospitalization, but the other interventions typically do not require an overnight hospital stay (NIDDK, 2017c). One study found that among working aged adults, approximately one third of people treated for kidney stones miss work and that they miss, on average, 19 hours of work per person (Saigal et al., 2005). With monitoring or treatment, people typically recover from kidney stones. However, over the long term, individuals who develop kidney stones are at increased risk of chronic kidney disease and end-stage renal disease, particularly if kidney stones are recurrent (Uribarri, 2020).

E. Summary.

The available peer-reviewed scientific literature demonstrates occupational heat exposure as a risk factor for kidney stones, in both indoor and outdoor environments. Kidney stones may require medical treatment and in some cases hospitalization. Finally, individuals who develop kidney stones are at increased risk of other kidney diseases.

III. Acute Kidney Injury.

A. Introduction.

Acute kidney injury (AKI) can affect workers exposed to occupational heat. AKI is an abrupt decline in kidney function in a short period (e.g., a few days). As normally functioning kidneys filter blood and maintain fluid balance in the body, AKI events can disrupt this fluid balance, which can impact major organs like the heart. AKI can also have metabolic consequences, like a build-up of too much potassium in the blood (hyperkalemia) (Goyal et al., 2023). AKI is not always accompanied by symptoms and is typically diagnosed with blood and/or urine tests (e.g., increase in serum creatinine). While damage to the kidneys is one potential consequence of heat stroke

(such as in the context of multi-organ failure, as mentioned in Section IV.E., Heat Stroke), this section is focused on AKI that is not necessarily preceded by clinical heat stroke.

B. Physiological Mechanisms.

There are three categories of AKI used to distinguish the location of the cause(s) of AKI—prerenal, intrarenal, and postrenal (Goyal et al., 2023). Prerenal AKI represents a reduction in blood volume being delivered to the kidneys (i.e., renal hypoperfusion). This can be the result of heat-induced sweating that leads to reduced circulating blood volume. Prerenal AKI that is reversed (e.g., dehydration is quickly reversed) is typically not associated with impairment to the kidney glomeruli or tubules, however prolonged exposure can lead to direct injury to renal cells through ischemia (inadequate blood and oxygen supply to cells). Intrarenal AKI is when the function of the glomeruli, tubules, or interstitium are affected, such as in the case of nephrotoxic exposures (e.g., heavy metals) or prolonged ischemia. Rhabdomyolysis, which was previously discussed in Section IV.H., Rhabdomyolysis, is one potential cause of necrosis of tubular cells resulting from myoglobin precipitation and direct iron toxicity (Sauret et al., 2002, Patel et al., 2009). Postrenal AKI is when there is an obstruction to the flow of urine, such as kidney stones, pelvic masses, or prostate enlargement. Postrenal AKI is less relevant to a discussion of heat-related health effects, apart from kidney stones, which is discussed in Section IV.M.II., Kidney Stones.

Researchers have written specifically about potential mechanisms leading from occupational heat exposure to AKI (Roncal-Jiménez et al., 2015; Johnson et al., 2019; Schlader et al., 2019; Hansson et al., 2020), often in the context of chronic kidney disease. As previously discussed in Section IV.B., General Mechanisms of Heat-Related Health Effects, working in the heat can lead to increases in core temperature and reductions in circulating blood volume. Researchers hypothesize that elevated core

temperature could directly injure renal tissue or that injury could be mediated through subclinical (mild and asymptomatic) rhabdomyolysis or increases in intestinal permeability that can cause inflammation. Reductions in blood volume could inflame or injure the kidneys through reduced renal blood flow that leads to ischemia and/or local reductions in adenosine triphosphate (ATP) availability. Reduced blood flow and increased blood osmolality also trigger physiologic pathways (e.g., renin-angiotensin-aldosterone system, polyol-fructokinase pathway) which are energy-intensive and may lead to oxidative stress and inflammation. Other mechanistic pathways under investigation include urate crystal-induced injury (Roncal-Jiménez et al., 2015) and increased reabsorption of nephrotoxicants (Johnson et al., 2019).

C. Identifying Cases of Acute Kidney Injury.

Serum creatinine levels are used in clinical settings to estimate kidney function (glomerular filtration rate, or GFR), as it is typically produced in the body at a relatively stable rate and is removed from circulation by the kidneys. Multiple criteria exist for defining AKI based on increases in serum creatinine over hours or days, such as the KDIGO criteria published by a non-profit organization that produces recommendations on kidney disease (KDIGO, 2012). There are multiple factors that could affect the reliability of using serum creatinine to estimate GFR, including the increased production of creatinine during exercise. As a result of the limitations of serum creatinine, there is growing use of alternative biomarkers to identify cases of AKI, which may be more reliable and specific to AKI, such as neutrophil gelatinase-associated lipocalin, or NGAL.

D. Experimental Evidence.

Researchers have documented an association between heat strain and biomarkers of AKI in controlled experimental conditions. In 2013, Junglee et al. documented elevations in urine and plasma NGAL and reductions in urine flow rate in participants

after a heat stress trial that induced elevations in core temperature and reductions in body mass (an indication of hydration status) (Junglee et al., 2013). These increases in NGAL were higher in an experimental group that underwent a muscle damaging, downhill (-10% gradient) run (compared to a non-muscle damaging run on a 1% gradient) prior to the heat stress trial, providing support for the argument that subclinical rhabdomyolysis may be a pathway from heat stress to kidney injury. Schlader et al. conducted a trial in which participants wearing firefighting gear completed two separate exercise trials in hot conditions of different durations. The longer duration trial was intended to induce higher levels of heat strain, while the shorter duration was intended to induce lower levels (Schlader et al., 2017). The researchers found that the longer trial was associated with elevated core temperature and reduced blood volume, as well as increases in serum creatinine and plasma NGAL, suggesting the magnitude of kidney injury may be proportional to the magnitude of heat strain. McDermott et al. tested longer durations of exercise in the heat (5.7 ± 1.2 hours) and similarly found elevations in serum creatinine and serum NGAL from before the trial to after (McDermott et al., 2018). To determine whether it is elevated core temperature or reduced blood volume that primarily drives heat-induced AKI, Chapman et al. conducted four trials in which subjects exercised for two hours in the same conditions, but received different interventions (water, cooling, water plus cooling, and no intervention) (Chapman et al., 2020). The group with no intervention had the highest levels of urinary AKI biomarkers in the recovery period, whereas the water and cooling groups each experienced reductions in AKI biomarker levels relative to the control group. The researchers concluded that limiting hyperthermia and/or dehydration reduces the risk of AKI.

The relationship between AKI and hyperthermia and/or dehydration has also been demonstrated in animal models (Hope and Tyssebotn 1983; Miyamoto 1994; Roncal-Jiménez et al., 2014; Sato et al., 2019).

E. Cases of Occupational Heat-Related AKI.

In addition to experimental evidence, heat-related AKI has also been observed in "real world" conditions going back to the 1960s. In 1967, Schrier et al. documented evidence of military recruits developing AKI (referred to as "acute renal failure") following training exercises in the heat (Schrier et al., 1967). It was soon after reported that AKI cases linked to exercise in the heat represented a sizeable portion (approximately 10%) of all AKI cases treated at Walter Reed General Hospital in the early 1960s (Schrier et al., 1970).

More recently, serum creatinine-defined AKI has been observed in agricultural workers in both Florida and California. Among a cohort of field workers from the Central Valley of California, Moyce et al. report a post-work shift incidence of AKI of 12.3% (35 of 283 workers) (Moyce et al., 2017). Workers with heat strain, characterized by increased core temperature and heart rate, were significantly more likely to have AKI (OR: 1.34, 95% CI: 1.04, 1.74). Among a cohort of agricultural workers in Florida, Mix et al. found that heat index (based on nearest weather monitor) was positively associated with the risk of AKI - 47% increase in the odds of AKI for every 5°F increase in heat index. The authors reported an incidence of AKI of 33% (i.e., 33% of workers had AKI on at least one day of monitoring) in this study (Mix et al., 2018).

OSHA researchers have also identified cases of heat-related AKI among workers in the agency's own databases: the Severe Injury Reports (SIR) database and case files from consultations by the Office of Occupational Medicine and Nursing (OOMN) (Shi et al., 2022). Shi et al. identified 22 cases of heat-related AKI between 2010 and 2020 in the OOMN consultation records (based on serum creatine elevations meeting the KDIGO requirements) after excluding cases related to severe hyperthermia, multi-organ failure, or death. Using inclusion criteria of a heat-related OIICS code (172*) and a mention of AKI

in the narrative, they also identified 57 cases of probable heat-related AKI between 2015 and 2020 in the SIR database.

Studies conducted among workers outside the U.S. have also reported a relationship between working in the heat and acute elevations in serum creatinine or increased risk of AKI (García-Trabanino et al., 2015; Wegman et al., 2018; Nerbass et al., 2019; Sorensen et al., 2019).

There are a few limitations to these observational studies, such as the use of serum creatinine to characterize AKI, as described above. An additional limitation is the inability to determine from these studies whether the AKI observed is due to prerenal or intrarenal causes. As discussed in *Physiological Mechanisms*, prerenal AKI may be due to reductions in renal blood flow (which would be expected in cases of dehydration) and is not necessarily indicative of clinically significant structural injury. Another limitation may be the use of serum creatinine measures taken over relatively short spans of time, which may be too short to see true reductions in GFR (Waikar and Bonventre, 2009). However, there are a growing number of studies that find a relationship between short-term fluctuations in serum creatinine and longer-term declines in kidney function among outdoor workers (see discussion in Section IV.M.IV., Chronic Kidney Disease).

F. Treatment and Recovery.

There is a spectrum of severity for AKI. For example, some individuals may not know they are experiencing AKI without a serum or urine test. There is also a spectrum of time and medical treatment needed for recovery, dependent on whether the AKI is quickly reversed or sustained for longer periods of time. In Schlader et al. 2017, researchers noted that the biomarkers of AKI for participants in their trial returned to baseline the following day. However, intrarenal causes of AKI may require longer periods of time for recovery and may potentially require the need for medication or dialysis (Goyal et al., 2023). AKI can be severe, which can be the case when resulting

from heat stroke, where it may represent irreversible damage to the kidneys and can be fatal (Roberts et al., 2008; King et al., 2015; Wu et al., 2021). Recurrent AKI may also lead to chronic kidney disease (as discussed in Section IV.M.IV., Chronic Kidney Disease).

G. Summary.

The available peer-reviewed scientific literature, both experimental and observational studies, suggests that occupational heat exposure causes AKI among workers. However, there are limitations in the case definitions used to define AKI in observational settings.

IV. Chronic Kidney Disease.

A. Introduction.

Chronic kidney disease (CKD) is a progressive disease characterized by a gradual decline in kidney function over months to years. It is typically asymptomatic or mildly symptomatic until later stages of the disease, when symptoms such as edema, weight loss, nausea, and vomiting can occur (NIDDK 2017d). People with CKD can be at a greater risk for other health conditions, like AKI, heart attacks, hypertension, and stroke. The diagnosis typically requires multiple blood and urine tests taken over time (NIDDK 2016). Typical risk factors for CKD include hypertension and diabetes.

Epidemics of CKD in Central America and other pockets of the world, such as India and Sri Lanka, that appear to be afflicting mostly young, outdoor workers with no history of hypertension or diabetes have raised questions about whether working in hot conditions can cause the development of CKD (Johnson et al., 2019). Researchers have been investigating this question and the cause of the epidemic over the past 20 years, including other potential exposures, such as heavy metals, agrichemicals, silica, and infectious agents (Crowe et al., 2020).

B. Physiological Mechanisms.

Researchers have proposed that working in the heat could lead to the development of CKD through repetitive AKI events (see discussion of heat-related mechanisms in Section IV.M.III., Acute Kidney Injury). However, some researchers acknowledge the possibility that the unexplained CKD cases observed in Central America and elsewhere may instead represent a chronic disease process that begins earlier in life which places workers at increased risk of AKI (Johnson et al., 2019; Schlader et al., 2019). Additionally, as discussed above in Section IV.M.III., Acute Kidney Injury, some occupational cases of AKI could be transient, the result of prerenal causes, and possibly unrelated to the development of CKD.

Independent of the epidemic of unexplained CKD, frequent and/or severe AKI has been identified as a risk factor for developing CKD (Ishani et al., 2009; Coca et al., 2012; Chawla et al., 2014; Hsu and Hsu 2016; Heung et al., 2016). The relationship between heat-related AKI and risk of developing CKD is untested in the experimental literature because of the ethical implications (Schlader et al., 2019; Hansson et al., 2020).

As discussed in Section IV.E., Heat Stroke, there is also evidence that experiencing heat stroke may increase an individual's risk of developing CKD (Wang et al., 2019; Tseng et al., 2020).

C. Identifying Cases of Chronic Kidney Disease.

As discussed previously in the context of AKI, serum creatinine is commonly used to estimate glomerular filtration rate (GFR), the indicator of kidney function. When measures of serum creatinine (and therefore estimates of GFR) are taken over periods of months to years, medical professionals can determine if an individual's kidney function is declining. CKD is typically diagnosed when the estimated GFR is below a rate of 60 mL/min/1.73m^2 for at least 3 months, although there are other indicators, like a high albumin-to-creatinine ratio. There are various stages of CKD; the final stage is called

end-stage renal disease (ESRD) and represents a point at which the kidneys can no longer function on their own and require dialysis or transplant.

D. Observational Evidence.

There is a growing body of evidence that suggests that heat-exposed workers who experience AKI (or short-term fluctuations in serum creatinine) are at greater risk of experiencing declines in kidney function over a period of months to years. For instance, sugarcane workers in Nicaragua who experienced cross-shift increases (i.e., increase from pre-shift to post-shift) in serum creatinine at the beginning of the harvest season were more likely to experience declines in estimate GFR nine weeks later (Wesseling et al., 2016). Another study conducted among Nicaraguan sugarcane workers found that approximately one third of workers who experienced AKI during the harvest season had newly decreased kidney function (greater than 30% decline) and a measure of estimated GFR of less than 60 mL/min/1.73m2 one year later (Kupferman et al., 2018). In an analysis among Guatemalan sugarcane workers, Dally et al. found that workers with severe fluctuations in serum creatinine over a period of 6 workdays had greater declines in estimated GFR (-20% on average) (Dally et al., 2020). In a separate study conducted in Northwest Mexico, researchers observed declines in estimated GFR among migrant and seasonal farm workers from March to July that were not observed in a reference group of office workers in the same region (López-Gálvez et al., 2021).

Further support for the hypothesis that working in the heat may lead to declines in GFR and increased risk of CKD comes from intervention studies in Central America, in which workers were given water-rest-shade interventions and observed longitudinally for kidney outcomes. In these studies, implementation of the heat stress controls was associated with reductions in the declines in kidney function and reduced rates of kidney injury (Glaser et al., 2020; Wegman et al., 2018).

While much of the literature is focused on Central American workers, OSHA did identify one paper conducted among a cohort of U.S. firefighters. Pinkerton et al. (2022) found lower than expected rates of ESRD in the cohort (relative to the general U.S. population) despite high levels of occupational exposure to heat. However, as the authors point out, this may be due to the healthy worker effect (i.e., a phenomenon in occupational epidemiology by which workers appear to be healthier than the general population due to individuals with health conditions leaving the workforce) (Pinkerton et al., 2022). The authors also examined associations between proxies for heat exposure and risk of developing ESRD and found non-significant associations between the number of exposed days and all-cause ESRD, systemic ESRD, and hypertensive ESRD. Very few of the ESRD cases identified in this cohort were due to interstitial nephritis (which would be most consistent with the CKD cases observed in Central America), limiting the authors' ability to examine associations between those cases and exposure.

There may be differences between the heat-exposed worker populations in Central America and the U.S. that could limit the ability to extrapolate findings from that region, such as differences in other potentially nephrotoxic exposures (e.g., agrichemicals, infectious agents). There is also evidence that children in regions with epidemics of unexplained CKD have signs of kidney injury (Leibler et al., 2021). Unfortunately, surveillance of CKD in the U.S. (namely the U.S. Renal Data System) may be missing cases among susceptible workers, such as migrant agricultural workers, limiting the ability to detect a potential epidemic of heat-related CKD in this country.

In addition to the general lack of studies conducted among U.S. workers, there may be other limitations with these observational studies, such as limited data on longer-term follow-up (i.e., years instead of months) and the potential for reverse causality (i.e., undetected CKD is causing AKI).

E. Treatment and Recovery.

Often kidney disease gets worse over time and function continues to decline as scarring occurs (NIDDK 2017d). As discussed above, late-stage CKD (or ESRD) requires dialysis or a kidney transplant for an individual to survive. Kidney failure is permanent. Having even early-stage CKD may impair workers' urine concentrating ability, which could increase their heat strain and risk of HRIs while working (Petropoulos et al., 2023).

F. Summary.

There is growing evidence suggesting that heat stress and dehydration may be contributing to an epidemic of CKD among workers in Central America and other parts of the world, although the cause is still being investigated by researchers. There is currently limited information as to whether this type of CKD is affecting U.S. workers and if so, to what extent. Experiencing heat stroke has been identified in the literature as a risk factor for developing CKD.

N. Other Health Effects.

I. Introduction.

In addition to the health effects discussed in the previous sub-sections, heat exposures have also been linked to reproductive health effects. Additionally, health effects have been associated with prior episodes of heat illness.

II. Reproductive and developmental health effects.

There is mixed evidence that heat affects reproductive and developmental health outcomes. NIOSH reported two mechanisms by which heat may affect reproductive and developmental health: infertility (e.g., such as through damaged sperm) and teratogenicity (harm to the developing fetus, e.g., spontaneous abortion or birth defects) (NIOSH, 2016). NIOSH concluded that while human data about reproductive risks at exposure limits (see NIOSH, 2016, table 5-1, p. 70) were limited, results of research and

animal experiments support the conclusion heat-related infertility and teratogenicity are possible (NIOSH, 2016, p. 91).

More recent evidence, although also limited, continues to provide support of a reproductive risk to people who are pregnant and developmental risk to their children. Numerous epidemiological studies have reported that heat exposure during pregnancy is associated with poor outcomes, such as pre-term labor and birth and low-birth weight babies (e.g., Kuehn and McCormick, 2017; Basu et al., 2018; Chersich et al., 2020; Rekha et al., 2023). While most studies assess this relationship in the general population of pregnant women and do not specifically address occupational exposures, Rekha et al. show that occupational exposures to heat were associated with adverse pregnancy and fetal outcomes, as well as adverse outcomes during birth in a cohort of pregnant women in Tamil Nadu, India (Rekha et al., 2023). Although the mechanisms for these outcomes are unclear, a study of pregnant women conducting agricultural work or similar activities for their homes in The Gambia reported an association between heat exposure and fetal strain (through measures of fetal heart rate and umbilical artery resistance) (Bonell et al., 2022). Further, a recent longitudinal prospective cohort study in Germany found that heat exposure was associated with vascular changes in the uterine artery. This study reports that changes of increased placental perfusion and decreased peripheral resistance in the uterine artery indicate blood redistribution to the fetus during the body's response to heat stress. They also report increased maternal cardiovascular strain. This data may support a mechanistic role for uterine and placental blood flow changes during heat exposures in resultant birth outcomes, such as pre-term birth (Yuzen et al., 2023; Bonell et al., 2022).

There is evidence that occupational heat exposures can affect male reproductive health (e.g., Mieusset and Bujan, 1995). Some research studies report associations between occupational heat exposure and time to conceive (e.g., Rachootin and Olsen, 1983; Thonneau et al., 1997), sperm velocity (Figa-Talamanca et al., 1992), and measures

of semen quality such as sperm abnormalities (Rachootin and Olsen, 1983; Bonde, 1992; Figa-Talamanca et al., 1992; De Fleurian et al., 2009). Effects of heat on sperm have also been demonstrated in experiments in animal models (Waites, 1991). Cao et al. report that in their study of heat stress in mice, heat stress reduced sperm count and motility (Cao et al., 2023). In this study, the heat exposed mice were exposed to 38°C (100.4°F) temperatures for 2 hours per day for two weeks. When the mice were not being exposed to heat, they were kept at 25°C (77°F). Control mice were kept at 25°C for the duration of the study. Their study results indicate that reduced sperm quality may be a result of disrupted testicular microbial environment and disruption in retinol metabolism that occurs during heat stress. Although, the authors note that the heat exposure does not accurately mimic real world heat exposures in humans.

While it is accepted that heat impairs spermatogenesis, or development of sperm (e.g., MacLeod and Hotchkiss, 1941; Mieusset et al., 1987; Thonneau et al., 1997), some studies of occupational heat exposure find no relationship between heat and semen quality (Eisenberg ML et al., 2015). Another study found observable but not statistically significant associations between heat and semen quality (Jurewicz et al., 2014). Many studies of the effects of occupational heat exposure on reproductive outcomes are cross-sectional in nature and measure exposures through occupation categories or self-report answers on questionnaires (e.g., Figa-Talamanca et al., 1992; Thonneau et al., 1997; Jurewicz et al., 2014). These methods can be susceptible to recall bias and misclassification errors, which can reduce accuracy in characterizing the association between occupational heat exposures and reproductive health outcomes, and they are also unable to determine causality on their own. Additional research that quantifies occupational heat exposures directly (e.g., through measures of heat strain or on-site temperatures) would help to clarify the impacts of occupational heat exposures on male reproductive outcomes.

III. Health effects associated with prior episodes of heat illness.

A limited number of studies have focused on a variety of long-term effects following a prior episode of heat illness. This includes research by Wallace et al., also reviewed by NIOSH in the 2016 *Criteria for a Recommended Standard Occupational Exposure to Heat and Hot Environments*, whose retrospective case control study of military members found that those who experienced an exertional heat illness event earlier in life were more likely to die due to cardiovascular or ischemic heart disease (Wallace et al., 2007). Similarly, Wang et al. reports that, in their retrospective cohort study in Taiwan, prior heat stroke was associated with a higher incidence of acute ischemic stroke, acute myocardial infarction, and an almost three-fold higher incidence of chronic kidney disease compared to patients who had other forms of heat illness or compared to the control group that had no prior heat illness, over the study's 14 year follow-up period (Wang et al., 2019). They also found significantly higher incidence of cardiovascular events, cardiovascular disease, and chronic kidney disease among individuals in the study who had other forms of heat illness (heat syncope, heat cramps, heat exhaustion, heat fatigue, heat edema and other unspecified effects) compared to the control group that had no prior heat illness. In a long-term follow-up study of military personnel who had experienced exertional heat illness, Phinney et al. reported a transient and small but observable increase in the rate of subsequent hospitalizations and decreased retention in the military (Phinney et al., 2001). While these studies suggest a relationship between episodes of serious heat illness and subsequent health effects, this body of research is small and subject to some limitations. The cross-sectional nature of some of these studies does not allow for determination of causality on their own. Additionally, given the retrospective nature of some of these studies it is possible that important confounding variables were not adjusted for in analyses, including occupation in some cases.

IV. Summary.

The description of evidence presented here demonstrates that there is some evidence to support a link between occupational heat exposures and adverse reproductive health outcomes. There is also limited evidence that prior episodes of heat illness may affect health outcomes later in life such as increased risk of cardiovascular disease and kidney diseases. This evidence of reproductive and developmental health effects and health effects associated with prior episodes of heat illness, while suggestive, is still nascent and requires further investigation.

O. Factors that Affect Risk for Heat-Related Health Effects.

I. Introduction.

This section discusses individual risk factors for heat-related injury and illness. The purpose of this discussion is to summarize the factors that may exacerbate the risk of workplace heat-related hazards and to provide information to better inform workers and employers about those hazards. However, exposure to workplace heat contributes to heat stress for all workers and can be detrimental to workers' health and safety regardless of individual risk factors. OSHA is not suggesting that application of the proposed standard would depend on an employer's knowledge or analysis of these factors for their individual workers. Nor do these individual risk factors detract from the causal link between occupational exposure to heat and adverse safety and health outcomes or an employer's obligation to address that occupational risk (see *Reich v. Arcadian Corp.*, 110 F.3d 1192, 1198 (5th Cir. 1997) (Congress intended the Act to protect all employees, "regardless of their individual susceptibilities"); *Pepperidge Farm, Inc.*, 17 O.S.H. Cas. (BNA) ¶ 1993 (O.S.H.R.C. Apr. 26, 1997) (that non-workplace factors may render some workers more susceptible to causal factors does not preclude finding the existence of an occupational hazard); see also *Bldg. & Const. Trades Dep't, AFL-CIO v. Brock*, 838 F.2d 1258, 1265 (D.C. Cir. 1988) (holding that OSHA did not err in including smokers in its

analysis of the significant risk posed by occupational exposure to asbestos, despite the "synergistic effects" of smoking and asbestos)). Many factors can influence an individual's risk of developing heat-related health effects. These factors include variation in genetics and physiology, demographic factors, certain co-occurring health conditions or illnesses, acclimatization status, certain medications and substances, and structural factors (e.g., economic, environmental, political and institutional factors) that lead to disproportionate exposures and outcomes. Although there is a lack of evidence that explores the full extent to which these factors interact to affect heat-related health effects, or how various risk factors compare in their impacts, there is evidence that each of these factors can affect risk of heat-related health effects. This section focuses on factors that relate to an individual's health status. For an in-depth discussion on acclimatization as a risk factor, see Section V., Risk Assessment, and for an in-depth discussion on demographic factors and structural factors that affect risk of heat-related illness, see Section VIII.I., Distributional Analysis.

II. Risk Factors.

There are a number of factors that can impact an individual's response to heat stress and lead to variation in heat stress response between individuals. These include variation in genotype (Heled et al., 2004), gene expression (Murray et al., 2022), body mass and differences in thermoregulation between the biological sexes (Notley et al., 2017), differences in thermoregulation as people age (e.g., Pandolf 1997, Kenny et al., 2010; Kenny et al., 2017), and pregnancy (Wells, 2002; NIOSH, 2016). Normal variation across individuals in genetics, physiology, and body mass results in variation in how individuals respond to heat stress. There is some evidence that, at least in some specific populations, variation in genotype (i.e., genetic makeup) can affect heat storage and heat strain (Heled et al., 2004; Gardner et al., 2020). Normal variation in body mass can also correspond to variation in thermoregulation between individuals (e.g., Havenith et al.,

1998). Results from Havenith et al.'s experimental study of heat stress under different climate and exercise types indicates that one reason for this effect may be due to the relationship between size and surface area of the skin which plays an important role in cooling capacity (Havenith et al., 1998). A more detailed discussion of the relationship between obesity and heat stress response can be found below.

There is some evidence that biological sex could be considered a risk factor for heat-related illness, although the evidence is mixed. Some studies find differences in heat stress response between males and females (e.g., Gagnon et al., 2008; Gagnon and Kenny, 2011; Gagnon and Kenny, 2012). These differences may be due to differences in body mass (Notley et al., 2017), lower sweat output in females or differences in metabolic heat production (Gagnon et al., 2008; Gagnon and Kenny, 2012). However, recent experimental data assessing differences in thermoeffector responses (autonomic responses that affect thermoregulation, such as skin blood flow and sweat rate) between males and females exposed to exercise show that differences between the sexes in heat stress response are mostly explained by differences in morphology (body shape and size and the resultant mass-surface ratios) (Notley et al., 2017). Although, Notley et al.'s (2017) experiment only involved heat environments where enough heat could be lost so that the body does not continue to gain heat (compensable heat stress), so it is unclear if an increased effect due to biological sex would occur in conditions where heat gain is expected, such as in occupational settings where environmental heat or environmental heat and exertion exceed the body's ability to cool.

Healthy aging processes can also make individuals more susceptible to heat-related illness. Aging may impact thermoregulation through reduced cardiovascular capacity (Minson et al., 1998; Lucas et al., 2015), reduced cutaneous vasodilation (the widening of blood vessels at the skin to aid heat loss), sweat rate, altered sensory function (Dufour and Candas, 2007; Wong and Hollowed, 2017), and changes in fluid balance and

thirst sensation (Pandolf, 1997). Observational evidence tends to show that elderly individuals, particularly those with co-existing chronic or acute diseases, are at highest risk for morbidity or mortality related to heat exposures, and that risk increases with age (e.g., Semenza et al., 1999; Fouillet et al., 2006; Knowlton et al., 2008). However, experimental evidence shows that, under certain conditions, when individuals are matched for fitness level and body build and composition, middle-aged individuals can compensate for heat exposures similarly to younger adults (Lind et al., 1970; Pandolf, 1997, Kenny et al., 2017). Conversely, observational studies of occupational populations often find that younger workers experience greater rates of heat-related illness than do older workers (e.g., Harduar Morano et al., 2015; Hesketh et al., 2020; Heinzerling et al., 2020). While it is unclear why younger workers appear to have greater rates of heat-related illness in epidemiological data, Heinzerling et al. (2020) suggest that this could be a result of a greater number of younger workers being employed in high-risk occupations. Further, younger workers have less work experience, meaning that younger workers are less familiar with the heat risks associated with their jobs, how their body responds to heat, and/or how to respond if they experience symptoms of heat-related illness.

Health status is another factor that plays a role in how someone responds to heat stress (e.g., Semenza et al., 1999; Knowlton et al., 2008; NIOSH, 2016; Vaidyanathan et al., 2019, 2020). Conditions such as cardiovascular disease and diabetes can affect risk of heat-related illness (e.g., Kenny et al., 2016; Kenny et al., 2018). The cardiovascular system plays an integral role in thermoregulation and heat stress response (Costrini et al., 1979; Lucas et al., 2015; Wong and Hollowed, 2017; Kenny et al., 2018). Cardiovascular diseases can affect the heart and blood vessels, increasing cardiovascular strain and decreasing cardiovascular function and thermoregulatory capacity (Kenny et al., 2010) and, as a result, increase risk of heat-related illness during heat stress (Kenny et al., 2010; Semenza et al., 1999). For example, people with hypertension (i.e., high blood pressure)

may be at increased risk of heat-related illness due to changes in skin blood flow that can impair heat dissipation during heat stress (Kenny et al., 2010). Further, many individuals with hypertension and cardiovascular diseases may take prescription medications that reduce thermoregulatory functions, through mechanisms like reduced blood flow to the skin, which can increase sensitivity to heat (Wee et al., 2023). Studies estimate that a substantial percentage of the population, and therefore the population of workers, have the type of health status (i.e., having a chronic condition such as cardiovascular diseases) (Boersma et al., 2020; Watson et al., 2022) that could affect their response to heat stress. For example, Watson et al. (2022) estimate that of the 46,781 surveyed adults between the ages of 18 and 34 who reported being employed, 26.1% have obesity, 11% have high blood pressure, and 9.7% have high cholesterol. Additionally, 19.4 % were estimated to have depression, which is sometimes treated with medications that can affect thermoregulation.

Diabetes and obesity are other factors that may affect risk of developing heat-related illness (Kenny et al., 2016). Both diabetes and obesity may affect thermoregulation by reducing a person's ability to dissipate heat through changes in skin blood flow and sweat response (Kenny et al., 2016). While some evidence shows that individuals with well-controlled diabetes may be able to maintain normal thermoregulatory capacity (Kenny et al., 2016), some evidence indicates that individuals with poorly controlled diabetes (Kenny et al., 2016) or older individuals with Type 2 diabetes (Notley et al., 2021) may experience decreased heat tolerance. Obesity has also been identified as a risk factor for exertional heat illness in the military (e.g., Bedno et al., 2014; Nelson et al., 2018b; Alele et al., 2020). Gardner et al. (1996) reported increasing risk of exertional heat illness among male Marine Corps recruits as BMI increased. Additionally, a smaller body mass to surface area ratio can reduce capacity for heat loss since surface area is relatively smaller in relationship to mass (Bar-Or et al., 1969; Kenny

et al., 2016). Differences in tissue properties between adipose (fat) tissue and other body tissues may indicate that a higher body fat mass can lead to greater rises in core temperature for a given amount of heat storage in the body (Kenny et al., 2016).

Beyond chronic health conditions, prior episodes of significant heat-related illness and recent or concurrent acute illness or infection may also affect an individual's response to heat stress and increase the risk of heat-related illness (e.g., Carter et al., 2007; Nelson et al., 2018a; Nelson et al., 2018b; Alele et al., 2020). Reviews of research and case studies of heat-related illness indicate that acute illnesses that may affect risk of heat-related illness include upper respiratory infections and gastrointestinal infections (Casa et al., 2012; Alele et al., 2020). However, statistical evidence is limited (Alele et al., 2020). Leon and Kenefick (2012) discuss results from a study of four marine recruits who presented with exertional heat illness and who also had an acute illness separate from heat-related illness. The recruits' blood tests showed elevated levels of immune-related substances which Leon and Kenefick identify as being substances that are both mediators of viral infection symptoms and substances associated with exertional heat illness. Leon and Kenefick interpret this observation, along with evidence from a study on rats that showed that bacteria exposure exacerbated inflammation and organ dysfunction due to heat stress, to suggest that pre-existing inflammatory states, such as those that occur with acute viral illness, compromise the ability to thermoregulate appropriately (Carter et al., 2007; Leon and Kenefick, 2012) (see also Bouchama and Knochel, 2002). Several studies in military populations also show that a prior heat illness may increase risk of a future episode of heat illness (Nelson et al., 2018b; Alele et al., 2020). Assessments of heat and epigenetics (the study of how the environment and behavior affects genes) suggest that the complex physiological responses to heat impact genetic mechanisms that could play a role in increasing susceptibility to future heat illness following an episode of heat illness (Sonna et al., 2004; Murray et al., 2022).

Certain medications can also affect thermoregulation and risk of heat-related illness. Medications that may decrease thermoregulatory capability include medications that treat cardiovascular diseases, diabetes, neuropsychiatric diseases, neurological diseases, and cancer (Wee et al., 2023). Some of these medications affect thermoregulation by directly affecting the region of the brain that controls thermoregulation or through other central nervous system effects (e.g., antipsychotics, dopaminergics, opioids, amphetamines) (Cuddy, 2004; Stollberger et al., 2009; Musselman and Saely, 2013; Gessel and Lin, 2020; Wee et al., 2023). Other medications affect thermoregulation through effects on heat dissipation that occur due to changes in sweat response and/or blood flow to the skin (e.g., anticholinergics, antihypertensives, antiplatelets, some antidepressants and antihistamines, aspirin) (see, e.g., Freund et al., 1987; Cuddy, 2004; Stollberger et al., 2009; Wee et al., 2023; CDC, 2024b). There are also medications that may affect ability to perceive heat and exertion (e.g., dopaminergics) (Wee et al., 2023). Some medications can affect electrolyte balances (e.g., diuretics, beta-blockers, calcium channel blockers, and antacids) (CDC, 2024b). When accompanied by dehydration, some medications also pose a toxicity risk (e.g., apixaban, lithium, carbamazepine) (CDC, 2024b). Finally, some medications can affect fluid volume, kidney function, hydration status, thirst perception, or cardiac output (e.g., diuretics, ACE inhibitors, some anti-diabetics, beta-blockers, non-steroidal anti-inflammatories (NSAIDs), tricyclic antidepressants, laxatives, and antihistamines) (Stollberger et al., 2009; Wee et al., 2023; CDC, 2024b). The NIOSH *Criteria for a Recommended Standard for Occupational Exposure to Heat and Hot Environments* (table 4-2), the Department of the Army's Technical Bulletin 507 (table 4-2), and CDC's *Heat and Medications – Guidance for Clinicians* contain additional information about classes of medications and the proposed mechanisms for how they affect thermoregulation (NIOSH, 2016; Department of the Army, 2022; CDC, 2024b).

Medications that can affect how individuals respond to heat are used by a significant portion of the U.S. population. Survey data from the National Health and Nutrition Examination Survey from 2015-2016 showed that 60% of adults aged 40-79 used a prescription medication within the last thirty days and approximately 22% of adults in that same age range took five or more prescription medications (Hales et al., 2019). Many of the medications reported by survey respondents are medications that can affect an individual's response to heat (e.g., commonly used blood pressure and diabetes medications).

Amphetamines (whether prescription or illicit), methamphetamines, and cocaine can also affect thermoregulation and increase risk of heat-related illness (NIOSH, 2016; Department of the Army, 2022). These substances can affect the central nervous system's thermoregulatory functions, stimulate heat generation, and reduce heat dissipation through vasoconstriction (Cuddy, 2004). The synergy between the hyperthermia induced by these substances, physical activity, and heat exposure can increase risk of heat-related illness (Kiyatkin and Sharma, 2009). Analyses of occupational heat-related fatalities find amphetamines and methamphetamines to be an important risk factor (Tustin et al., 2018a, Karasick et al., 2020; Lin et al., 2023). In Lin et al.'s 2023 review of heat-related hospitalizations and fatalities documented through NIOSH *Fatalities in Oil and Gas Database* (2014-2019) and OSHA's Severe Injury Report Database (2015-2021), 50% of identified fatalities occurred in workers that had tested positive for amphetamines or methamphetamines after they died. However, small sample sizes, sampling strategies, and incomplete data have so far limited the ability of studies to fully characterize the association between these substances and risk of heat-related illness or fatality. Poor data quality or limited data has also limited current studies from concluding if and when amphetamine-like substances are from prescription or non-prescription use.

Alcohol and caffeine use may also affect risk of heat-related illness through effects on hydration status and heat tolerance (NIOSH, 2016; Tustin, 2018; Department of the Army, 2022). There have been cases of fatalities due to occupational heat exposure in individuals with a history of "alcohol abuse or high-risk drinking" (Tustin et al., 2018a, p. e385). Both alcohol and caffeine may affect how someone responds to heat stress due to their ability to cause loss of fluids and subsequently dehydration, and alcohol also affects central nervous system function (NIOSH, 2016). In the case of caffeine, it appears that moderate consumption associated with normally caffeinated beverages (e.g., one cup of coffee, tea, soda) may not interfere with thermoregulation in a way that negatively affects response to heat stress (NIOSH, 2016; Kazman et al., 2020; Department of the Army, 2022). However, heavily caffeinated beverages, such as energy drinks, have been linked to negative health outcomes (Costantino et al., 2023) and could potentially exacerbate heat stress through diuretic (salt and water loss) mechanisms and cardiovascular strain (NIOSH, 2016). Overall, there is a lack of robust data that quantify the specific amounts of alcohol or caffeine that are problematic for heat stress response. However, experts generally advise against drinking alcohol or caffeinated beverages before or during work or exercise in the heat (NIOSH, 2016; Department of the Army, 2022; CDC, 2022).

III. Summary.

The evidence presented in this section demonstrates that there are numerous factors that can affect risk of heat-related illness (e.g., genetics, age, body mass, some chronic conditions, prescription medications and drugs). Because prevalence data show that a majority of working-age adults live with or experience at least one risk factor, these factors should be considered an important component of understanding how individuals can be at increased risk for heat-related illness. OSHA acknowledges, however, that for most of the described risk factors, the evidence is not robust enough to determine the full

picture of how the factor impacts risk of heat-related illness or to establish the degree to which the risk factor contributes to overall risk of developing heat-related illness. There is also a lack of evidence evaluating the way in which multiple risk factors combine to affect risk of heat-related health outcomes.

P. Heat-Related Injuries.

I. Introduction.

In addition to heat-related illnesses, heat exposure can lead to a range of occupational heat-related injuries. A heat-related injury means an injury, such as a fall or cut, that is linked to heat exposure. A heat-related injury may occur as a result of a heat-related illness, such as a fracture following heat syncope. The association between heat exposure and heat-related injury among workers has been well documented over the last decade (Tawatsupa et al., 2013; Xiang et al., 2014b; Adam-Poupart et al., 2015; Spector et al., 2016; McInnes et al., 2017; Calkins et al., 2019; Dillender, 2021; Dally et al., 2020; Park et al., 2021; Negrusa et al., 2024). In particular, analyses of workers' compensation claim data has demonstrated the increased risk of occupational traumatic injury with increasing heat exposure (Xiang et al., 2014b; Adam-Poupart et al., 2015; Spector et al., 2016; McInnes et al., 2017; Calkins et al., 2019; Dillender, 2021; Park et al., 2021; Negrusa et al., 2024). These types of heat-related injuries can cause hospitalizations, extended time out of work, and reduced productivity. In some instances, a heat-related injury may be fatal, like in the event of accidents such as a slip, trip, or fall. In 1972, NIOSH identified occupational heat exposure as contributing to workplace injuries, and discussed how accidents and injuries were outcomes that could be prevented by a heat stress standard (NIOSH, 1972). Specifically, NIOSH highlighted how reduced physical and psychological performance, fatigue, accuracy of response, psychomotor performance, sweaty palms, and impaired vision may result in a workplace heat-related injury.

Since multiple types of injuries can be heat-related (e.g., strain, fracture, crushing) and the mechanisms underlying those injuries vary (e.g., impaired speed and reaction time, impaired vision, impaired dexterity), the identification and classification of heat-related injuries varies on a case-by-case basis. Although there are no ICD or OIICS codes specific to diagnosing heat-related injuries, medical professionals and occupational health professionals can combine a heat-related illness code with other injury related codes to indicate an injury is heat-related. An injury specifically attributed to heat would be expected to be assigned both a heat-related OIICS or ICD code and an injury OIICS or ICD code. Numerous researchers have used ICD and OIICS code to conduct studies on heat-related injuries (Dillender, 2021; Garzon-Villalba et al., 2016; Morabito et al., 2006; Spector et al., 2016).

This section first presents the epidemiological evidence of increasing occupational injuries during periods of hotter temperatures, followed by a discussion of mechanisms that can lead to heat-related injuries.

II. Occupational Heat-Related Injuries.

A multitude of studies have identified an association between heat exposure and occupational injury in the U.S. (Knapik et al., 2002; Fogleman et al., 2005; Garzon-Villalba et al., 2016; Spector et al., 2016; Calkins et al., 2019; Dillender, 2021; Park et al., 2021; Negrusa et al., 2024). These analyses primarily rely on workers' compensation claim data and meteorological data and are often case-crossover or observational time-series in design.

In two studies of outdoor agricultural workers (Spector et al., 2016) and outdoor construction workers (Calkins et al., 2019) in Washington State, traumatic injury claims were significantly associated with heat exposure. Among outdoor agricultural workers (n=12,213 claims), Spector et al. (2016) found a statistically significant increased risk of traumatic injuries at a daily maximum humidex (the apparent, or "feels like," temperature

calculated from air temperature and dew point, similar to heat index) above 25°C (77°F). Among outdoor construction workers (n=63,720 claims), Calkins et al. (2019) found an almost linear statistically significant association between traumatic injury risk and humidex. Both studies reported that injuries most commonly resulted from falls or bodily reaction and exertion, which may include sudden occurrences of strains, sprains, fractures, or loss of balance, among others (Spector et al., 2016; Calkins et al., 2019).

Using workers' compensation claim data from Texas, Dillender (2021) found that hotter temperatures resulted in larger percent increases in traumatic injuries among two similar sets of injury types, "open wounds, crushing injuries, and factures" and "sprains, strains, bruises, and muscle issues." Park et al. (2021) examined over 11 million workers' compensation records in California and estimated that approximately 20,000 additional injuries per year between 2001 and 2018 were related to hotter temperatures. In comparison to a day with temperatures in the 60s°F, the risk of occupational heat-related injury increased by 5-7% ($p<0.05$) and 10-15% ($p<0.05$) on days with high temperatures between 85-90°F and above 100°F, respectively (Park et al., 2021).

In these case-crossover studies, cases serve as their own controls, allowing for variables such as age, sex, race, and ethnicity, as well as other known and unknown time-invariant confounders to be controlled. However, there are still some limitations to these studies, such as the potential for time-varying confounders (e.g., air pollutants like ozone and sleep duration influenced by nighttime temperatures).

Studies conducted among workers outside the U.S. have also reported a relationship between working in the heat and increased risk of injuries (Morabito et al., 2006; Tawatsupa et al., 2013; Adam-Poupart et al., 2015; McInnes et al., 2017; Martinez-Solanas et al., 2018). Analyses from Dally et al. (2020), found an increase in injury risk with increasing average daily mean WBGT above 30°C (86°F) among sugarcane

harvesters in Guatemala; although this result was not statistically significant, this may have been due to small sample and event size.

III. Mechanisms.

Heat exposure can impair workers' psychomotor and mental performance, which can interfere with routine occupational tasks. Consequently, the risk of work-related injuries, including slips, trips, and falls, as well as cuts and other traumatic injuries, is exacerbated when job tasks are performed in hot environments. As summarized in the prior health effects sections of this preamble, heat can impair a variety of physiological systems and produce a range of symptoms. Changes in the cardiorespiratory, locomotor, and nervous systems due to heat exposure can induce various bodily responses such as fatigue, which may lead to injury (Ross et al., 2016). Changes from elevated skin and core body temperatures, which may result in increased sweating and dehydration, can cause decrements in physical, visuomotor, psychomotor, and cognitive performance (Grandjean and Grandjean, 2007; Lieberman, 2007). Even experiencing a high level of heat sensation may contribute to discomfort and distress, causing distraction and other behavioral changes that can result in accidents and injuries (Simmons et al., 2008). An explanation of how heat exposure can impair psychomotor and mental performance, and consequently lead to occupational heat-related injuries is provided below.

A. Impaired Psychomotor Performance.

Heat exposure can impair psychomotor function (i.e., the connection between mental and muscle functions) which may cause heat-related injuries. Impaired psychomotor function from heat exposure can take multiple forms, including impaired movement, strength, or coordination (fatigue); impaired postural stability and balance; and impaired accuracy, speed, and reaction time. Each of these impairments to psychomotor performance are discussed in turn below.

I. Impaired Movement, Strength, or Coordination (Fatigue).

Heat exposure can hamper psychomotor performance by impairing workers' movement, strength, or coordination and causing fatigue. Fatigue has been described as having a lack of energy or a feeling of weariness or tiredness (NIOSH, 2023b). Effects from heat strain on the cardiorespiratory and locomotor systems can cause both central and peripheral fatigue due to increased heat storage at the brain and muscle levels, along with other physiological mechanisms (Ross et al., 2016). As an individual's metabolic rate increases in hot environments, blood pH level may become more acidic and cause muscle fatigue from increased muscle glycogen degradation, lactate accumulation, and elevated carbohydrate metabolism (Varghese et al., 2018). These changes have been shown to compromise performance.

Numerous studies demonstrate the relationship between heat exposure and fatigue. In a cross-sectional survey of 256 occupational health and safety professionals in Australia, fatigue was the most reported incident in workers during higher temperatures (Varghese et al., 2020). Among two groups of 55 steel plant workers who completed a questionnaire assessing fatigue, the group of workers exposed to hotter environments (30 – 33.2°C (80 – 91.76 °F) WBGT) were significantly more likely to report symptoms of fatigue in comparison to workers in cooler environments (25.4-28.7°C (77.7–83.6°F) WBGT) (Chen et al., 2003). This study highlights how fatigue symptoms increase with rising heat exposure levels (Chen et al., 2003).

Moreover, in a review of 55 studies on workplace heat exposure, core temperature elevation and dehydration have been shown to have numerous negative behavioral effects including fatigue, lethargy, and impaired coordination, which may lead to injury (Xiang et al., 2014a). These 55 articles included ecological (22%), cross-sectional (64%), and cohort (5%) studies, as well as epidemiological experiments (9%). From one study included in the review, 42% of construction workers surveyed reported it was "easy to get fatigued" while working in the summer (Inaba and Mirbod, 2007). In another review

of heat stress risks in the construction industry, Rowlinson et al. (2014) also discussed the association of high temperatures and level of fatigue, which has been considered one of the critical factors leading to construction accidents (Garrett and Teizer, 2009; Chan, 2011). In a case study of 15 workers who experienced fatigue-related accidents, fatigue was shown to trigger other safety risks, such as not following proper safety procedures or becoming distracted, which can induce injury (Chan, 2011).

II. Impaired Postural Stability and Balance.

Heat exposure has also been shown to impair postural stability and balance as increases in metabolic heat can impact workers' gross motor capacity (i.e., the ability to move the body with appropriate sequencing and timing to perform bodily movements with refined control), including postural balance. As individuals become dehydrated, they may experience negative neuromuscular effects. Distefano et al. (2013) demonstrated the detrimental impact of dehydration during task performance in hot conditions, where subjects experienced decreased neuromuscular control as characterized by poorer postural stability. The authors found that neuromuscular control was impaired while participants were hypohydrated (defined as uncompensated loss of body water) and hyperthermic. Additionally, when an individual is experiencing high-intensity exertion in hot environments and is already dehydrated, this can result in further dilution of blood sodium. When blood sodium is diluted, water may be forced from the extracellular compartment into the intracellular compartment, which could lead to pulmonary congestion, brain swelling, and heat stroke (Distefano et al., 2013). At this stage, neurons begin degenerating in the cerebellum and cerebral cortex, and this process coupled with the rise in body temperature, impairs central nervous system functionality (Sawka et al., 2011; Nybo, 2007; Distefano et al., 2013).

Research also indicates that performing exertional activities in a hot environment may impair balance. To better understand lower extremity biomechanics, Distefano et al.

(2013) used an assessment tool to measure gross movement errors, such as medial knee displacement, hip or knee rotation, and limited sagittal plane (front to back) motion. The authors found that after performing the exercise protocol, participants demonstrated poorer movement technique when they were hypohydrated in a hot environment compared with when they were hypohydrated in a temperate environment or in a hot environment but euhydrated (state of optimal total body water content) (Distefano et al., 2013). These findings suggest that working in hot temperatures while dehydrated may increase risk for injury due to impaired balance (Distefano et al., 2013).

III. Impaired Performance in Accuracy, Speed, and Reaction Time.

The compromising effects of heat strain on psychomotor function have long been established, but the level of performance deterioration is dependent on the severity of heat strain and the complexity of the task (Taylor et al., 2016; Hancock, 1986; Ramsey, 1995; Pilcher et al., 2002; Hancock and Vasmatzidis, 2003). Some research has found that when high skin and core temperatures increase cardiovascular strain, heat exposure results in faster reaction times where individuals respond more quickly, but less accurately when in the heat (Simmons et al., 2008). Other research, such as Mazloumi et al. (2014), found that heat stress conditions impair selective attention (the ability to select and focus on a particular task while simultaneously ignoring other stimuli) and reaction time. In their study of 70 workers in Iran, where half of the workers experienced heat stress and half worked in air-conditioning, the authors found impaired psychomotor function among the exposed workers indicated through an increase in the duration of a task and response time as well as an increase in the number of errors (Mazloumi et al., 2014).

Additional studies examine the impacts of high skin and core temperatures on psychomotor function contributing to more mistakes (Allan and Gibson, 1979; Gibson and Allan, 1979; Gibson et al., 1980). In one study of foundry workers, response time,

reaction time, and number of errors were reported to be adversely affected when workers were exposed to WBGTs of 31-35°C (87.8-95°F) compared to unexposed workers in a WBGT of 17°C (62.6°F) (Mazlomi et al., 2017). A meta-analysis review of 23 studies supports these conclusions, finding that under hot conditions, performance on mathematical-related tasks and reaction time tasks can be negatively impacted at 32.2°C (89.9°F) with a roughly 15% average decrement in performance (Pilcher et al., 2002).

Pyschomotor performance is an important factor when considering job tasks that require precision and concentration to prevent injuries. In a study observing steel plant workers, it was found that electrical arc melting workers who were exposed to hotter environments (30-33.2°C WBGT) experienced a significant decrease in their attention span and slower response time compared to the continuous cast workers, who worked in cooler environments (25.4-28.7°C WBGT) (Chen et al., 2003). A decline in psychomotor function could also negatively affect speed of response, reasoning ability, associative learning, mental alertness, and visual perception, which has been reported as a key cause of fatal accidents (Rowlinson et al., 2014).

B. Impaired Mental Performance.

The effects of heat exposure on mental performance can also play a significant role in increasing workplace accidents and injuries and compromise workplace safety. Heat exposure can result in impaired cognition or cognitive performance; impaired visual motor tracking; and impaired decision-making or judgment, which can lead to unsafe behaviors (like the removal of required PPE). Each of these are discussed in turn below.

I. Impaired Cognition or Cognitive Performance.

Declines in cognitive function from heat are correlated with an elevated risk of injury. Evidence indicates a statistically significant increase in unsafe behaviors above 23°C WBGT and an increased risk of accidents (Ramsey et al., 1983). When an individual experiences hyperthermia, even if it is mild and only occurring for a short

period, the central nervous system is vulnerable to damage (Hancock and Vasmatzidis, 2003). This can acutely affect memory, attention, and ability to process information (Walter and Carraretto, 2016). When hyperthermia triggers cerebral damage, these cerebral injuries can be characterized into three broad areas. The first area includes cellular effects (where cells are damaged as temperatures continue to rise and normal cell function is disrupted and cell replication is no longer possible). The second area includes local effects (like inflammatory changes and vascular damage), and the third area includes systemic changes (like changes in cerebral blood flow (Walter and Carraretto, 2016). These negative effects are typically seen when core body temperatures reach 40°C (104°F), although some changes can begin at temperatures of 38°C (100.4°F) (Walter and Carraretto, 2016). These physiological changes also negatively impact cognitive performance.

Heat exposure has been shown to affect cognitive performance differentially, based on type of cognitive task (Yeoman et al., 2022). The more complex a task, especially if it requires motor accuracy, the more likely an individual's cognitive ability to perform the task will decline because of heat stress (Hancock and Vasmatzidis, 2003). Some research indicates a decrease in cognitive performance for tasks requiring more perceptual motor skills will be observed in the 30-33°C (80-91.4°F) range, well before the physiological system reaches its tolerance limit (Ramsey and Kwon, 1992; Hancock and Vasmatzidis, 2003; Piil et al., 2017). Ramsey and Kwon (1992) have summarized over 150 studies looking at task exposure time and task type and found statistically significant performance decrements at the 30-33°C (80-91.4°F) range. The decrements at this range occurred regardless of duration of exposure (from short exposures under 30 minutes and longer exposures up to 8 hours) (Ramsey and Kwon, 1992). Furthermore, in a case study of nine male volunteers, results indicate that highly motivated subjects were strongly affected by heat load within the first two hours of exposure, and that these

subjects' performance was significantly impaired when assigned complex tasks requiring a significant amount of reasoning and judgment (Epstein et al., 1980). The authors found that performance began to decrease when workers were exposed to temperatures above 27°C (80.6°F).

Moreover, in a review of fifteen laboratory experiments assessing the effects of high ambient temperature on mental performance, one study found that mental performance declines were statistically significant at exposure durations of four consecutive hours in 87°F (30.55°C) temperatures (Wing, 1965). Similarly, in a study of the effects of hot-humid and hot-dry environments on mental functioning, 25 participants were exposed to a variety of temperatures in humid and dry conditions, while performing physical exercises with bouts of rest, to assess mental alertness, associative learning, reasoning ability and dual-performance efficiency (Sharma et al., 1983). The authors found that all the psychological functions tested were adversely affected under heat stress, and that a significant drop in various psychological functions was seen at temperatures of 32.2°C (89.9°F) and 33.3°C (91.9°F) in hot-humid and hot-dry conditions, respectively. Moreover, the authors suggest that, for heat-acclimatized subjects who continuously work for four hours, that the temperature should not exceed 31.1 °C (87.9°F) in hot and humid conditions, and 32.2°C (89.9°F) for workers in hot desert conditions (Sharma et al., 1983).

II. Impaired Visual-Motor Tracking.

Hyperthermia and dehydration, a common symptom of heat exposure, have been found to impair visual-motor tracking (i.e., the eyes' ability to focus on and follow an object), increasing the risk of workplace injury. In a review of studies on hydration and cognition, the authors indicate that a 2% or more loss of body weight due to dehydration from heat and exercise can result in significant reduction in visual-motor tracking (Lieberman, 2007). In an experimental study assessing performance in complex motor

tasks in hyperthermic humans (Piil et al., 2017), the authors found that visual-motor tracking performance was reduced following exercise-induced hyperthermia. Participants were exposed to hot (40°C (104°F)) and control (20°C (68°F)) conditions. At baseline, and after exercise, participants completed simple and complex motor tasks, which included visual tracking assessment. The authors concluded that visual-motor tracking is impaired by hyperthermia, and especially so when multiple tasks are combined (Piil et al., 2017).

III. Impaired Decision-making or Judgment.

Heat exposure has been found to affect decision-making or judgment amongst workers, increasing the risk of injury. In a review of ecological, cross-sectional, and cohort studies, as well as epidemiological experiments, Xiang, et al. indicate that core temperature elevation and dehydration impair judgment and concentration (Xiang, et al., 2014a). In a study analyzing over 17,000 observations of unsafe behavioral acts (e.g. mishandling tools, equipment, or materials) in two industrial facilities with varying temperature conditions, authors found that unsafe behavioral acts decreased within the zone of preferred temperature (approximately 17°C (62.6°F) to 23°C (73.4°F), WBGT) and increased outside of this zone (when the temperature was equal to or less than 17°C WBGT or equal to or greater than 23°C WBGT) (Ramsey et al., 1983). This study indicates that the risk of unsafe behavioral acts may increase when the temperature increases.

C. Other Factors Contributing to Heat-Related Injury.

In addition to psychomotor and mental impairments that can result from heat exposure, other mechanisms may also contribute to heat-related injuries. The purpose of this section is to summarize some additional factors that may exacerbate the risk of workplace heat-related injuries and to provide information to better inform workers and employers about those hazards.

PPE is another factor that plays a role in increasing susceptibility to a heat-related injury given that some PPE insolates the body and reduces evaporative cooling capacity. For instance, research among firefighters finds that a self-contained breathing apparatus can lead to heat buildup and can impact postural stability and balance (Hur et al., 2015; Hur et al., 2013; Games et al., 2020; Mani et al., 2013; Ross, 2016). Other examples of PPE that may result in heat stress, and therefore increase the risk of heat-related injuries, include reflective vests that are made of water impermeable material that block effective heat dissipation and safety helmets with no ventilation that can raise the temperature inside the helmet. In one case, the air temperature inside a worker's helmet (57°C (134.6°F)) was measured to be over 20°C hotter than the environmental temperature (33°C (91.4°F)) they were working in (Rowlinson et al., 2014). The authors found that workers will often remove helmets in these situations to alleviate heat stress, exposing them to other workplace hazards (e.g., falling objects) (Rowlinson et al., 2014). Other research by Karthick et al. (2023) found that in hot weather conditions, physical health challenges, specifically major accidents at the job site, minor injuries, physical fatigue, excessive sweating, and dermatological problems were found to be significant based on a workers' clothing comfort. The authors highlighted how PPE can make workers feel uncomfortable, and when combined with extremely hot weather, it creates fatigue which may increase the number of workplace injuries and accidents (Karthick et al., 2023).

There is also evidence indicating heat exposure can contribute to impaired vision, which may lead to workplace injuries. For example, fogged safety glasses or sweat in eyes due to heat exposure can reduce workers' visibility, creating additional hazards and increasing risk of injury (NIOSH, 2016). Individual case studies also report issues with protective eyewear in hot temperatures, noting the uncomfortable feeling of the eyewear under heat and in sunlight as well as difficulty seeing through the glasses (Choudhry and Fang, 2008). In a survey conducted among occupational health and safety professionals

in Australia, one of the most frequently cited causes of heat-related injuries was from "impaired vision due to fogged safety glasses (39%)" (Varghese et al., 2020). Injuries resulting from impaired vision may include manual handling (musculoskeletal injuries), joint/ligament injuries, hand injuries, wounds or lacerations, burns, head or neck injuries, motor vehicle accidents, eye injuries, or fractures (Varghese et al., 2020).

When exposed to heat, workers may also experience impaired dexterity (or fine motor skills) leading to workplace injuries. For example, sweaty palms and hands due to heat exposure can reduce workers' ability to handle tools or other work-related materials, increasing the risk of injury. Occupational health and safety professionals have reported losing control of tools as one of the most common causes for heat-related injuries (Varghese et al., 2020). Researchers have also found sweaty palms to increase the risk of workplace injuries (Shulte et al., 2016).

IV. Summary.

The scientific and mechanistic data and association studies on heat-related injuries summarized in this section demonstrate that heat-related injuries are a recognized health effect of occupational heat exposure. While the types of heat-related injuries can be broad, the scientific community recognizes that heat exposure can diminish the body's senses through various mechanisms like impaired psychomotor performance (e.g., fatigue, impaired balance, or impaired dexterity), and impaired mental performance (e.g., impaired cognition or vision) which can result in various types of injuries. The best available evidence demonstrates that heat-related injuries can have serious adverse effects on worker safety and health.

Q. Requests for Comments.

OSHA requests information and comments on the following question and requests that stakeholders provide any relevant data, information, or additional studies (or citations) supporting their view, and explain the reasoning for including such studies:

- Has OSHA adequately identified and documented the studies and other information relevant to its conclusions regarding heat-related health effects, and are there additional studies OSHA should consider?

V. Risk Assessment

A. Risk Assessment.

I. Introduction.

In this risk assessment, OSHA relied on surveillance data of occupational heat-related fatalities and non-fatal injuries and illnesses reported by the Bureau of Labor Statistics (BLS). Additionally, OSHA relied on annual incidence estimates derived from State workers' compensation systems and hospital discharge datasets. These estimates were calculated and reported in a variety of sources, such as reports from State health departments, as well as the peer-reviewed scientific literature. OSHA has preliminarily concluded that inclusion criteria for HRIs in these data sources (days away from work, workers' compensation claim, emergency department visit, or inpatient hospitalization) demonstrate that the HRIs are a material impairment of health, thus making these data sources relevant to OSHA's determination of significant risk.

OSHA has previously relied on such injury, illness, and death data to demonstrate the extent of risk (see, e.g., Fall Protection, 81 FR 82494 (2016); Working Conditions in Shipyards, 76 FR 24576 (2011); Permit-Required Confined Spaces, 58 FR 4462, 4465 (1993) (finding significant risk based on available accident data showing that confined space hazards had caused deaths and injuries); Hazard Communication, 48 FR 53280, 53284-85, 53321 (1983) (finding significant risk of harm from inadequate chemical hazard communication based on BLS chemical source injury and illness data)).

Estimating annual incidence among heat-exposed workers (i.e., the number of annual work-related HRIs divided by the number of heat-exposed workers) requires being able to accurately estimate the number of exposed workers and using that number

in the denominator. Unfortunately, there is no published estimate for the number of U.S. workers exposed to hazardous heat on the job and the majority of the incidence estimates that OSHA identified used a denominator that would include both exposed and unexposed workers. This use of a larger denominator has the effect of diluting the resulting annual incidence estimates. For instance, BLS estimates and reports annual incidence of injuries and illnesses involving days away from work that were the result of "exposure to environmental heat," but in their calculation, BLS captures the broader U.S. workforce in the denominator, which includes a large number of unexposed workers (e.g., office workers in climate-controlled buildings).

Some of the annual incidence estimates that OSHA identified, such as those based on workers' compensation claims in California and Washington State, were stratified by sector, industry, or occupation. OSHA considers these incidence estimates to be helpful in getting to a more accurate estimate of risk among heat-exposed workers, specifically the sectors, industries, and occupations where exposure to hazardous heat on the job is more common. Furthermore, OSHA identified incidence estimates from cohort data in which the entire cohort was presumed to be exposed to hazardous heat on the job. These estimates are much higher than the estimates based on surveillance data. One potential reason for this difference is that the denominator used in the cohort studies contains much less unexposed worker-time.

In the following sections (V.A.II., and V.A.III.), OSHA has summarized the best available incidence data that the agency identified. Given the limitations with these data, OSHA relied on this incidence data as a range of possible incidence estimates with the assumption that many of these estimates represent a lower bound and that the true incidence is likely higher.

II. Reported Annual Incidence of Nonfatal Occupational Heat-Related Injuries and Illnesses.

A. BLS Survey of Occupational Injuries and Illnesses.

The BLS Survey of Occupational Injuries and Illnesses (SOII) is the primary nationwide source of surveillance data for nonfatal occupational injuries and illnesses. The scope includes both private and public (State and local government) sector employees, but excludes the self-employed, workers on farms with 10 or fewer employees, private household workers, volunteers, and Federal Government employees. The data are derived from a two-stage sampling process, during which a sample of employers are surveyed and report to BLS the number of injuries and illnesses occurring at their workplace. To reduce the reporting burden on employers, BLS only requires detailed case information on a sample of the injuries and illnesses that occurred at each establishment. BLS uses these survey responses to estimate the counts and incidence for nonfatal injuries and illnesses across all workplaces. In estimating annual incidence, BLS uses a denominator of full-time equivalent (FTE) workers, which is based on 2,000 hours worked per year (i.e., 40 hours per week over 50 weeks). Relevant Occupational Injury and Illness Classification System (OIICS) v2.01 event and nature codes for this proposed standard include "Exposure to environmental heat" (event code-531) and "Effects of heat and light" (nature codes beginning in 172-). Codes beginning with 172- include heat stroke and heat exhaustion (among other outcomes) but exclude sunburn and loss of consciousness without reference to heat. For more information about OIICS codes generally, see Section IV., Health Effects.

Between 2011 and 2020, there were an estimated 33,890 work-related injuries and illnesses that involved days away from work that were coded with event code 531, for an annual average of 3,389 such injuries and illnesses during this period (BLS 2023b). In 2023, BLS reported biennial rather than annual estimates for work-related injuries and illnesses that involved days away from work (as well as for the first time reporting an estimate of injuries and illnesses involving job restriction or job transfer). The biennial

estimate for 2021-2022 for heat-related cases meeting either of these criteria was 6,550 (5,560 cases involved days away from work; 990 cases involved job transfer or restriction) (BLS 2023g). The estimated annual heat-related injury and illness incidence (for cases involving days away from work) calculated by BLS for all workers covered by SOII from 2011-2020 varied by year but ranged from 2.0/100,000 workers to 4.0/100,000 workers. The average estimated annual incidence for the entire time period was 3.0/100,000 workers. However, as stated above, OSHA considers these incidence estimates to be underestimated for heat-exposed workers because BLS calculates the incidence rate for the entire U.S. workforce covered by SOII. Therefore, they are including workers who are not exposed to hazardous heat. In subsectors and industries where OSHA expects a greater proportion of workers to be exposed to hazardous heat, the incidence rate estimates are much higher. For instance, according to unpublished data from BLS SOII for the period 2011-2020, the crop production subsector (NAICS code 111) had an annual average incidence of 14.2/100,000 workers, and the specialty trade contractors subsector (NAICS code 238) had an annual average of 9.3/100,000 workers. This was also true of subsectors with primarily indoor workers where OSHA expects a greater proportion of those workers to be exposed to hazardous heat, including the primary metal manufacturing subsector (NAICS code 331), which had an annual average incidence of 13.1/100,000 workers for the period 2011-2020.

B. Workers' Compensation Claims.

Workers' compensation claims are an alternative way to quantify occupational injuries and illnesses, particularly those that involve outpatient medical treatment, inpatient hospitalization, intensive care, and/or lost workdays. OSHA identified five papers and a report from Wisconsin that have evaluated State workers' compensation data and calculated statewide incidence for heat-related injuries and illnesses.

I. Washington State.

The earliest of these, a paper by Bonauto et al., in 2007, evaluated workers' compensation claims submitted to and accepted by the Washington State Fund between 1995 and 2005 (Bonauto et al., 2007). The State Fund is the sole provider of workers' compensation insurance to Washington employers unless they are self-insured or fall under an alternative system (e.g., Federal employees) and it covers approximately two-thirds of the State's workers. Certain workers are exempt from mandatory coverage, such as self-employed and household workers. The authors identified heat-related cases using the American National Standards Institute (ANSI) Z16.2 codes[2] submitted in the claims by workers or their physicians, the ICD-9 codes submitted on bills from healthcare providers and hospitals, and a physician review of cases that included relevant Z16.2 or ICD-9 codes. The researchers used all ICD-9 codes beginning in 992 ("Effects of heat and light," specifically 992.0–992.9) and the ANSI Z16.2 type code 151 ("Contact with general heat—atmosphere or environment"). ICD-9 codes were not available for claims from the self-insured, so the authors restricted the analysis to State Fund claims only. They also excluded claims in which the employer's physical location was outside of Washington (n=12).

Over the 11-year study period, 480 accepted claims met the authors' inclusion criteria after physician review, in which they identified and removed cases where the recorded illness had been miscoded, contained incorrect data, or represented a burn. Most of the 480 claims (n=442; 92.1%) were medical-only claims, meaning the State Fund only paid for the medical bills and did not compensate the worker otherwise (e.g., wage replacement, disability benefits). The claims included the employer's NAICS code, which the authors used to stratify cases by industry sectors and industries. Employers

[2] The American National Standards Institute, or ANSI, created a standard for occupational health and safety metrics in 1962 (revised in 1969) referred to as ANSI Z16. The first version of OIICS was based on the ANSI coding scheme. ANSI revised the Z16 standard in 1995 and adopted the OIICS scheme in that revision.

covered under the Washington State Fund are required to report hours worked by their employees every quarter (i.e., three-month increments), which the authors used to estimate denominators for rates assuming 2,000 work hours is 1 FTE. This means the authors could calculate rates for certain portions of the year rather than the whole year without needing to divide by the total number of annual workers (i.e., they could adjust for hours worked only during the specified portion). The employment reporting by quarter also allowed for the authors to estimate claim rates for the third quarter only (July, August, and September), which corresponded to the time of year with the "greatest level of exposure to elevated environmental temperatures" (Bonauto et al., 2007, p. 5).

The authors reported an average annual claim rate (which can be thought of similarly to an injury or illness incidence rate) of 3.1 claims/100,000 FTE for the overall workforce covered by the State Fund during the study period, with annual rates ranging from 1.9 to 5.1/100,000 FTE. They reported a corresponding average third-quarter claim rate of 8.6 claims/100,000 FTE for the overall workforce covered by the State Fund during the study period. In their paper, Bonauto et al. report annual and third-quarter rates for all sectors and industries that had more than five claims during the study period. The sectors (2-digit NAICS) with the highest annual average claim rates were:

1. Construction (12.1/100,000 FTE),
2. Public administration (12.0/100,000 FTE),
3. Agriculture, forestry, fishing, and hunting (5.2/100,000 FTE),
4. Administrative and support and waste management and remediation services (3.9/100,000 FTE), and
5. Transportation and warehousing (3.5/100,000 FTE).

The corresponding average third-quarter claim rates for these sectors were more than double the annual averages: 33.8/100,000 FTE, 31.2/100,000 FTE, 12.6/100,000 FTE, 9.9/100,000 FTE, and 10.6/100,000 FTE, respectively. This pattern was also true

for some sectors with a majority of indoor claims. For example, Manufacturing (3.0/100,000 FTE vs. 7.6/100,000 FTE) and Accommodation and food services (1.7/100,000 FTE vs. 5.1/100,000 FTE).

The industries (6-digit NAICS) with the highest annual average claim rates were:

1. Fire protection (80.8/100,000 FTE),
2. Roofing construction (59.0/100,000 FTE),
3. Highway, street and bridge construction (44.8/100,000 FTE),
4. Site preparation construction (35.9/100,000 FTE) (tie), and
5. Poured concrete foundation and structural construction (35.9/100,000 FTE) (tie).

Similar to the pattern observed among sectors, the corresponding third-quarter claim rates for the top 5 industries were more than double the annual averages, except for fire protection—158.8/100,000 FTE, 161.2/100,000, 105.6/100,000 FTE, 106.5/100,000 FTE, and 102.6/100,000 FTE, respectively. This was also true for restaurants: limited service restaurants (2.4/100,000 FTE vs. 6.0/100,000 FTE) and full service restaurants (1.6/100,000 FTE vs. 5.3/100,000 FTE). These industries have few to no outdoor claims, indicating that even some industries that involve primarily indoor work are at higher risk in the summer months.

A follow-up paper to Bonauto et al., 2007, published in 2014, examined heat-related illnesses among workers in Washington State in certain agriculture and forestry subsectors between 1995 and 2009 (Spector et al., 2014). The State changed their injury and illness codes from ANSI to OIICS in July 2005, so for this paper, the researchers used a combination of ANSI (prior to July 2005), OIICS (beginning in July 2005), and ICD-9 codes to identify potential heat-related claims and then reviewed each claim to ensure it was heat-related. These authors used additional ICD-9 codes that were not included in the 2007 paper, specifically: prickly heat (705.1), hyperosmolality and/or hypernatremia (276.0), volume depletion (276.5 and 276.50), dehydration (276.51),

hypovolemia (276.52), and acute renal failure (584 and 584.9). The authors identified 84 accepted claims meeting their eligibility criteria, the majority of which (n=76; 90%) were medical only claims. Of the 84 claims, 61 (73%) met the diagnostic code criteria used in the 2007 paper (ICD-9 codes beginning in 992). The average annual claim rate for the agriculture and forestry subsectors the authors examined over the 15-year period was 7.0/100,000 FTE and the average third-quarter (July – September) claim rate was 15.7/100,000 FTE. The majority of claims (61%) were among crop production and support workers (NAICS 111 or 1151).

A second follow-up paper to Bonauto et al., 2007, was published in 2020 and included all Washington State Fund-covered workers over a more recent 12-year period, 2006 to 2017 (Hesketh et al., 2020). The authors used similar methods, except for different screening criteria for ascertaining cases prior to investigators reviewing each case. To identify potential heat-related claims, they used OIICS v1.01 event/exposure code 321, OIICS nature code 072*, OIICS source codes 9362 and 9392 (Sun), and the ICD-9 codes used in Spector et al., 2014. (Note that these OIICS codes are v1.01 OIICS, which was the coding scheme used from 1992-2010. BLS updated the coding scheme in 2010, which first applied to 2011 data.) The State adopted ICD-10 coding in October 2015, so the following ICD-10 codes were used for claims after that date: E86* (Volume depletion), T67* (Effects of heat and light), T73.2* (Exhaustion due to exposure), W92* (Exposure to excessive heat of man-made origin), X30* (Exposure to excessive natural heat), and Z57.6 (Occupational exposure to extreme temperature). The researchers excluded claims in which service date for treatment of dehydration or kidney failure was not within one day of the illness date or claims in which dehydration or kidney failure were the only identifiers flagged, as they noted that these cases often did not represent heat-related illnesses.

The authors reported a total of 918 confirmed heat-related claims, of which 654 (71%) were accepted claims. Of the accepted claims, 595 (91%) were medical-only claims. Using only accepted claims, they estimated an average annual claim rate of 3.2 claims/100,000 FTE for the overall workforce covered by the State Fund during the study period (Communication with David Bonauto and June Spector, June 2024). Similar to Bonauto et al., 2007, the authors reported claim rates for all sectors and industries with more than 11 claims. The sectors (2-digit NAICS) with the highest annual average accepted claim rates were:

1. Agriculture, forestry, fishing, and hunting (13.0/100,000 FTE),
2. Construction (10.8/100,000 FTE),
3. Public administration (10.3/100,000 FTE),
4. Administrative and support and waste management and remediation services (4.6/100,000 FTE), and
5. Transportation and Warehousing (3.8/100,000 FTE).

The average third-quarter (July – September) claim rates for some sectors were more than 10 times greater than the average annual rates. These third-quarter claim rates were also much higher than those calculated for 1995-2005 in Bonauto et al., 2007. The sectors with the highest average third-quarter accepted claim rates were:

1. Public administration (131.3/100,000 FTE),
2. Agriculture, forestry, fishing, and hunting (102.6/100,000 FTE),
3. Construction (70.0/100,000 FTE),
4. Administrative and support and waste management and remediation services (61.5/100,000 FTE), and
5. Wholesale trade (44.9/100,000 FTE).

The industries (6-digit NAICS) with the highest annual average accepted claims rates were:

1. Farm labor contractors and crew leaders (77.3/100,000 FTE),
2. Fire protection (60.0/100,000 FTE),
3. Structural steel and precast concrete contractors (54.2/100,000 FTE),
4. Poured concrete foundation and structure contractors (31.6/100,000 FTE), and
5. Roofing contractors (29.0/100,000 FTE).

The ratio between third-quarter rates and annual rates for all industries reported in table 3 of the paper ranged from 2.5-13.7, with the highest average third-quarter accepted claim rates in the following industries:

1. Farm labor contractors and crew leaders (600.9/100,000 FTE),
2. Fire protection (394.6/100,000 FTE),
3. Administration of conservation programs (282.7/100,000 FTE),
4. Site preparation contractors (232.1/100,000 FTE), and
5. Poured concrete foundation and structure contractors (172.3/100,000 FTE).

II. California.

A group of researchers conducted a similar analysis for the State of California, using data from the California Workers' Compensation Information System (WCIS) between 2000 and 2017 (Heinzerling et al., 2020). Virtually all California employees are required to be covered by workers' compensation; voluntary, non-compensated workers, owners, and workers covered under separate programs are excluded. The WCIS contains all accepted and rejected workers' compensation claims in the State since 2000 that required medical treatment beyond first aid or more than one day of lost work time. The investigators identified heat-related claims in the system using WCIS-specific nature of injury and cause of injury codes (e.g., "temperature extremes"), heat-related illness keywords (e.g., "heat stroke"), and certain ICD-9 (992.0-992.9 and E900.0-E900.9) and ICD-10 (T67.0-T67.9, X30, and W92) codes. They also manually reviewed all claims that met only the ICD code identification criteria to ensure the claims were heat-related,

as some of the codes they used to identify claims were not specific to heat-related illness or injury. In WCIS, the employer's industry is coded using NAICS codes classified by the claims adjusters. The authors converted the NAICS codes into the appropriate 2002 census industry codes using the NIOSH Industry and Occupation Computerized Coding System (NIOCCS). This was necessary to obtain the corresponding employment denominator estimates from the NIOSH Employed Labor Force Tool, which relies on data from the Current Population Survey (CPS), a Census Bureau survey conducted for BLS. The CPS data provide estimates of all employed and non-institutionalized civilian workers over the age of 15. To account for changes in coding schemes implemented in 2002, the investigators extrapolated 2002 – 2017 data to estimate denominators for 2000 and 2001.

The authors excluded claims for workers below 16 years of age (n=104 claims) and institutionalized workers (n=455 claims), as these workers are excluded from CPS data. They reported a final estimate of 15,996 claims meeting their inclusion criteria, corresponding to an overall annual claims rate of 6.0/100,000 workers. Industry and occupation codes were available for 86% and 74% of the included claims, respectively. The authors reported claim rates for all sectors, but the sectors with the highest annual claim rates were:

1. Agriculture, forestry, fishing, and hunting (38.6/100,000 workers; 95% CI: 26.9, 40.4),
2. Public administration (35.3/100,000 workers; 95% CI: 34.3, 36.3),
3. Mining (21.3/100,000 workers; 95% CI: 17.6, 25.7),
4. Utilities (11.4/100,000 workers; 95% CI: 10.1, 12.8), and
5. Administrative and support and waste management (8.8/100,000 workers; 95% CI: 8.3, 9.3).

The major occupational groups with the highest annual claim rates were:

1. Protective services (56.7/100,000 workers; 95% CI: 54.9, 58.7),
2. Farming, fishing, and forestry (35.9/100,000 workers; 95% CI: 34.1, 37.9),
3. Material moving (12.3/100,000 workers; 95% CI: 11.5, 13.1),
4. Construction and extraction (8.9/100,000 workers; 95% CI: 8.4, 9.4), and
5. Building and grounds cleaning and maintenance (6.0/100,000 workers; 95% CI: 5.6, 6.5).

III. Texas.

Another study examined workers' compensation claims in an unnamed, mid-sized Texas city before and after an intervention among a cohort of 604 municipal workers and calculated the incidence of HRI claims from 2009 to 2017 (McCarthy et al., 2019). The municipal departments included in the study were picked because the job descriptions for workers within each included work in hot environments with moderate and heavy physical activity. These departments were Streets and Traffic, Parks and Recreation, Utilities, and Solid Waste. After removing worker-time contributed by administrative personnel who were not exposed to heat on the job, the remaining worker-time represented 329 FTEs per year. Prior to the intervention in 2011, the heat-exposed workers experienced 17 total HRIs between 2009 and 2010. The authors reported an average annual rate of HRIs among the heat-exposed workers during this time of 25.5/1,000 FTEs (McCarthy et al., 2019, Figure 2). These estimates are much higher than other incidence estimates reported in this section, possibly because the denominator is solely comprised of heat-exposed workers. This explanation is supported by evidence of higher incidences reported in other cohort studies (e.g., approximately 3 HRIs/1,000 National Guard troops involved in flood relief activities between July 5 and August 18, 1993, calculated from data in Dellinger et al., 1996). The results of the voluntary intervention are discussed in Section V.C., Risk Reduction.

IV. Wisconsin.

Finally, a report issued by the Wisconsin Occupational Health and Safety Surveillance Program in 2024 summarized an analysis of heat-related workers' compensation claims in the State from 2010-2022 (Fall et al., 2024). The authors analyzed lost work time claims (under Wisconsin workers' compensation, there must be more than three days of lost work time to be compensable) reported by both insurance carriers and self-insured employers and reported rates by industry sector and industry subsector (rather than overall workforce rates). These do not include medical-only claims, which were the majority of HRI claims reported in the Washington State Fund database. The authors reported cumulative claim rates only. To convert cumulative rates to annual average rates, OSHA divided the reported rates by 13 (the number of years' worth of data reported). The sectors with the highest annual average claim rates were:

1. Administrative and Support and Waste Management and Remediation Services (2.9/100,000 FTE),
2. Public Administration (2.8/100,000 FTE),
3. Wholesale Trade (1.9/100,000 FTE),
4. Construction (1.4/100,000 FTE), and
5. Transportation and Warehousing (1.1/100,000 FTE).

The major occupational groups with the highest annual average claims rates were:

1. Protective Service (4.1/100,000 FTE),
2. Transportation and Material Moving (2.6/100,000 FTE),
3. Production (1.6/100,000 FTE),
4. Construction and Extraction (1.5/100,000 FTE), and
5. Building and Grounds Cleaning and Maintenance (1.5/100,000 FTE).

Similarly, the minor occupational groups with the highest annual average claims rates were:

1. Fire Fighting and Prevention (14.7/100,000 FTE),

2. Material Moving Workers (3.3/100,000 FTE),
3. Metal and Plastic Workers (2.8/100,000 FTE),
4. Motor Vehicle Operations (2.2/100,000 FTE), and
5. Assemblers and Fabricators (2.2/100,000 FTE).

C. Emergency Department (ED) Visits and Inpatient Hospitalizations.

Another way to quantify occupational injury and illnesses requiring medical treatment is to use data reported directly by hospitals to public health departments or national databases, such as the National Electronic Injury Surveillance System (NEISS). Data in NEISS are estimated from a nationally representative probability sample of hospitals across the country, which report data for every injury-related ED visit. A paper from 2010 analyzed NEISS data for heat-related emergency department visits from 2001-2004 (Sanchez et al., 2010). The authors reported an annual average of 8,376 work-related ED visits for nonfatal heat injuries and illnesses. OSHA used annual average employment estimates from NIOSH's Employed Labor Force query system for 2001-2004 (both total workers and FTEs) to estimate a nationwide annual average rate of 6.1 visits/100,000 workers and 6.3 visits/100,000 FTEs from this study. More recent studies estimating the incidence of work-related ED visits and/or hospitalizations for HRIs within individual or multiple States are discussed below.

I. Southeast U.S.

A group of public health researchers from nine States in the Southeast (Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia) used hospital discharge data reported directly to State health departments to characterize rates of heat-related inpatient hospitalization and ED visits among workers from 2007 – 2011 (Harduar Morano et al., 2015). The researchers used ICD-9 codes to identify heat-related cases, specifically 992.0-992.9, E900.0, E900.1, and E900.9. To assess work-relatedness, they determined whether the expected payer was workers'

compensation or if a work-related external cause of injury code (sometimes referred to as E-codes) was noted by the physician (e.g., E000.0 Civilian activity done for income). They restricted cases only to those where the patient was at least 16 years old but included both State residents and non-residents in reported case counts. To calculate rates, the investigators used CPS data for estimating denominators, which were age-adjusted using direct standardization and population weights for the entire U.S. Non-residents were not included in the rate calculations. The authors noted that hospital discharge data weren't available for every year in every State and that the missing data were primarily for discharges following ED visits.

Across the five-year study period, the authors identified 8,315 occupational heat-related ED visits (7,664 of these among residents, or 92%), which corresponded to an overall age-adjusted rate of 6.5 visits/100,000 workers (95% confidence interval, CI = 6.4, 6.7). While they reported rates for each State (e.g., 4.8 visits/100,000 workers in Florida and 17.3 visits/100,000 workers in Louisiana), they cautioned against directly comparing between States given differences in the data collection methods, data availability, and use of work-related variables. They identified 1,051 occupational heat-related inpatient hospitalizations (930 among residents, or 88%), which corresponded to an overall age-adjusted rate of 0.61 hospitalizations/100,000 workers (95% CI = 0.58, 0.66). The average length of stay for State residents was 2.7 days, which was comparable to non-residents (2.4 days).

II. Florida.

The Florida Department of Health published a similar analysis in 2011 using the same methods for the State of Florida for the years 2005 – 2009 (Florida DOH, 2011). They identified 2,198 occupational heat-related hospitalizations and ED visits, which corresponded to an average overall age-adjusted annual rate of 3.7 cases/100,000 workers (95% CI = 1.9, 5.5) and a crude rate (no age adjustment) of 5.1/100,000 workers

(Communication with Laurel Harduar Morano, October 2023). The majority of these (89.4%) were ED visits. They identified 3 fatalities in this subset, which they noted corresponds to a case fatality rate of 1.4 fatalities/1,000 cases. They reported a third-quarter (July, August, and September) rate of 3.2 cases/100,000 workers using a denominator of total number of workers, whereas using a denominator of FTEs instead produced a third-quarter rate of 13.0 cases/100,000 FTE (Communication with Laurel Harduar Morano, October 2023). A 2016 study conducted a more in-depth analysis of the statewide Florida hospitalization data and included data for three additional years (2010, 2011, and 2012) (Harduar Morano et al., 2016). The authors restricted the data to cases occurring in May-October of each year and identified a total of 2,979 work-related ED visits and 415 work-related hospitalizations between 2005-2012. Using total number of workers in the denominator (calculated from monthly CPS data), these corresponded to average annual age-adjusted rates of 8.5 ED visits/100,000 workers and 1.1 hospitalizations/100,000 workers.

III. Louisiana.

In March 2023, the Louisiana Department of Health published a report on heat-related illnesses in the State using ED and hospitalization data from 2010-2020 (Louisiana DOH 2023). The authors used workers' compensation as payer and work-related ICD codes to determine which cases were among workers. They reported an annual average of 320 work-related ED visits and 20 work-related hospitalizations for heat-related illness during this period. Using State employment data from CPS, the authors calculated an overall age-adjusted rate of 15.1 work-related ED visits/100,000 workers and 0.9 work-related hospitalizations/100,000 workers. In 2024, the Department of Health released a syndromic surveillance report on ED visits for HRIs between April 1 and October 31, 2023 (Louisiana DOH 2024). They identified 1,412 ED visits for HRIs among workers during this time period.

IV. Multiple States.

Since 2013 over 20 States have reported rates of heat-related ED visits among workers to the Council of State and Territorial Epidemiologists (CSTE), comprising the organization's *Occupational Health Indicator #24* (see *www.cste.org/page/ohindicatorstable*). These data are compiled by the State health departments using workers' compensation as primary payer and external cause of injury codes to determine work-relatedness. Rates are calculated using CPS estimates of total employed persons by State. While multiple States report their annual rates to CSTE, the organization cautions against directly comparing these rates between States because "workers' compensation eligibility criteria and availability of data from workers' compensation programs varies among states, prohibiting state-level data from being directly compared to other states or with national estimates."

Additionally, given that these data are not available for every State, they cannot be combined to produce an accurate national rate. The State-reported rates are currently available for 2013-2019. During this period, the annual rates for heat-related ED visits ranged from 0.1 to 18.7 ED visits per 100,000 workers.

V. Maricopa County, Arizona.

Arizona is not one of the States to share their ED visit data to CSTE, but the most populated county in the State - Maricopa County - has published a *Heat Morbidity Report* in which they provide case counts for heat-related hospitalization discharges, including a breakdown of the "preceding activity type" (determined by ICD activity E-codes) (Maricopa County Public Health Department, n.d.). Using the case counts reported under "occupational" activity type and yearly estimates of the average annual employment for Maricopa County provided by the BLS Quarterly Census of Employment and Wages, there was an average annual hospitalization rate among workers of 4.1 cases/100,000 workers (range: 3.1-6.4/100,000) between 2010-2017. Primary payer of workers'

compensation was not used to determine work-relatedness, which means some occupational cases not involving E-codes may have been missed. Given that for the majority of cases (77%-83% per year), the preceding activity was marked as "unknown", it's likely that some number of these were occupational in nature and just not listed as such. This is supported by the fact that an "Industrial Site" was the place of injury for, on average, 8% of cases, which may also be an underestimate. It should be noted that the authors only used the following ICD-9/ICD-10 activity E-codes to determine work-relatedness: E011/Y93.C Activities involving computer technology and electronic devices; E012/Y93.D Activities involving arts and handcrafts; and E016/Y93.H Activities involving exterior property and land maintenance, building and construction. To OSHA's knowledge, the authors did not use any other external cause of injury codes, such as E000.0 Civilian activity done for income, but it is not clear from the report if these E-codes were not available or were just not used.

D. Indirect Injuries.

As discussed in Section IV.P., Heat Related Injuries, one area of research has used the natural fluctuations in temperatures to conduct quasi-experimental studies examining the relationship between heat and workers' compensation claims for traumatic injuries (e.g., Spector et al., 2016; Calkins et al., 2019; Dillender 2021; Park et al., 2021). The findings of these papers suggest that there may be many workers' compensation claims that are heat-related but not coded as such. For instance, Park, Pankratz, and Behrer (2021) estimated that approximately 20,000 injuries per year in California between 2001-2018 resulted from hotter temperatures (relative to "optimal" temperature). For comparison, for a similar time period (2000-2017), Heinzerling et al. (2020) only identified an average of 889 HRI workers' compensation claims per year in California (a 22-fold difference), suggesting that relying on workers' compensation claims coded as HRIs alone does not capture the higher incidence of injuries of other kinds where heat

may have played a role. A research report from the Workers Compensation Research Institute expanded this type of analysis to 24 States, using a convenience sample of workers' compensation claims from May-October 2016-2021 (Negrusa et al., 2024). They found that the number of injuries increased 3.2-6.1% when the daily maximum temperature was 75°F or higher relative to a day with a daily maximum temperature of 65-70°F. This relationship was even more pronounced for the construction industry.

E. Worker Self-Reports.

Another source of incidence data is surveys of workers exposed to heat. Multiple papers describe the results of surveys of outdoor workers, typically agricultural workers, who are asked about heat-related symptoms experienced over a week-long period while working in the summer months (Fleischer et al., 2013; Kearney et al., 2016; Mutic et al., 2018). Commonly reported symptoms in these studies include heavy sweating (38-66% of surveyed workers), headache (44-58%), muscle cramps (30-36%), dizziness (14-32%), weakness or fatigue (18%), and nausea or vomiting (9-17%). Notably, in two of these studies, multiple workers reported fainting on the job. A study in southern Georgia found that 4% of 405 farmworkers experienced fainting within the previous week, during which the heat index ranged from 100-108°F (Fleischer et al., 2013). Another study involved asking 281 farmworkers in North Carolina if they had ever worked in "extreme heat." Of those answering "yes", 3% reported having ever fainted on the job (Mirabelli et al., 2010). When asked about symptoms over a single workday, a separate study found that 25% of workers reported cramps, 22% headache, 10% dizziness, and 3% nausea (Smith et al., 2021).

F. Summary of Reported Annual Incidence of Nonfatal Occupational Heat-Related Injuries and Illnesses.

OSHA identified multiple sources that have reported annual incidence estimates for nonfatal HRIs among workers. These studies and reports generally reported heat-

related incidence across an entire workforce (either National or State), using the total workforce as the denominator. This would understate the risk to workers who are actually exposed to heat on the job since the denominator includes a large percentage of workers who are not exposed to heat (e.g., office workers). Evidence in support of this claim comes from studies showing higher incidence of HRI when populations are stratified by sector, industry, or occupation, as well as those reporting incidence that occurred only during the third quarter (July, August, and September). For instance, in Heinzerling et al., 2020, the authors report an overall annual incidence of 6.0/100,000 workers whereas they report an annual incidence of 38.6/100,000 workers for workers in the agriculture, forestry, fishing, and hunting sector (a greater than 6-fold difference). OSHA considers these stratified estimates to be more accurate estimates of the "true" incidence of HRIs among heat-exposed workers.

A summary of the annual incidence estimates for nonfatal occupational HRIs discussed above can be found in table V-1. In the same table, OSHA calculated the number of non-fatal HRIs that would be expected over a working lifetime (assuming a working lifetime is 45 years long) based on those annual incidence estimates (i.e., the annual incidence multiplied by 45). These estimates represent the total number of HRIs that may be expected to occur in a cohort of 100,000 workers all of whom enter the workforce at the same time and all of whom work for 45 years. Estimates of HRI risk over a working lifetime based on annual incidence among entire working populations (National or State) range from 90-180/100,000 for HRIs requiring days away from work, 140-270/100,000 for HRIs leading to a workers' compensation claim, and 4.5-842/100,000 for HRIs leading to emergency department visits or inpatient hospitalizations. Like incidence estimates, these values understate the risk to workers who are actually exposed to heat on the job since the denominator includes a large percentage of workers who are not exposed to heat (e.g., office workers). However, when

using incidence estimates specific to individual sectors, industries, or occupations, the HRI estimates over a working lifetime are much higher, ranging from 49.5-114,750/100,000 for HRIs leading to a workers' compensation claim.

III. Reported Occupational Heat-Related Fatalities.

The BLS Census of Fatal Occupational Injuries (CFOI), established in 1992, is the primary source of surveillance data on work-related fatalities, including fatalities due to environmental heat exposure, for the United States. The fatality data in CFOI come from diverse data sources to identify, verify, and describe work-related fatalities. In each case, at least two sources (e.g., death certificates, workers' compensation reports, media reports, and government agency administrative reports) and an average of four are used to validate that the fatality was work-related and to verify the event or exposure leading to death and the nature of injury or illness in each case, which are then classified with OIICS codes. Heat-related fatalities can be identified with an event code ("Exposure to environmental heat") and/or a nature code ("Effects of heat and light").

According to BLS's CFOI, occupational heat exposure killed 1,042 U.S. workers between 1992 and 2022 (BLS, 2024c). Between 2011 and 2022, BLS reports 479 worker deaths, an average of 40 fatalities per year during that time. During the latest three years for which BLS reports data (2020-2022), there was an average of 45 work-related deaths due to exposure to environmental heat per year. Multiple sources have relied on BLS surveillance data to estimate annual incidence rates of occupational heat-related fatalities.

Gubernot et al. (2015) calculated overall fatality rates and fatality rates by industry sector using BLS CFOI data from 2000 – 2010 (Gubernot et al., 2015). The authors focused on the three industry sectors with the highest rates in preliminary analyses: Agriculture, Forestry, Fishing and Hunting (NAICS code 11); Construction (NAICS code 23); and Administrative and Support and Waste Management and Remediation Services (NAICS code 56). All other industry sectors were combined for

comparison as a referent group. The authors used nationwide worker population data from the CPS to estimate fatality rates. The CPS data provide estimates of all employed and non-institutionalized civilian workers over the age of 15.

The authors identified 339 occupational heat-related deaths from 2000 – 2010, after excluding volunteers and military personnel. They reported an average annual heat-related fatality rate of 0.022 fatalities per 100,000 workers for the overall workforce.

For the three industry sectors preliminarily identified as having the highest rates, the authors reported the following average annual fatality rates:

1. Agriculture, forestry, fishing and hunting (0.306 fatalities per 100,000 workers),
2. Construction (0.113 fatalities per 100,000 workers), and
3. Administrative and Support and Waste Management and Remediation Services (0.056 fatalities per 100,000 workers).

For all other industry sectors combined, the average annual fatality rate was substantially smaller (0.009 fatalities per 100,000 workers). The agriculture and construction sectors combined accounted for 58% of the fatalities during the study period (n=207).

A CDC Morbidity and Mortality Weekly Report (MMWR) from 2008 reported by Luginbuhl et al. investigated heat-related fatalities among all workers - and agriculture workers in particular - using BLS CFOI data from 1992 – 2006 (Luginbuhl et al., 2008). During the study period, the authors identified 423 deaths related to environmental heat in CFOI using the OIICS v1.01 event/exposure code 321 (Exposure to environmental heat) and nature code 072* (Effects of heat and light). Similar to the approach taken by Gubernot et al., the authors calculated rates using CPS estimates of the average annual worker population for denominators.

For the overall workforce, the authors calculated an average annual incidence of 0.02 fatalities/100,000 workers, which is similar to the estimate reported by Gubernot et

al. for 2000 – 2010 (0.022/100,000). Of the 423 fatalities identified, 102 (24%) occurred in the agriculture, forestry, fishing, and hunting sector (average annual fatality rate of 0.16/100,000 workers) and 68 occurred among workers in crop production or support activities for crop production (annual fatality rate of 0.39/100,000 workers). The rates for crop workers in North Carolina, Florida, and California were 2.36/100,000 workers, 0.74/100,000 workers, and 0.49/100,000 workers, respectively. These findings were later included in a peer-reviewed article (Jackson and Rosenberg 2010).

The editorial note accompanying this MMWR report mentioned, among other limitations, that CPS estimates used for denominators likely underestimate the number of crop workers - because of the potential lack of stable residences among these workers and the seasonal trends in employment - which would lead to an overestimate of risk for these workers. This limitation would presumably apply to any rate estimates calculated with CPS data for this specific population. To OSHA's knowledge, this is the only reported limitation in the included articles that would suggest a potential overestimation of incidence.

A third paper analyzed BLS CFOI heat-related fatality data for the construction sector, estimating fatality rates for various occupations within the sector using Standard Occupational Classification codes (Dong et al., 2019). Using the OIICS v2.01 nature code 172* (Effects of heat and light) to determine heat-relatedness and CPS estimates for sector-wide and occupation-specific denominators, the authors identified 82 heat-related construction deaths between 2011 – 2016 and estimated an average annual fatality rate for the entire sector (0.15 fatalities/100,000 workers) as well as for specific occupations. The occupations with the highest fatality rates included cement masons (1.62/100,000); roofers (1.04/100,000); helpers (1.03/100,000); brick masons (0.50/100,000); and laborers (0.29/100,000).

Finally, a paper from 2005 by Mirabelli and Richardson identified heat-related fatalities using medical examiner records from North Carolina for the period from 1977 to 2001, including 15 years of data before the creation of CFOI (Mirabelli and Richardson 2005). They determined that heat was a primary or underlying cause of death based on ICD-9 codes. The researchers used the decedents' location and activities reported in the records to determine work-relatedness, and they excluded cases in which the decedent was < 10 years old or those which involved manufactured sources of heat.

The authors identified 40 occupational heat-related deaths. They classified 18 of these as farm workers and reported an annual fatality rate among these farm workers of 1.52 fatalities/100,000 workers. They reported 10 cases having occurred at a construction site but did not report a fatality rate for this group of workers. The average annual fatality rate for the entire State working population was 0.05 fatalities/100,000 workers.

As none of the identified papers reported fatality rates for the overall workforce for years beyond 2010, OSHA used the heat-related fatality counts reported by BLS for 2011 – 2022 (479 worker deaths) and employment estimates for the same years from CPS to calculate fatality rates for these years. For the denominator, OSHA used the total number of workers and average hours worked to estimate total FTEs per year. The average annual fatality rate during this period was 0.029 deaths/100,000 FTEs.

A. Summary of Reported Occupational Heat-Related Fatalities.

OSHA identified multiple studies that calculated and reported annual incidence estimates for heat-related fatalities among workers using data from BLS CFOI or medical examiner records. These studies reported heat-related fatality rates across an entire workforce (either National or State), using the total workforce as the denominator. As mentioned above, this would understate the risk to workers who are actually exposed to heat on the job since the denominator includes a large percentage of workers who are not exposed to heat (e.g., office workers). Evidence in support of this claim comes from

studies showing higher fatality rates when populations are stratified by sector, industry, or occupation. For instance, in Gubernot et al., 2015, the authors report an overall annual fatality rate of 0.022/100,000 workers whereas they report an annual fatality rate of 0.306/100,000 workers for workers in the agriculture, forestry, fishing, and hunting sector (a 14-fold difference). OSHA considers these stratified estimates to be more accurate estimates of the "true" incidence of heat-related fatalities among heat-exposed workers.

Table V-1 Estimated Risk of Experiencing a Heat-Related Injury or Illness Annually and Over a 45-Year Working Lifetime

Population	Source of Data	Average Annual Rate (per 100,000 Workers)	Expected Number of Non-Fatal HRIs per 100,000 workers over Working Lifetime
Rates Based on Entire Working Populations			
U.S., All Workers	BLS SOII Injuries and Illnesses Involving Days Away from Work	2.0 – 4.0[1]	90-180
State Working Populations	Workers' Compensation Records	3.1 – 6.0[2]	140-270
State Working Populations	Emergency Department Visits and/or Inpatient Hospitalization	0.1 – 18.7[3]	4.5-842
Rates Based on Sector-Specific Groups (2-digit NAICS)			
Agriculture, forestry, fishing, and hunting	Washington State, 1995-2005 Washington State, 2006 – 2017 California, 2000 – 2017	5.2 13.0 38.6	234 585 1,737
Construction	Washington State, 1995-2005 Washington State, 2006 – 2017 Wisconsin, 2010-2022	12.1 10.8 1.4	545 486 63.0
Public Administration	Washington State, 1995-2005 Washington State, 2006 – 2017 California, 2000-2017 Wisconsin, 2010-2022	12 10.3 35.3 2.8	540 464 1,589 126
Administrative and support and waste management and remediation services	Washington State, 1995-2005 Washington State, 2006 – 2017 California, 2000-2017 Wisconsin, 2010-2022	3.9 4.6 8.8 2.9	176 207 396 131
Transportation and warehousing	Washington State, 1995-2005 Washington State, 2006 – 2017 Wisconsin, 2010-2022	3.5 3.8 1.1	158 171 49.5
Utilities	California, 2000-2017	11.4	513
Mining	California, 2000-2017	21.3	959
Wholesale Trade	Wisconsin, 2010-2022	1.9	85.5

Population	Source of Data	Average Annual Rate (per 100,000 Workers)	Expected Number of Non-Fatal HRIs per 100,000 workers over Working Lifetime
Rates Based on Industry-Specific Groups (6-digit NAICS)			
Farm labor contractors and crew leaders	Washington State, 2006-2017	77.3	3,479
Fire protection	Washington State, 1995-2005 Washington State, 2006-2017	80.8 60.0	3,636 2,700
Structural steel and precast concrete	Washington State, 2006-2017	54.2	2,439
Poured concrete foundation and structural contractors	Washington State, 1995-2005 Washington State, 2006-2017	35.9 31.6	1,616 1,422
Roofing contractors	Washington State, 1995-2005 Washington State, 2006-2017	59.0 29.0	2,655 1,305
Highway, street, and bridge construction	Washington State, 1995-2005	44.8	2,016
Site preparation construction	Washington State, 1995-2005	35.9	1,616
Rates Based on Major Occupational Groups			
Protective services	California, 2000-2017 Wisconsin, 2010-2022	56.7 4.1	2,552 185
Farming, fishing, and forestry	California, 2000-2017	35.9	1,616
Transportation and Material moving	California, 2000-2017 Wisconsin, 2010-2022	12.3 2.6	554 117
Construction and extraction	California, 2000-2017 Wisconsin, 2010-2022	8.9 1.5	401 67.5
Building and grounds cleaning and maintenance	California, 2000-2017 Wisconsin, 2010-2022	6.0 1.5	270 67.5
Production	Wisconsin, 2010-2022	1.6	72.0
Municipal workers in departments governing streets and traffic, parks and recreation, utilities, and solid waste	Texas, 2009-2017	2,550	114,750
Rates Based on Minor Occupational Groups			
Fire Fighting and Prevention	Wisconsin, 2010-2022	14.7	662
Material Moving Workers	Wisconsin, 2010-2022	3.3	149
Metal and Plastic Workers	Wisconsin, 2010-2022	2.8	126
Motor Vehicle Operations	Wisconsin, 2010-2022	2.2	99.0
Assemblers and Fabricators	Wisconsin, 2010-2022	2.2	99.0

[1] Ranges reflect varying annual average estimates between 2011-2020.

[2] Ranges reflect values reported in Heinzerling et al., 2020, Bonauto et al., 2007, and Hesketh et al., 2020.
[3] Ranges reflect values reported in or derived from Harduar Morano et al., 2015, Florida DOH 2011, Louisiana DOH 2023, Harduar Morano et al., 2016, CSTE, and Maricopa County Public Health Department.

IV. Limitations and Underreporting.

Evidence suggests that existing surveillance data undercount the total number of heat-related injuries, illnesses, and fatalities, among workers. The incident rates presented in the previous section are likely vast underestimates both because they use this surveillance data as the numerator when calculating incidence rates and because they overestimate the number of workers exposed to hot work environments (i.e., the denominator for incidence rates). These sources of uncertainty are described below.

A. Incidence Estimation.

Incidence estimates based on BLS data are likely to underestimate the true risk to workers who are exposed to specific hazards, like heat, in part because of difficulties in estimating the population of exposed workers. The current approach for BLS SOII rate estimates is to use the population of all workers in the U.S. for the denominator, not just those exposed to the hazard of interest. For instance, the denominators used for the risk estimates presented above would include most office workers who work in climate-controlled buildings and would therefore not have occupational exposure to the levels of heat stress that have been associated with adverse outcomes. For 2022, BLS reported 116,435,925 full-time workers in the U.S. However, OSHA estimates the proposed standard would cover approximately 36 million workers, approximately one-third of the total full-time workers in the U.S. Therefore, BLS's use of a larger denominator likely underestimates risk because it includes workers not exposed to hazardous heat and therefore less likely to experience an HRI.

The denominators for the annual incidence estimates presented above also include worker-time for the entire year, even though for many workers, exposure to potentially harmful levels of heat only occurs during the hottest months of the year. Including

unexposed worker-time in the denominator has the effect of diluting the incidence estimates, meaning annual incidence estimates do not accurately represent the risk to workers when they are actually exposed to hazardous heat. The risk to workers whose jobs do expose them to harmful levels of heat, on the days on which those exposures occur, would therefore be expected to be higher than the estimates published by BLS. In addition, using total worker populations as a basis for estimating incidence likely will underestimate the risk to particularly susceptible workers, such as older workers, workers with pre-existing conditions, and workers not acclimatized to the heat.

OSHA believes that studies that reported illness rates by sector or occupation provide evidence showing that the annual average illness rates reported across the entire workforce underestimate risk for exposed workers. For example, the Washington State and California workers' compensation studies found that heat-related illness rates for sector- or occupation-specific populations were substantially higher than the rates for the general working population in the State (Heinzerling et al., 2020; Bonauto et al., 2007; Hesketh et al., 2020). The sectors and occupations examined included those where exposure to hot environments was more likely than for the population as a whole (e.g., Construction and Agriculture, Forestry, Fishing, and Hunting). Additionally, many of the surveillance papers described above also reported the month in which the injury, illness, or fatality occurred and found that most cases were clustered in the hotter, summer months (e.g., June, July, and August). When researchers in Washington and Florida restricted their rate estimates to include data only for the third quarter (July, August, and September), they found rates that were several-fold higher than annual average illness rates over the whole population, which include many unexposed worker-days.

B. Undercounting of Cases.

The general underreporting and undercounting of occupational injuries and illnesses has been a topic of multiple government reports (e.g., Ruser, 2008; Miller, 2008;

GAO, 2009; Wiatrowski, 2014). The authors of the peer-reviewed papers described in sections V.A.II., and V.A.III., above list underreporting or misclassification of cases as a limitation in their analyses that would have the effect of underestimating risk.

I. BLS SOII.

Two papers from the early 2000s that linked workers' compensation records to BLS SOII data found evidence that SOII missed a substantial amount of workers' compensation claims, depending on the State analyzed and the assumptions and methodology used (Rosenman et al., 2006; Boden and Ozonoff, 2008). In response to increased attention around this topic at the time, BLS funded additional research to examine the extent of underestimation in SOII and potential reasons (Wiatrowski, 2014). One of these studies involved linking multiple data sources (i.e., not just SOII and workers' compensation) for cases of amputation and carpal tunnel syndrome (Joe et al., 2014). The authors found that the State-based surveillance systems included 5 times and 10 times more cases than BLS SOII, respectively.

Another study conducted as part of this broader effort estimated that approximately 30% of all workers' compensation claims in Washington between 2003 – 2011 were not captured in BLS SOII (Wuellner et al., 2016). This included sectors with higher rates of heat-related injuries and illnesses, such as Agriculture, Forestry, Fishing, and Hunting (28% of cases uncaptured) and Construction (28% uncaptured) (Wuellner et al., 2016, Table III). The rate of underreporting was particularly high for large construction firms (Wuellner et al., 2016, Table IV).

In response to the studies on SOII undercount, BLS authors have argued that differences in the inclusion criteria, scope, and purpose between BLS SOII and workers' compensation explain some of differences in the estimates and complicate the interpretations of the linkage-based studies (Ruser, 2008; Wiatrowski, 2014). SOII estimates OSHA-recordable injuries and illnesses each year and provides detailed case

and demographic information (e.g., nature of injury) for a specific subset of the more severe cases (e.g., those involving days away from work). This scope (OSHA-recordable injuries and illnesses) inherently limits the ability for SOII to be used to estimate all occupational injuries and illnesses. Additionally, injuries and illnesses involving days away from work represent a limited percentage of the total injuries and illnesses reported to BLS. In 2022, these cases were 42% of total recordable cases, suggesting the case counts for HRIs in SOII could be missing up to 58% of all OSHA-recordable HRIs (i.e., those not involving days away from work) (*https://www.bls.gov/iif/latest-numbers.htm*).

The injury and illness data that employers report to BLS come from the employer's OSHA Form 300 Log of Work-Related Injuries and Illnesses and OSHA Form 301 Injury and Illness Incident Report, so information on the quality of the data in these forms is relevant for understanding limitations of SOII. Through the Recordkeeping National Emphasis Program (NEP) from 2009-2012, OSHA found that almost half (47%) of establishments inspected by the agency had unrecorded and/or under-recorded cases, which were more common at establishments that originally reported low rates (Fagan and Hodgson, 2017). Several factors contributed to the under-recording and unrecording cases. First, in conducting thousands of interviews, the authors found that workers do not always report injuries to their employers because of fear of retaliation or disciplinary action. Second, some employers used on-site medical units, which the authors explained could contribute to underreporting (e.g., if these units were used to provide first aid when additional medical care, which would have warranted reporting on OSHA forms, should have been provided).

Employers rely on workers to report injuries and illnesses that may otherwise be unobserved, but workers have multiple reasons to not do so. In addition to Fagan and Hodgson 2017, multiple studies have interviewed or surveyed workers on this topic. A recent systematic review of 20 studies found that 20-74% of workers - which included

cleaning staff, carpenters, construction workers, and healthcare workers - did not report injuries or illnesses to management (Kyung et al., 2023). Some of the researchers asked workers about the barriers to reporting, which included fear, a lack of knowledge on the reporting process, and considering the injury to be a part of the job or not serious.

Finally, employers are disincentivized from reporting injuries and illnesses on their OSHA logs. Disincentives for reporting include workers' compensation premiums being tied to injury and illness rates, competition for contracts involving safety records, and a perception that reporting will increase the probability of being inspected by OSHA (GAO, 2009).

In interviews with employers selected to respond to SOII, researchers found that 42% of them were not maintaining a log (Wuellner and Phipps, 2018). In the same study, researchers found evidence to suggest that misunderstandings about the reporting requirements would likely lead to employers underreporting cases involving days away from work. A similar study conducted among SOII respondents in Washington State found that 12% weren't maintaining a log and 90% weren't complying with some aspect of OSHA's recordkeeping requirements (Wuellner and Bonauto, 2014).

While the general underreporting articles described here are not specific to heat, Heinzerling et al. 2020 examined rates of heat-related injuries and illnesses among workers in California and found that California's workers' compensation database, WCIS, had 3-6 times the number of heat-related cases between 2009 – 2017 than the official BLS SOII estimates for California for each year in that period (Heinzerling et al., 2020). Part of the reason for this discrepancy could be the difference in inclusion criteria between the two datasets, however, it is still a useful estimate for contextualizing the potential magnitude of underreporting of heat-related cases when using only SOII. While outside the U.S., a recent survey of 51 Canadian health and safety professionals in the

mining industry found that 71% of respondents believed HRIs were underreported (Tetzlaff et al., 2024).

II. Workers' Compensation.

While workers' compensation data may capture injury and illness cases not included in BLS SOII, the data are not available for the entire U.S., as insurance coverage and reporting requirements vary across States, and most States do not have single-payer systems. Therefore, the majority of claims data are compiled by various insurers and not within a single database. Even when the data are available for an entire State, it is generally presumed that not all worker injuries and illnesses are captured in these data, in part because of eligibility criteria and in part because of underutilization of workers' compensation for reimbursement of work-related medical expenses.

Multiple papers have examined the extent to which and reasons why workers don't always use workers' compensation insurance to pay for work-related medical expenses and other reimbursable expenses. Some reasons workers have reported for not filing workers' compensation claims include fear, a lack of knowledge, "too much trouble" or effort, and considering the injury to be a part of the job or not serious (Kyung et al., 2023; Scherzer et al., 2005). Using the Washington State Behavioral Risk Factor Surveillance System (BRFSS), a telephone survey, Fan et al. (2006) found that 52% of the respondents in 2002 reporting a work-related injury or illness filed a workers' compensation claim. Using similar methodology across 10 States, Bonauto et al. (2010) found that among respondents who reported a work-related injury, there was a wide range in the proportion who reported having their treatment paid for by workers' compensation by State - 47% in Texas to 77% in Kentucky (with a median of 61%). A study from 2013 estimated that 40% of work-related ED visits were paid for by a source other than workers' compensation (Groenewold and Baron, 2013). Worker race, geography, and

having an illness rather than an injury were all predictors of whether workers' compensation was the expected payer.

There are a few papers that suggest this phenomenon is occurring for heat-related outcomes. Harduar Morano et al. 2015 (described above in Section V.A.II., Reported Annual Incidence of Nonfatal Occupational Heat-Related Injuries and Illnesses) found that across several southeastern States, workers' compensation as expected primary payer alone captured 60% of all emergency department visits and inpatient hospitalizations, which varied by State (50-80% for emergency department visits and 38-84% for inpatient hospitalizations) (Harduar Morano et al., 2015). Similarly, in the 2011 report by the Florida Department of Health (described above in Section V.A.II., Reported Annual Incidence of Nonfatal Occupational Heat-Related Injuries and Illnesses), 83% of claims identified were captured by workers' compensation as primary payer (Florida DOH, 2011). It should be noted that these percentages are influenced by the total number of captured cases and in both sources the authors presume that they did not capture all relevant cases.

III. Hospital Discharge Data.

Hospital discharge data are the only surveillance data presented in this risk assessment for which work-relatedness is not an inclusion criterion; therefore, researchers relying on this data need to take an additional step to assess work-relatedness for each case that introduces the possibility that work-related cases are not recognized as such and are thus excluded. Researchers identifying work-related cases typically use a combination of workers' compensation as the primary payer or ICD codes for external cause of injury. As discussed in the previous section, workers' compensation is not always used by workers, so relying on this variable will lead to undercounting. For external cause of injury codes (e.g., E900.9 Excessive heat of unspecified origin), researchers have found that these are not always present or accurate for work-related injury cases (Hunt et al.,

2007), which isn't unexpected given that they aren't required for reimbursement. For instance, codes indicating the location of occurrence were present in 43% of probable work-related injury cases the authors reviewed (Hunt et al., 2007). Harduar Morano and Watkins (2017) used external cause of injury codes to identify work-related emergency department visits and hospitalizations for heat-related illnesses in Florida. They found that 2.8% of emergency department visits, 1.2% of hospitalizations, and 0% of deaths were identified solely by an external cause of injury code for work.

Both workers' compensation claims and hospitalization data are also affected by the accuracy of diagnostic codes for identifying heat-related cases. While the use of ICD codes for surveillance of heat-related deaths, illnesses, and injuries is widely accepted, it is not infallible, as these codes are designed for billing rather than surveillance. The use of specific codes is up to the discretion of healthcare providers, so practices may vary by provider and facility. Healthcare providers may not always recognize that a patient's symptoms are heat-related and thus, they may not record a heat-specific ICD code. For example, a patient who presents to the emergency room after fainting would likely be diagnosed with "syncope" (the medical term for fainting). If the provider is aware that the patient fainted due to heat exposure, they should record a heat-specific ICD-10 code, T67.1 *Heat syncope*. However, if the provider is unaware that the patient fainted due to heat exposure (or otherwise fails to recognize the connection between the two), they may record a non-heat-specific ICD-10 code, R55 *Syncope and collapse.* Researchers suspect underreporting when ICD codes are used for surveillance of HRIs (Harduar Morano and Watkins, 2017) and recommend researchers use all possible fields available (e.g., primary diagnosis, secondary diagnosis, underlying cause of death, contributing cause of death).

Researchers examining trends in heat-related illnesses using electronic health records for the Veterans Health Administration identified a dramatic increase in cases when ICD-10 was adopted, suggesting that the coding scheme in ICD-9 may have led to

systematic underreporting of heat-related cases, at least for this population (Osborne et al., 2023). The authors also note that 8.4% of the HRI cases they identified were captured using unstructured fields (e.g., chief complaint, reason for admission) and not ICD codes.

Not all sick and injured workers go to an emergency department or hospital and those that do are likely to be more severe cases. Unfortunately, estimating the proportion of injured and sick workers who do go to the hospital or emergency room is difficult, given a lack of data on this topic. In a 1998 CDC Morbidity and Mortality Weekly Report written by NIOSH safety researchers, the authors reported an analysis of unpublished data from the 1988 National Health Interview Survey (NHIS) Occupational Health Supplement which found that 34% of all occupational injuries were first treated in hospital emergency departments, 34% in doctors' offices/clinics, 14% in work site health clinics, and 9% in walk-in clinics (NIOSH DSR 1998). 1988 was the last year that NIOSH asked that question in the NHIS.

Care-seeking for workers experiencing heat-related symptoms specifically may be low. In a study evaluating post-deployment survey response data among a subset of the Deepwater Horizon oil spill responders (U.S. Coast Guard), Erickson et al. found that less than 1% of respondents reported seeking medical treatment for heat-related illness, yet 12% reported experiencing any heat-related symptoms (Erickson et al., 2019).

IV. BLS CFOI.

CFOI is well-regarded as the most complete and authoritative source on fatal workplace injuries. However, the approach used to classify the event and nature codes by BLS is not immune to misclassification of heat-related deaths. BLS relies on death certificates, OSHA fatality reports, news articles, and coroner reports (among other sources) to determine the primary or contributing causes of death. The criteria for defining a heat-related death or illness can vary by State, and among physicians, medical

examiners, and coroners. Additionally, individuals who fill out death certificates are not necessarily equipped to make these distinctions or confident in their accuracy (Wexelman, 2013). Depending on State policies, individuals performing this role may be a medical professional or an elected official with limited or no medically relevant experience (National Research Council, 2009; CDC, 2023).

Researchers estimating fatality rates attributable to heat in the overall U.S. population using historical temperature records have produced much higher counts than approaches solely using death certificates (Weinberger et al., 2020). While outside the U.S., a recent study examining causes of death among migrant Nepali workers in Qatar from 2009-2017 demonstrated that deaths coded as cardiovascular-related (e.g., "cardiac arrest") among these mostly young workers were unexpectedly common and correlated with higher wet bulb globe temperatures, suggesting that these deaths may have been heat-related but not coded as such (Pradhan et al., 2019). Heat-related deaths are uniquely hard to identify if the medical professional didn't witness the events preceding the death, particularly because heat can exacerbate an existing medical condition, acting as a contributing factor (Luber et al., 2006).

C. Summary.

In conclusion, the available evidence indicates that the existing surveillance data vastly undercount cases of heat-related injuries and illnesses among workers. OSHA additionally believes that the inclusion of unexposed worker-time in the denominator for incidence estimates underestimates the true risk among heat-exposed workers.

V. Requests for Comments.

OSHA requests information and comments on the following questions and requests that stakeholders provide any relevant data, information, or additional studies (or citations) supporting their view, and explain the reasoning for including such studies:

- Are there additional data or studies OSHA should consider regarding the annual incidence of HRIs and heat-related fatalities among workers?
- OSHA has identified data from cohort-based and time series studies that would suggest higher incidence rates than data from surveillance datasets (e.g., BLS SOII, workers' compensation claims). Are there other data from cohort-based or time series studies that OSHA should rely on for determining risk of HRIs to heat-exposed workers?
- Are employers aware of occupational HRIs that are not reported through BLS SOII, workers' compensation claims, or hospital discharge data? How commonly do HRIs occur that are not recorded on OSHA 300 logs?
- Are there additional data or studies that OSHA should consider regarding the extent of underreporting and underestimating of HRIs or heat-related fatalities?

B. Basis for Initial and High Heat Triggers.

I. Introduction.

In this section, OSHA presents the evidence that forms the basis of the heat triggers contained in the proposed standard. These triggers are based on the heat index and wet bulb globe temperature (WBGT). The WBGT triggers are based on NIOSH exposure limits (i.e., the REL and RAL), which are supported by empirical evidence dating back to the 1960s and have been found to be highly sensitive in capturing unsustainable heat exposures.

Although there are no consensus-based heat index exposure limits for workers, the question of which heat index values represent a highly sensitive and appropriate screening threshold for heat stress controls in the workplace has been evaluated in the peer-reviewed scientific literature. The evidence described below provides information on the sensitivity of alternative heat index values, that is, the degree to which a particular heat index value can be used to screen for potential risk of heat-related injuries and

illnesses (HRIs) and fatalities. OSHA looked at both experimental and observational evidence, including efforts to derive more accessible and easily understood heat index-based triggers from WBGT-based exposure limits, to preliminarily determine appropriate heat index values for triggering heat stress control measures. Each of these evidence streams has strengths and limitations in informing this question.

Relevant experimental evidence in the physiology literature is often conducted in controlled laboratory settings among healthy, young volunteers, but the conditions may not always mimic conditions experienced by workers (e.g., workers often experience multiple days in a row of working in high temperatures). Observational evidence does not have this limitation because the data are collected among actual workers in real-world settings. However, observational evidence is potentially affected by exposure misclassification since exposure metrics are often derived from local weather stations and rely on maximum daily values. Experimental data does not have this limitation, since the laboratory conditions are highly controlled, including the exposure levels.

OSHA used both streams of evidence to support proposing an initial heat trigger of 80°F (heat index) and a high heat trigger of 90°F (heat index). The observational evidence that OSHA identified suggests that the vast majority of known occupational heat-related fatalities occur above the initial heat index trigger, making it a sensitive trigger for heat-related fatalities. The vast majority of nonfatal occupational HRIs also occur above this trigger. The experimental evidence (specifically the WBGT-based exposure limits) also suggests that when there is high radiant heat, a heat index of 90°F would be an appropriate time to institute additional controls (e.g., mandatory rest breaks). This is supported by observational evidence that shows a rapidly declining sensitivity above a heat index of 90°F. OSHA has preliminarily concluded that the experimental evidence also supports the selection of these triggers as highly sensitive and therefore protective.

II. Observational Evidence.

To determine an appropriate initial heat trigger, OSHA sought to identify a highly sensitive screening level above which the majority of fatal and nonfatal HRIs occur. This could presumably be used to identify the environmental conditions for which engineering and administrative controls would be most important to prevent HRIs from occurring. One challenge for determining this trigger level is that many factors influence an individual's risk of developing an HRI. In addition to workload, PPE, and acclimatization status, the risk of developing an HRI is also influenced by workers' abilities to self-pace at their jobs as well as whether there had been exposure to hot conditions on the prior day(s). There are also medications and comorbidities that may increase workers' risk of HRIs (see discussion in Section IV.O., Factors that Affect Risk for Heat-Related Health Effects).

The observational studies reviewed by OSHA used retrospective temperature and humidity data matched to the locations where HRIs and fatalities occurred over a period of time. Although these studies did not account specifically for workload, PPE use, acclimatization status, or other relevant factors, the HRI cases studied included worker populations where these factors were likely present to varying degrees. Therefore, OSHA has preliminarily determined that retrospective observational data collected among workers who have experienced fatal or nonfatal HRIs on the job is valuable to informing a screening level that reflects the presence of these multiple risk factors among worker populations. These studies are summarized in the following sections.

A. Fatalities.

In a doctoral dissertation from 2015, Gubernot matched historic weather data to the heat-related fatalities reported in BLS CFOI (fatality data described in Section V.A., Risk Assessment) between 2000-2010 (Gubernot, 2015). Gubernot used historic, weather monitor-based temperature and dew point measurements from the National Climatic Data

Center to recreate the heat index (using daily maximum temperature and daily average dew point) on the day of each fatality. If there was not already a monitor in the county where a fatality occurred, then the next closest weather monitor to that county was used. Of the 327 fatalities identified as being related to ambient heat exposure (i.e., cases with secondary heat sources, like ovens, were excluded), 96.3% occurred on a day with a calculated heat index above 80°F and 86.9% occurred on a day above 90°F. Using a higher threshold such as a heat index of 95°F would have only captured approximately 71% of fatalities (estimated from Figure 4-2 of the study). The author also evaluated how many cases occurred on a day when a National Weather Service (NWS)-defined excessive heat event (EHE) was declared. In a directive to field offices, the NWS outlines when offices should issue excessive heat warnings—when there will be 2 or more days that meet or exceed a heat index of 105°F for the Northern U.S. and 110°F for the Southern U.S., with temperatures not falling below 75°F (although local offices are allowed to use their own criteria) (NWS, 2024a). Gubernot appears to have used a simpler criterion to evaluate the sensitivity of these EHEs - whether the heat index on the day of the fatality was at or above 105°F for northern States and at or above 110°F for southern States. Only 42 fatalities (12.8%) occurred on days meeting the EHE definitions, suggesting EHEs are not a sensitive trigger for occupational heat-related fatalities. During the SBREFA process, small entity representatives suggested that OSHA consider the NWS EHE definitions as options for the initial and/or high heat triggers, but based on these findings (and those reported in other studies summarized in this section), OSHA has preliminarily determined that these criteria are not sensitive enough and would not adequately protect workers.

Some limitations of this analysis include the use of nearest-monitor exposure assignment, as well as the use of maximum temperature with average dew point to calculate heat index, both of which may introduce exposure misclassification. Although

the author did not refer to the latter as a daily maximum heat index, this estimate would most closely approximate that value, which would suggest that workers were likely exposed to heat index values below that level during the work shift leading up to the fatality.

In a meta-analysis published in 2020, Maung and Tustin (both affiliated with OSHA at the time) conducted a systematic review of studies, such as the one described above by Gubernot, where researchers retrospectively assigned heat exposure estimates to occupational heat-related fatalities (Maung and Tustin, 2020). The purpose of their meta-analysis was to identify a heat index threshold below which occupational heat-related fatalities do not occur (i.e., a highly sensitive threshold). Maung and Tustin identified 418 heat-related fatalities among civilian workers across 8 studies. Approximately three quarters of these civilian fatalities (n=327; 78%) came from Gubernot 2015. The authors found a heat index threshold of 80°F to be highly sensitive for civilian workers - 96% of fatalities (402 of 418) occurred on days with a heat index estimate at or above this level. A heat index threshold of 90°F had slightly lower sensitivity—approximately 86% (estimated from table 1 and figure 3 of their study). Similar to the findings reported in Gubernot 2015, one of the NWS thresholds for issuing heat advisories (heat index of 105°F) did not appear to be a sensitive trigger, missing 68% of civilian worker fatalities.

The limitations for Gubernot 2015 apply to this analysis as well. These analyses (including the data from Gubernot, 2015) were limited to outdoor workers, potentially limiting the generalizability of the findings. This analysis also relied on single values (e.g., daily maximum heat index) to capture exposure across a work shift. As pointed out by Maung and Tustin, it is important to consider that exposure characterizations using daily maximum heat index likely over-estimates the exposures that workers experience throughout the shift leading to the fatality. For example, a fatality occurring on a day with

a daily maximum heat index of 90°F likely involved prolonged exposure to heat index values in the 80s°F.

In 2019, a group of OSHA researchers published a similar analysis for both fatal and nonfatal HRIs reported to OSHA in 2016 among outdoor workers (Morris CE et al., 2019). They identified 17 fatalities in this subset and used nearest weather station data to estimate daily maximum heat index on the day of the fatality. All 17 fatalities occurred on a day with a daily maximum heat index of at least 80°F (the lowest was at 88°F). A daily maximum heat index of 90°F had a sensitivity of approximately 94%, while 100°F had a sensitivity of approximately 35%. A major limitation with this analysis is its small sample size (n=17 fatalities).

B. Non-Fatalities.

Morris et al., identified 217 nonfatal HRIs among outdoor workers reported to OSHA in 2016 (Morris CE et al., 2019). They found that 99% of these cases happened on a day with a daily maximum heat index of at least 80°F. There is a steep decline in sensitivity for daily maximum heat index values in the 90s°F - 89% for 90°F but approximately 58% for 100°F (estimated from Figure 5 of the study which combines fatal and nonfatal cases) - suggesting that many nonfatal HRIs occur on days when the heat index does not reach 100°F. One limitation of this dataset is potential selection bias, because the dataset only included cases that were reported to OSHA. This study therefore did not include cases in State Plan States.

A much larger analysis conducted among emergency department (ED) visits in the Southeastern U.S. was published by Shire et al. (Shire et al., 2020). The authors identified 5,017 hyperthermia-related ED visits among workers in 5 southeastern States (Florida, Georgia, Kentucky, Louisiana, and Tennessee) between May and September in 2010-2012. While the previously described studies used nearest monitor data, Shire et al. used data from the North American Land Data Assimilation System (NLDAS), which

incorporates both observation and modeled data to fill in gaps between locations of monitors, providing data at a higher geographic resolution (0.125° grid). Since the authors only had ED visit data at the county level, they used the NLDAS data to compute population-weighted, county-level estimates of daily maximum heat index using all the grids within each county. They found that approximately 99% of ED visits occurred on days with a daily maximum heat index of at least 80°F and about 95% of cases on days with a maximum heat index of at least 90°F. Approximately 54% of cases occurred on days with a daily maximum heat index of 103°F or higher. This further supports the finding from Morris et al. (2019) that sensitivity declines steeply above a heat index of 90°F. One limitation of this analysis is the use of the emergency department location as the basis for the exposure assignment, which has the potential to introduce exposure misclassification if workers were working far away from the ED facility.

In a 2016 doctoral dissertation, Harduar Morano conducted a retrospective analysis of 3,394 heat-related hospitalizations and ED visits among Florida workers in May-October between 2005-2012, using data from the weather monitor nearest to the zip codes where the hospitalizations and ED visits occurred to characterize heat exposure (Harduar Morano, 2016). The vast majority of cases occurred on a day with a daily maximum heat index of at least 80°F, with approximately 91% of cases occurring on a day with a maximum heat index of at least 90°F (estimated from Figure 6-4). There was also a 13% increase in the HRI hospitalization and ED visit rate for every 1°F increase in heat index at values below 99°F (Figure 6-4, Lag 0 plot of the study), suggesting that potential triggers in the mid-to-high 90's would increasingly miss many cases. One limitation of this analysis and that conducted by Shire et al. is that hospitalization and ED visit data did not include enough information to distinguish between indoor vs outdoor workers; it is possible that indoor workers could have been exposed to conditions not captured by the weather data (such as working near hot industrial processes).

In addition, four studies of workers' compensation data in Washington State - three of which were reported in Section V.A., Risk Assessment - have examined maximum temperature or heat index on the days of reported HRIs (Bonauto et al., 2007; Spector et al., 2014; Hesketh et al., 2020; Spector et al., 2023). Hesketh et al., 2020 (an update on Bonauto et al., 2007) matched weather data to addresses for the HRI claims in the State's workers' compensation database between 2006 and 2017 (Hesketh et al., 2020). They found that, of the 905 claims for which they had temperature data, over 75% of HRIs occurred on days with a maximum temperature of at least 80°F and approximately 50% of claims occurred on days with a maximum temperature of at least 90°F (estimated from Figure 2). They also reported that approximately 75% of claim cases occurred when the hourly maximum temperature was at least approximately 79°F. This paper is part of the rationale for Washington State lowering the trigger level in its heat-specific standard from 89°F to 80°F - the old trigger of 89°F had missed 45% of cases in this dataset (Washington Dept. of Labor & Industries, 2023). A similar study published in 2023 expanded the dataset used by Hesketh et al. to include HRI claims from 2006 to 2021 (n=1,241) (Spector et al., 2023). The authors used gridded meteorological data from the PRISM Climate Group at Oregon State University and geocoded accident location (or business location or provider location if accident location was unable to be used) to determine the maximum temperature on the day of the event. They found that 76% of HRI claims occurred on a day with a maximum temperature of at least 80°F (this increased to 79% when restricted to cases that were "definitely" or "probably" outdoors). A major limitation of these studies is the use of ambient temperature, limiting the ability to compare findings to other papers that relied on the heat index. In Spector et al. 2014, the authors calculated the daily maximum heat index for each county with an HRI in their dataset on the date of injury (Spector et al., 2014). They obtained the county of injury and, when not available, imputed the location of the

injury rather than using the employer address, which is assumed to be more accurate for characterizing exposure. In their analysis of 45 agriculture and forestry worker HRI claims between 1995-2009 that had corresponding weather data, Spector et al. found that 75% of HRI claims occurred on days when the maximum heat index was at least 90°F, whereas only 50% occurred on days when it was at least 99°F and 25% for 106°F.

C. Summary.

In summary, researchers have identified a heat index of 80°F as a highly sensitive trigger for heat-related fatalities (capturing 96-100% of fatalities) and nonfatalities (99-100%) among workers (excluding results from Washington State). When looking at ambient temperature, researchers in Washington found that 75-76% of HRI claims occurred on a day with a maximum ambient temperature of 80°F or greater. Multiple studies additionally identified a rapidly declining sensitivity above a heat index of 90°F, suggesting that additional protective measures (e.g., observation for signs and symptoms of HRIs) are needed once the heat index reaches approximately 90°F.

One of the common limitations of the analyses presented in this section is the use of a single reading (e.g., daily maximum heat index) to capture each affected worker's exposure on the day of the event. In reality, conditions fluctuate throughout the day, so relying on maximum measures would likely overestimate heat exposure across the workday. The use of nearest monitor weather data is also likely to lead to exposure misclassification. The inclusion of indoor workers in some of the studies is also a limitation, since the exposure for those workers could be very different (e.g., if there is process heat). In Spector et al. 2023, the authors noted an increase in the percent of cases occurring on days with a maximum temperature of 80°F when restricting to cases that definitely or probably occurred outdoors. In all these studies, researchers can only examine conditions for the cases that were captured in the surveillance systems. There could be a bias such that cases occurring on hotter days were more likely to have been

coded as heat-related and included in these databases. Failure to ascertain HRI cases occurring at lower heat indices could have skewed the findings upwards, making it appear that hotter thresholds were more sensitive than they actually were. Finally, the use of heat index (or ambient temperature) ignores the impacts of air movement as well as radiant heat, which can substantially increase the heat stress a worker is exposed to and increase the risk of an HRI.

III. Experimental Evidence.

NIOSH has published exposure limits based on WBGT in its *Criteria for a Recommended Standard* going back multiple decades.[3] These exposure limits - the REL and RAL - account for the contributions of wind velocity and solar irradiance, in addition to ambient temperature and humidity. (ACGIH has published similar exposure limits - the TLV and AL.) In addition to WBGT, NIOSH and ACGIH heat stress guidelines require the user to account for metabolic heat production (through the estimation of workload) and the contributions of PPE and clothing. The user adds an adjustment factor to the measured WBGT to account for the specific clothing or PPE worn (specifically those ensembles that impair heat loss) and uses a formula based on workload to estimate the exposure limit. They then compare the measured (or adjusted, if using a clothing adjustment factor) WBGT to the calculated exposure limit to determine if the limit is exceeded. Work-rest schedules with increasing time spent on break can further increase the exposure limit.

These exposure limits and guidelines are based in empirical evidence, such as laboratory-based trials conducted in the 1960s and 1970s. This basis for WBGT exposure limits is described in detail by both NIOSH and ACGIH (NIOSH, 2016; ACGIH, 2017). These exposure limits have been tested and found to be highly sensitive (100%) in

[3] NIOSH plays an important role in carrying out the purpose of the OSH Act, including developing and establishing recommended occupational safety and health standards (29 U.S.C. 671).

modern laboratory conditions in capturing unsustainable heat exposures (i.e., when a steady increase in core temperature is observed) (Garzon-Villalba et al., 2017). Among workers in real-world settings, these WBGT-based exposure limits have been found to be highly sensitive for fatal outcomes (100% in one study; 92-100% in another) and, although slightly less so, still sensitive for nonfatal outcomes (73% in one study; 88-97% in another); however, these studies are limited by their small sample size and retrospective characterization of workload, acclimatization status, and clothing/PPE use (which are required for accurately estimating WBGT-based exposure limits) (Tustin et al., 2018b; Morris CE et al., 2019).

Two papers have attempted to apply the concepts of the WBGT-based exposure limits to the more easily accessible and understood heat index metric. Based on the relationship between WBGT and heat index, Bernard and Iheanacho developed a screening tool that reflects heat stress risk based on heat index and workload category—light (180 W), moderate (300 W), and heavy (415 W) - using assumptions about radiant heat but ignoring the contributions of wind and clothing (Bernard and Iheanacho, 2015). To do this, they created a model predicting WBGT from the heat index. From this model, WBGT estimates were produced within a 1°C range for heat index values of 100°F or more but the model was less accurate at heat index values below 100°F. Using their reported screening table, which allows the user to adjust for low vs high radiant heat, an acclimatized worker performing a heavy (415 W) workload in high radiant heat outdoors would be above the WBGT-based exposure limit and in need of a break at a heat index of 90°F. The same worker, if unacclimatized, would be above the exposure limit at a heat index of 80°F. These findings support the provision of 15-minute breaks at a heat index of 90°F in OSHA's proposed standard, as well as the provision requiring these breaks for unacclimatized workers at a heat index of 80°F (unless the employer is following the gradual acclimatization schedule and providing breaks if needed). The authors noted that

high radiant heat indoors could require even greater adjustments to the heat index. As further evidence for the need to adjust these values for radiant heat exposure, Morris et al. (2019) reported that for the days on which HRIs occurred in their dataset, cloud cover was often minimal suggesting there was exposure to high radiant heat when the HRIs occurred.

More recently, Garzón-Villalba et al. used an experimental approach to derive workload-based HI heat stress thresholds (Garzón-Villalba et al., 2019). The researchers used data from two progressive heat stress studies of 29 acclimatized individuals. Participants were assigned different work rates and wore different clothing throughout the trials, serving as their own controls. Once thermal equilibrium was established, the ambient temperature was increased in five-minute intervals while holding relative humidity constant. The critical condition defined for each subject was the condition at which there was a transition from a stable core body temperature to an increasing core body temperature (i.e., the point at which heat exposure became unsustainable). Using the results from these trials, the authors established an equation deriving a heat index exposure limit (equivalent to the TLV or REL) at different metabolic rates for a worker wearing woven clothing:

$$\text{HI benchmark (°C)} = 49 - 0.026\ M$$

Where M is workload in Watts.

Garzón-Villalba et al. assessed the effectiveness of the proposed heat index thresholds for predicting unsustainable heat stress by using receiver operating characteristic curves and area-under-the-curve (AUC) values to determine predictive power (this technique is commonly used to evaluate the predictive power of diagnostic tests). The AUC value for the proposed heat index thresholds with subjects wearing woven clothing was 0.86, which is similar to that of the WBGT-based thresholds, based on the authors' prior analysis (Garzón-Villalba et al., 2017). This result showed that the

heat index thresholds derived by Garzón-Villalba et al. (2019) would reasonably identify unsustainable heat exposure conditions.

Compared to the heat index thresholds proposed by Bernard and Iheanacho (2015), the heat index thresholds proposed by Garzón-Villalba et al. are the same at low metabolic rates (111°F for 180 W) but higher at higher metabolic rates: 105.8°F versus 100°F at 300 W and 100.4°F versus 95°F at 415 W (Note: these values are unadjusted for radiant heat). This is likely because the ACGIH WBGT-based exposure limits, upon which Bernard and Iheanacho based their heat index thresholds, are intentionally more conservative at higher metabolic rates, whereas Garzón-Villalba used a less conservative linear model to derive their heat index thresholds (Garzón-Villalba et al., 2019). When adding an adjustment for full sunshine provided by the authors, the proposed heat index-based exposure limit derived from the Garzón-Villalba et al. (2019) equation for a worker performing a very heavy workload (450 W) is 92.8°F.

Thus, laboratory-derived heat index thresholds for unsustainable heat exposure are higher than heat index thresholds shown in observational studies to be sensitive for predicting the occurrence of HRIs. There are several reasons that may explain why values determined to be sensitive in laboratory settings are higher than those reported among workers in real-world settings. For one, volunteers in laboratory studies are often young, healthy, and euhydrated (i.e., beginning the trial adequately hydrated). They are also not exposed to consecutive days of heat exposure for eight-hour or longer work shifts. Working in hot conditions on the prior day has been demonstrated in the literature to be a risk factor for HRIs, even among acclimatized individuals (Garzón-Villalba et al., 2016; Wallace et al., 2005). Therefore, the use of volunteers and exposure conditions in laboratory-based trials may not always provide good proxies for workers and the environments in which they work. There is also significant inter-individual variability in

heat stress tolerance, which may mean trial studies with few participants might not capture the full range of heat susceptibilities faced by workers.

In summary, long-established and empirically validated occupational exposure limits exist for WBGT. In observational studies, WBGT exposure limits have been found to be highly sensitive for detecting fatal HRIs among workers and, although slightly less so, still sensitive for nonfatal outcomes (although these studies are limited by small sample size and retrospective work characterization). Research efforts to crosswalk the WBGT-based exposure limits to the more accessible heat index metric have demonstrated that a heat index of 90-92.8°F would represent an appropriate trigger for controls such as mandatory rest breaks for acclimatized workers performing heavy or very heavy workloads in high radiant heat conditions (Bernard and Iheanacho, 2015; Garzón-Villalba et al., 2019). For unacclimatized workers performing heavy workloads in high radiant heat conditions, a heat index trigger of 80°F would be in line with the WBGT-based exposure limits (Bernard and Iheanacho, 2015). Although these two studies suggest that higher triggers could reasonably be applied to workers performing lighter workloads, the assumptions used may not always apply to workers (e.g., no exposure to working in the heat the prior day, healthy, euhydrated). This may explain, at least in part, the discrepancy in findings between the observational and experimental studies discussed in this section.

IV. State Standards and Non-Governmental Recommendations.

In their heat-specific standards, summarized in the table below, States use various initial and high heat triggers, some of which depend on the clothing or gear worn by workers. OSHA's proposed triggers are generally in line with those used by these States.

OSHA is proposing using the same initial heat trigger (heat index of 80°F) as Oregon’s existing standard and Maryland’s proposed standard (Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022); Code of Maryland Regulations

09.12.32: Heat Stress Standards (2024)). California and Colorado use an ambient temperature trigger of 80°F for outdoor work sites and agricultural sites, respectively, as does the Washington standard for workers wearing breathable clothing (Cal. Code of Regulations (CCR), tit. 8, section 3395 (2015); 7 Colo. Code Regs. section 1103-15 (2022); Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)). California's proposed indoor standard uses an ambient temperature trigger of 82°F (CCR, tit. 8, section 3396 (2023)).

The high heat trigger that OSHA is proposing (heat index of 90°F) is the same as Oregon's existing standard and Maryland's proposed standard. California and Colorado use an ambient temperature high heat trigger of 95°F, while the Washington standard uses 90°F. The California indoor proposal uses an ambient temperature or heat index trigger of 87°F to impose additional requirements.

Table V-2 Summary of triggers used in various heat-specific standards at the State level

State	Setting	Initial Heat Trigger	High Heat Trigger
California	Outdoor	80°F (Ambient)	95°F (Ambient)
Washington	Outdoor	80°F (Ambient) (all other clothing) 52°F (non-breathable clothes)	90°F (Ambient)
California (proposal)	Indoor	82°F (Ambient)	87°F (Ambient or **Heat Index**), except for certain clothing or in high radiant heat (82°F)
Oregon	Indoor/Outdoor	80°F **(Heat Index)**	90°F **(Heat Index)**
Maryland (proposal)	Indoor/Outdoor	80°F **(Heat Index)**	90°F **(Heat Index)**
Colorado	Indoor/Outdoor Agriculture only	80°F (Ambient)	95°F (Ambient) or other conditions

Note: There are different provisions required at each trigger by each State.

In the Heat Stress and Strain chapter of their most recent TLV booklet, ACGIH recommends establishing a heat stress management plan when heat stress is suspected (ACGIH, 2023). One criterion they provide for determining when heat stress may be present is whether the heat index or air temperature is 80°F. In comments received from small entity representatives during the SBREFA process and a public commenter during the ACCSH meeting on April 24, 2024, OSHA heard feedback that the agency should consider different triggers that vary by geography. Neither the ACGIH TLV/REL nor

NIOSH REL/RAL vary by geography; these formulas are used globally. Additionally, California regulators, in their existing outdoor heat standard and their proposed indoor heat standard, use single State-wide triggers, despite the State experiencing a wide range of microclimates (e.g., both desert and coastal areas exist in the State). Such microclimates would make it difficult to identify appropriate geographically specific triggers, as factors like elevation and humidity can vary widely even within a specific State or region. OSHA has also heard from stakeholders who suggested that the triggers in a proposed rule should be presented simply, which would be challenging if there were multiple triggers for different parts of the country.

V. Summary.

In conclusion, OSHA preliminarily finds that the experimental and observational evidence support that heat index triggers of 80°F and 90°F are highly sensitive and therefore highly protective of workers. These triggers are also generally in-line with current and proposed triggers in State heat-specific standards. Therefore, OSHA is proposing an initial heat trigger of heat index of 80°F and a high heat trigger of heat index of 90°F. OSHA is also proposing to permit employers to use the WBGT-based NIOSH RAL and REL, which are supported by empirical evidence and have been found to be highly sensitive in capturing unsustainable heat exposure.

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether OSHA has adequately identified, documented, and correctly interpreted all studies and other information relevant to its conclusion about sensitive heat triggers;
- Whether there are additional observational studies or data that use more robust exposure metrics (e.g., more than daily maximum heat index) to retrospectively

assess occupational heat exposure on the day of heat-related fatalities and nonfatal HRIs;

- Whether OSHA should consider other values for the initial and/or high heat trigger and if so, what evidence exists to support those other values;
- The appropriateness of using heat index to define the initial and high heat triggers;
- Whether OSHA should explicitly incorporate radiant heat into the initial and/or high heat triggers, and if so, how;
- Whether OSHA should explicitly incorporate clothing adjustment factors into the initial and/or high heat triggers, and if so, how;
- Whether OSHA should use different triggers for different parts of the country, and if so, how;
- The appropriateness of applying the same triggers to employers who conduct on-site measurements as opposed to employers who use forecast data; and
- Whether OSHA should consider an additional trigger specific to heat waves or sudden increases in temperature and, if so, whether there are definitions of heat waves that are simple and easy-to-apply.

C. Risk Reduction.

I. Introduction.

OSHA identified and reviewed dozens of studies evaluating the effectiveness of various controls designed to reduce the risk of heat-related injuries and illnesses (HRIs). The studies captured include observational and experimental studies that examined the effect of either a single control or the combined effect of multiple controls. These studies were conducted among civilian workers, athletes, military personnel, and volunteers. Observational studies conducted outside the U.S. were included if OSHA determined the

work tasks to be comparable to those of U.S.-based workers. OSHA also examined systematic review articles that summarized the literature on various individual controls.

OSHA acknowledges that observational studies evaluating the effectiveness of multi-pronged interventions or programs in reducing HRI incidence in "real-world" occupational settings are the most relevant for assessing the reduction in risk of the proposed rule. However, OSHA identified very few of these studies in the literature review and determined there to be some limitations in extrapolating their findings to the proposed rule. Therefore, OSHA also examined studies looking at the effectiveness of single interventions, many of which were experimental in design.

One limitation of the experimental studies - often conducted in laboratory settings - is that they were not conducted in "real-world" occupational settings. However, some of these studies were designed to simulate actual work tasks and work environments, which increases the generalizability for occupational settings (i.e., the extent that the study results can be applied to employees exposed in the workplace). Additionally, one advantage of experimental studies is that they can be conducted under controlled conditions and are thus able to better measure endpoints of interest and control for confounding variables. Experimental studies are also sometimes able to examine situations in which subjects experience high levels of heat strain because the close physiological monitoring of subjects allows the study to be stopped before the subject is at risk of heat stroke or death.

Although many of these studies evaluated measures of heat strain (e.g., core body temperature, heart rate) rather than instances of HRIs, OSHA believes that these metrics are important for understanding risk of HRIs. As discussed in Section IV., Health Effects, these metrics are intermediary endpoints on the path to HRIs (e.g., heat stroke, heat exhaustion). The controls required in the proposed standard are effective in that they

reduce or slow the accumulation of heat in the body, which in turn reduces the risk of HRIs.

OSHA also examined and summarized systematic review articles that reviewed and discussed the experimental literature. These articles were written by prominent heat safety experts (in either an occupational or athletic context) and were typically conducted using a consensus-type approach. OSHA also looked outside the peer-reviewed literature for consensus statements, reports, recommendations, and requirements from governmental bodies and non-governmental organizations.

Despite the limitations noted above, the studies, review articles, and non-peer reviewed sources presented in this section represent the best available evidence OSHA has identified regarding the effectiveness of controls designed to reduce the risk of HRIs. The following summary of OSHA's findings demonstrates that the requirements of the proposed rule will be effective in reducing the risk of HRIs among workers.

II. Evidence on the Effectiveness of Individual Control Measures.

A. Systematic Reviews and Consensus Statements.

Several publications have summarized the literature on the efficacy of controls to reduce the risk of HRI in the form of review articles or consensus statements. For example, Morris et al. (2020) assessed systematic reviews, meta-analyses, and original studies on heat-related intervention strategies published in English prior to November 6, 2019, that included studies conducted at ambient temperatures over 28°C or among hypohydrated (i.e., fluid intake is less than water lost through sweat) participants, used healthy adult participants, and reported physiological outcomes (e.g., change in heart rate, core temperature, thermal comfort) and/or physical or cognitive performance outcomes. Most of the captured articles were from the exercise literature, but 9 of the 36 systematic reviews (i.e., a detailed and comprehensive reviews of relevant scientific studies and other evidence) mentioned occupational exposure in various professions, such as military

personnel, firefighters, and emergency responders. A second search identified 7 original studies that were not covered in the systematic reviews. Based on their systematic review, the study authors identified the following effective interventions: environmental conditioning (e.g., fans, shade, air-conditioning); optimal clothing (e.g., hats; loose fitting, light/brightly colored/reflective, breathable, clothing; ventilation patches in PPE; cooling garments/PPE); physiological adaptation (e.g., acclimatization, improving physical fitness); pacing (e.g., reduced work intensity, breaks); hydration and nutrition (e.g., hydration, electrolytes); and personal cooling options (e.g., cold water ingestion, water immersion). They also noted that "a generally under investigated, yet likely effective. . . intervention is to utilize pre-planned breaks in combination with the cooling interventions mentioned above." Morris et al. (2020) also noted that "maintaining hydration is important for maintaining cognitive and physical performance" (Morris et al., 2020).

Morrissey et al. (2021b) assembled 51 experts with experience in physiology, occupational health, and HRIs to review and summarize current data and gaps in knowledge for eight heat safety topics to develop consensus recommendations. The experts created a list of 40 heat safety recommendations within those eight topics that employers could implement at their work site to protect workers and to avoid productivity losses associated with occupational heat stress. These recommendations for each of the eight topics included:

(1) Hydration: e.g., access and availability to cool, potable water; training on hydration; addressing availability of fluids during rest breaks in the prevention plan;

(2) Environmental monitoring: e.g., measurements as close to the work site as possible; consideration of environmental conditions (e.g., temperature, humidity, wind speed, radiance), work demands, PPE, and worker acclimatization status in

assessing heat stress; including environment-based work modifications (e.g., number of rest breaks) in a prevention plan;

(3) Emergency procedures and plans: e.g., availability of an emergency plan for each work site; identification of personnel to create, manage, and implement the plan; making available, rehearsing, and reviewing the plan annually;

(4) Body cooling: e.g., availability of rest/cooling/hydration areas made accessible to workers as needed; cooling during rest breaks (e.g., immersion, shade, hydration, PPE removal); use of fans (at temperatures below 40°C (104°F)) or air-conditioners; use of portable cooling strategies (e.g., ice, water, ice towels) in areas without electricity; use of cooling strategies before, during, and after work; cooling PPE used under other PPE when PPE can't be removed;

(5) Acclimatization: e.g., creation and implementation of a 5-7 day acclimatization plan; plans for both new and returning workers that are tailored to factors such as environmental conditions and PPE; training on benefits of acclimatization;

(6) Textiles/PPE: e.g., use of clothing/PPE that is thin, lightweight, promotes heat dissipation, that fits properly, and adequately protects against hazards; PPE with ventilated openings; removal of PPE/extra layers during rest periods;

(7) Physiological monitoring (e.g., checking heart rate/body temperature); and

(8) Heat hygiene: e.g., annual training on heat related illness, prevention, first aid, and emergency response in language and manner that is easily understood; designated personnel or "buddy approach to monitor for symptoms"; communication strategies to inform employees of heat mitigation strategies before the work shift, healthcare worker using examination results (if examinations are required or recommended) to educate employees.

Racinais et al. (2015) presented consensus recommendations to reduce physiological heat strain and optimize sports performance in hot conditions that were

developed in roundtable discussions by a panel of experts. While recommendations were focused on athletes, the study authors noted that current knowledge on heat stress is mainly available from military and occupational research, with information from sport sciences available only more recently. The study authors recommended three main interventions. The first recommendation, considered to be most important by study authors, was acclimatization, involving repeated training in heat for at least 60 minutes a day over a 1-2 week period. The authors explained that acclimatization attenuates the physiological strain of heat by improving cardiovascular stability and electrolyte balance through an increase in sweat rate, skin blood flow, and plasma volume. The second recommendation was drinking sufficient fluids to maintain adequate hydration before and after exercise. Study authors explain that sweating during exercise can lead to dehydration which, if not mitigated by fluid intake, has the potential to exacerbate cardiovascular strain and reduce the capacity to exercise in the heat. The third recommendation was cooling methods to reduce heat storage and physiological strain (e.g., fanning, iced garments/towels, cold fluid intake, cooling vests, water immersion). Additional recommendations for event organizers included planning for shaded areas, cooling and rehydration facilities, and longer recovery periods (i.e., break periods) for hydration and cooling.

B. Summary for Systematic Reviews and Consensus Statements.

In conclusion, OSHA reviewed three sets of recommendations on effective controls to prevent HRI developed by scientific experts following extensive literature reviews. A number of the recommendations were consistent with requirements or options in OSHA's proposed standard. For example, all three groups of experts recommended hydration, rest breaks, shade, cooling measures such as fans, and acclimatization (Morris et al., 2020; Morrissey et al., 2021b; Racinais et al., 2015). Two of the expert groups also recommended cooling methods such as air conditioning (Morris et al., 2020; Morrissey et

al., 2021b). One of the groups recommended environmental monitoring, development of emergency procedures and plans, training, a buddy system to monitor for health effects, and communication of heat mitigation strategies (Morrissey et al., 2021b).

III. Experimental and Observational Evidence.

A. Rest Breaks.

Administrative controls, such as varying employees' work schedules, are a well-accepted and long-standing approach to protect workers from occupational hazards. Administrative controls are regularly used to address limitations in human capacity for physical work and commonly include work-rest cycles. Rest breaks provide an opportunity for workers to reduce their metabolic rate and body temperature periodically throughout the day. Length and frequency of breaks can be adjusted based on heat exposure, workload, acclimatization, and clothing/PPE factors. Such an approach of work-rest cycles that consider these factors has been recommended by NIOSH and ACGIH (NIOSH, 2016; ACGIH 2023). Observational and experimental studies show the effectiveness of rest breaks in reducing heat strain that could lead to HRIs, and those studies are described below. In addition to reducing heat strain, rest breaks allow workers to take advantage of other cooling strategies, such as hydrating, removing PPE, and sitting in areas that are shaded, cooled, or fanned. The literature on the efficacy of rest breaks described below includes observational studies of workers, laboratory-based exercise trials, and predictive modeling.

I. Observational Studies.

Several observational studies examined participants in work settings or training exercises while at work and at rest and evaluated the associations between rest breaks or time at rest and markers of heat strain.

Horn et al. (2013) evaluated core body temperature and heart rate (HR) among nine firefighters (six male and three females, ages 20-45 years) over a 3-hour period in

which four repeat bouts of firefighting drills were conducted (approximately 15-30 minutes each) while wearing full PPE and a self-contained breathing apparatus. The drills were separated by three rest periods (approximately 20-40 minutes each) in which the firefighters were encouraged to hydrate and cool down by removing their gear, while being evaluated/critiqued by instructors and refilling air cylinders. The study authors estimated the duration of work and rest cycle lengths based on sustained rates of heart rate increases and decreases. Ambient temperatures ranged from 15°C to 25°C (59-77°F) during the summer and fall months when this study was conducted. During work cycles, mean maximum core temperatures ranged from 38.4-38.7°C, mean peak heart rate ranged from 181.2-188.4 beats per minute (bpm), and the mean average heart rate (averaged over 60 second intervals per work cycle) ranged from 139.6-160.0 bpm. Mean maximum core temperature and mean average heart rate decreased during rest periods, and the study authors concluded that physiological recovery in this study appeared to be closely linked to the duration of rest periods. Rest break duration was significantly and negatively correlated with the following measurements taken during rest breaks: minimum heart rate (r: -0.687, $p<0.001$), average heart rate (r: -0.482, $p=0.011$), and minimum core temperature (r: -0.584, $p=0.001$), indicating that longer breaks result in reduced heat strain. The authors concluded that the association was independent of obesity, fitness, and intensity of firefighting activities. Limitations noted by study authors included enrollment of young firefighters who were screened for cardiovascular disease, and thus might not represent the whole firefighting population. In addition, "significant breaks" were provided and the duration of exposure to fires was shortened later in the day, both factors that might underestimate increases in core temperatures with longer firefighting activities and shorter breaks.

Petropoulos et al. (2023) characterized heat stress and heat strain in a cohort of 569 male outdoor workers in Nicaragua (sugarcane, plantain, and brickmaking industries)

and El Salvador (sugarcane, corn, and construction industries) across three workdays in 2018. Median wet bulb globe temperatures (WBGT) ranged from 26.0-29.2 °C (78.8-84.6°F) and median heat index ranged from 28.5-36.1°C (83.3-97.0°F) at the work sites. Time spent on rest breaks-estimated based on physical activity data collected with an accelerometer (i.e., a device that can be used to measure physical activity and sedentary time)—was estimated at 4.1-21% of the shift. A 10% increase in the time spent on break was associated with a 1.5% absolute decrease in median percent maximum heart rate (95% CI: -2.1%, -0.85%; $p<0.0001$), when adjusting for industry/company, job task, shift duration, liquid consumption, median WBGT, and mean metabolic rate. Petropoulos et al. (2023) found no significant associations between rest breaks and maximum core body temperature, and concluded that the lack of findings could have been due to incomplete control of confounding factors.

Lucas et al. (2023) examined the effects of recommended rest breaks for sugarcane workers in Nicaragua, specifically in male burned cane cutters, by comparing the period from 2019-2020, identified as Harvest 3 (H3; n=40 burned cane cutters) with the period from 2018-2019, identified as Harvest 2 (H2; n=12 burned cane cutters). OSHA notes that a major limitation of the study identified by authors was a shorter shift duration by 1 to 2 hours for seed cutters (SC) during H2, and that "the shorter shifts in H2 likely affected SC workload comparisons between H2 and H3 and could explain why increasing the rest component in H3 did not reduce the physiological workload in this group." Because of this limitation in seed cutters, this summary focuses on effects on burned cane cutters. In H3, an extra 10-minute rest break was recommended (increasing recommended rest breaks to a total of 80 min over a six-hour shift), and interventions from H2 were continued (e.g., improvements to hydration and movable tents, in addition to delaying cutting after burning to reduce radiant heat exposure). Daily average WBGT was higher in H2: 29.5°C (85.1°F) than in H3: 26.7°C (80.6°F). Rest periods were

defined by a greater than 10 bpm drop in heart rate lasting 4 or more minutes, as determined by continuous measurements by heart rate sensors worn on the chest; based on those measurements, the rest/work ratio for burned cane cutters increased slightly from 21% rest in H2 to 26% rest in H3. Average percent maximum heart rate (adjusted for age) decreased slightly in H3 compared to H2 (mean [95% CI] 63% [60-65%] to 58% [56-60%]) across the work shift). No significant differences were noted for estimated core temperatures (based on modeling) from H2 to H3. The study authors acknowledged that observational study design, small number of workers in H2, and the lower temperatures in H3 may make conclusions uncertain; therefore experimental laboratory studies may better test the impact of the intervention. OSHA also observes that the increased number of burned cane cutters observed from H2 to H3 means that the population of workers observed was different in the two periods and results may have been affected by different characteristics of the workers.

Ioannou et al. (2021a) examined the effectiveness of rest breaks of different durations in agricultural, construction, and tourism employees. Findings in the intervention group were compared to a "business as usual" (BAU) group, where workers followed their normal routine. Of note, shaded areas, water stations, and air-conditioned areas to be used for rest breaks were part of BAU for construction workers in Spain; those same interventions were part of BAU for construction workers in Qatar, in addition to requiring workers to carry a water bottle, and education. BAU practices were not specified for the agriculture and tourism industries, but according to communications with study authors, the BAU agricultural employees in Qatar were not offered scheduled work/rest cycles, and agricultural employees who were monitored in Qatar performed low intensity work (Communication with Leonidas Ioannou, April 2024). Endpoints observed included core temperature, skin temperature, heart rate, and metabolic rate. No significant effects compared to the BAU group were observed for any of these endpoints

for agricultural workers in Cyprus provided with a 90-second break every 30 minutes, tourism workers in Greece provided with a 90-second break every 30 minutes or a 2-minute break every 60 minutes combined with ice slurry ingestion, or construction workers in Spain provided with two 7-minute breaks over the workday. For employees in Qatar who were provided with 10-minute breaks every 50 minutes, significant differences in the intervention group compared to the BAU group included lower mean skin temperature, heart rate, and metabolic rate for construction employees, but increased heart rate for agricultural employees. The study authors postulated that the increased heart rate in agricultural workers resulted from inherent changes in body posture (i.e., moving from a crouching position while crop picking to standing and walking during breaks). A limitation in this study is that some BAU groups, which were used as comparison groups, appeared to have access to breaks in air-conditioned areas and it was not described how the frequency or duration of rest breaks varied between the intervention and BAU groups.

Two additional studies were conducted in utility workers. In a case study by Meade et al. (2017), conducted in an unspecified location, four highly experienced electrical utilities workers were observed via video analysis over two consecutive hot days. The study authors noted that employees often spent 80% or more of the monitoring period working in direct sunlight. Meade et al. (2017) reported similar average core body temperatures and average %HRmax on both days, despite an increase in the percentage of time spent at rest on Day 2 versus Day 1 (time at rest: 66±5%, range: 60-71%, on Day 2 versus 51±15%, range: 30-63% on Day 1). Three of the four workers had a higher peak core temperature on Day 2 than Day 1. The study authors attributed these core temperature and heart rate trends in part to residual heat storage or fatigue-related changes in work efficiency that possibly occurred over two consecutive work shifts. Meade et al. (2016a) observed work and rest periods in 32 electrical utilities workers

(mean age of 36 years; 11 ground workers, 9 bucket workers, 12 manual pole workers; 17 in West Virginia, 15 in Texas) via video analysis and accelerometry over 1 day (Heat Index: West Virginia 48 ± 3°C (118.4°F), Texas 42 ± 3°C (107.6°F)). On average, the work-to-rest ratio was (3.1 ± 3.9):1 and workers rested for a total of 35.9 ± 15.9% of the work shift. Heat index, work-to-rest ratios, work shift duration, and time at rest were not significantly correlated with mean core temperature or %HRmax. However, time spent or percentage of time in heavy work was moderately, positively correlated with mean core temperature (r=0.51) and %HRreserve (r=0.40) (i.e., increased time spent in heavy work was associated with increased mean core temperature and %HRmax). OSHA notes limitation in these studies, including, for example, the very small sample size in Meade et al. (2017) and lack of adjustment for possible confounding factors in Meade et al. (2016a).

A limited number of cross-sectional studies surveyed or interviewed employees for self-reported symptoms of HRI to determine possible risks associated with inadequate breaks. These types of studies are the most limited because of uncertainties such as recall bias (i.e., inaccurate recollection of previous events or experiences) and the potential for dependent misclassification as a result of using self-reporting for characterizing both the exposure and outcome. Therefore, only brief summaries of these studies are provided. Two of these studies were conducted in agricultural workers in the U.S. (Spector et al., 2015; Fleischer et al., 2013), and one was conducted in pesticide applicators in Italy (Riccò et al., 2020). Spector et al. (2015) found a significantly increased odds of HRI in workers paid by piece as compared to workers paid hourly (OR: 6.20, 95% CI: 1.11, 34.54). Spector et al. (2015) noted that piece rate workers might work harder and faster because of economic incentives, thus leading to increased metabolic heat generation; however, adjustment for task and exertion in the small sample size of employees did not completely attenuate the observed association, thus suggesting other factors contributed

to development of symptoms. Through population intervention modeling, Fleischer et al. (2013) estimated that the prevalence of three or more HRI symptoms could be reduced by 6.0% if workers had access to regular breaks, and by 9.2% if breaks were taken in shaded areas. Of note, participants in the study were asked about "regular breaks," but the term was not specified regarding frequency and duration. Lastly, Riccò et al. (2020) found taking rest breaks in shaded, non-air-conditioned areas was associated with experiencing HRI (adjusted OR: 5.5, 95% CI: 1.4, 22), while taking rest breaks in cooler, air-conditioned areas was not. Riccò et al. (2020) discussed possible reasons for the observed association between shaded rest breaks and incidences of HRI, including that (1) taking breaks in shade may be insufficient to prevent HRIs among pesticide applicators who undertake more strenuous tasks or have longer exposures to unsafe limits, and (2) rest breaks in shade may be taken to alleviate, rather than prevent, HRI symptoms (i.e. possible reverse causation).

II. Experimental Studies.

OSHA examined a number of laboratory studies that provide information on the efficacy of rest breaks for preventing heat strain or HRI in subjects exercising under conditions that include high heat and at least moderate activity. The studies typically measured rectal temperature, which allowed for an assessment of the efficacy of breaks in maintaining lower rectal temperatures and slowing the increase in rectal temperatures. ACGIH (2023) indicates that an increase in rectal temperature exceeding 1°C from a "pre-job" temperature of less than 37.5°C might indicate excessive heat strain. One study summarized below also examines the effect of rest breaks on the autonomic nervous system and cardiovascular function.

Smallcombe et al. (2022) conducted a study over a seven-hour period that was designed to mimic a typical workday in the U.S. In that study, 9 males (average age 23.7 years) of varying fitness levels walked on a treadmill at speeds to maintain a constant

heart rate of 130 bpm, which the authors indicated to be the demarcation between moderate and heavy strain. The subjects completed six cycles of exercise for 50 minutes in the heat chamber separated by 10 minutes of rest at an ambient temperature of 21°C (69.8°F), 50% relative humidity (RH) while drinking water as desired. A one-hour lunch period was also provided at 21°C (69.8 F), 50% RH after the third exercise period, with all subjects given the same lunch and allowed to drink water as desired. Each subject was tested under 4 temperature conditions: 1) referent (cool condition) at 15°C (59°F) (WBGT = 12.6°C); 2) moderate condition at 35°C (95°F) (WBGT = 29.4°C); 3); hot condition at 40°C (104°F) (WBGT = 33.4°C); and 4) very hot condition at 40°C (104°F) (WBGT = 36.1°C). The RH for each temperature condition was approximately 50%, except for the very hot condition, which was 70% RH. In the very hot condition group, data were limited for the sixth exercise cycle because an unspecified number of participants reached the cut-off point for terminating the study (i.e., a heart rate exceeding 130 bpm while at rest).

Significant increases in mean rectal temperature were observed in the moderate, hot, and very hot condition groups in work period 1 versus work period 6, but the average rectal temperature remained at or below 38°C (100.4°F) in all groups during each exercise period (figure S1 and table S2) (Smallcombe et al., 2022). No individual subject had a rectal temperature that exceeded 38°C in the referent and moderate condition groups, however, three subjects exceeded 38°C in the hot exposure group, and four subjects exceeded 38°C in the very hot exposure group. With the exception of two subjects whose rectal temperatures were measured at approximately 38.6°C (101.5°F) and 38.7°C (101.7°F) in the very hot exposure group, all rectal temperatures were below 38.5°C (as estimated from Figure S1). In addition, mean rectal temperatures dropped during each rest period, with all rectal temperatures measured near or below 38°C by the end of the rest period (as estimated from Figure 4). Skin temperatures did not increase

during work periods. The authors concluded that under the conditions of this study, which limited metabolic heat production based on the fixed heart rate protocol, participants rarely reached levels of core temperature that would be concerning. Study limitations noted by study authors included possible limited relevance of breaks provided in cooler areas, and the possibility that thermo-physiological impacts may have been higher had breaks not been provided in cooler areas or metabolic heat production not been limited.

In Uchiyama et al. (2022) thirteen males (average age 39 years) each underwent two 225-minute trials that included 180 minutes of treadmill walking in a chamber at 37°C (98.6°F) and 40% RH interspersed with 45 minutes of rest breaks in an air-conditioned room at 22°C (71.6°F) and 35% RH, designed to mimic summer working and rest conditions at mines in Northwest Australia. Participants were allowed to drink room temperature water during exercise and refrigerated water while on rest breaks. Two different rest/work cycles were tested, including (1) current practice: 1 hour of work and 30 minutes of rest, followed by 1 hour of work and 15 minutes rest, and a final 1 hour work period; and (2) experimental: 1 hour of work and 15 minutes rest, followed by three half hour work periods separated by 10-minute rest periods and, and a final half hour work period. OSHA observes that in the current practice group, average core temperature only increased by more than 1°C (1.8°F) of baseline level at the final measurement reported at 180 minutes into the study (increased from 37.2°C at baseline to 38.29°C at 180 minutes). Average core temperatures remained within 1°C of baseline levels in the experimental group at all time points.

Three studies (Meade et al., 2016b; Lamarche et al., 2017; and Kaltsatou et al., 2020) conducted 2-hour studies in which small groups of 9-12 males cycled in a heat chamber at 360 watts (W) of metabolic heat production (considered moderate-to-heavy intensity and equivalent to conditions experienced by some workers in the mining and

utility industries). Over the 2-hour period, the effects of various temperatures (approximate values provided) and work/rest protocols recommended by ACGIH were examined including: (1) continuous work at WBGT 28°C (82.4°F) (41°C (105.8°F) dry-bulb, 19.5% RH or 36°C (96.8°F) dry-bulb, 38% RH); (2) a 3:1 work/rest ratio (15 min work, 5 min rest) at WBGT 29°C (84.2°F) (43°C (109.4°F) dry-bulb, 17.5% RH or 38°C (100.4°F) dry-bulb, 34% RH); and (3) a 1:1 work/rest ratio (15 min work, 15 min rest) at WBGT 30°C (86°F) (46°C (114.8°F) dry-bulb, 13.5% RH or 40°C (104°F) dry-bulb, 30% RH). Meade et al. (2016b) examined a fourth condition: 4) a 1:3 work/rest ratio (15 min work, 45 min rest) at WBGT 31.5°C (88.7°F) (46.5°C (115.7°F) dry-bulb, 17.5% RH). The mean age of participants in the Meade et al. (2016b) study was 21 years while the mean age in both the Lamarche et al. (2017) and Kaltsatou et al. (2020) studies was 58 years.

Meade et al. (2016b) found that among younger males, the percentages of participants with rectal temperatures exceeding 38°C over the 2-hour protocol was lower in the groups who took longer rest breaks, despite those groups also being subjected to a higher WBGT. Meade et al. (2016b) reported core temperatures exceeding 38°C in 12% of participants in the 1:3 work/rest at 31.5°C WBGT group, 0% in the 1:1 work/rest at 30°C WBGT group, 33% in the 3:1 work/rest at 29°C WBGT group, and 33% in the continuous work at 28°C WBGT group.

Lamarche et al. (2017) found that among older males, the percentage of participants with rectal temperatures exceeding 38°C over the 2-hour protocol was lowest in the group with the longest breaks (i.e., 67% in the 1:1 work/rest at 30°C WBGT group, 100% in the 3:1 work/rest at 29°C WBGT group, and 100% in the continuous work at 28°C WBGT group) although the findings did not achieve statistical significance. Lamarche et al. (2017) also reported that time to exceed a rectal temperature of 38°C was higher in both groups who received rest breaks as compared with the continuous work

group and this did reach statistical significance. Specifically, the time to exceed a rectal temperature of 38°C was 100 minutes in the 1:1 work/rest at 30°C WBGT group, 79 minutes in the 3:1 work/rest at 29°C WBGT group, and 53 minutes in the continuous work at 28°C WBGT group. Further, because of heat exhaustion, five participants in the Lamarche et al. (2017) study did not complete the continuous work at 28°C WBGT protocol, one did not complete the 3:1 work/rest at 29°C WBGT protocol, but all completed the 1:1 work/rest 30°C WBGT protocol. No significant differences in heart rate were observed.

Kaltsatou et al. (2020) examined autonomic stress and cardiovascular function in the same subjects examined by Larmarche et al. (2017). The authors measured 12 markers of heart rate variability (HRV), a predictor of adverse heart events, most of which are associated with the autonomic nervous system (i.e., a part of the nervous system that controls involuntary responses including heart rate and blood pressure). After one hour of accumulated work and when rectal temperatures exceeded 38°C, three markers of HRV were significantly lower in the continuous work group than in the 3:1 work/rest at 29°C WBGT group. One marker of HRV was significantly lower in the continuous group, compared to the 1:1 work/rest at 30°C WBGT group at 1 hour of accumulated work. After 2 hours of accumulated work, 4 markers of HRV were significantly lower in the continuous work group compared to the 1:1 work/rest at 30°C WBGT group. Study authors interpreted these results to indicate that continuous work was the least safe for workers, while a 1:1 work/rest ratio offered the best protection. Kaltsatou al. (2020) concluded that breaks during moderate-to-heavy work in heat can reduce autonomic stress and increase the time to exceed a rectal temperature of 38°C.

In the studies by Meade et al. (2016b), Lamarche et al. (2017), and Kaltsatou et al. (2020), participants were well-hydrated before the study period but not provided drinking water during the study. Kaltsatou et al. (2020) acknowledged that not providing water

during the study could have affected sweat secretion and, as a result heat balance, hydration status, baroreceptor function (involved in blood pressure regulation), and the autonomic control of heart rate. OSHA agrees and also notes that rest breaks were provided in the same ambient conditions as work periods, and studies were conducted at a fixed work rate that would have not considered possible effects of self-pacing. Because hydration and shade or cooling measures during rest breaks would be provided as part of an effectively implemented multi-pronged approach to preventing HRI, OSHA preliminarily concludes that some of the effects observed in these studies might have been less severe if interventions other than rest were provided.

In a study by Chan et al. (2012), recovery time, as measured by physiological strain index (based on heart rate and core temperatures), was determined in 19 healthy construction rebar employees (mean age 45 years) who had worked until exhaustion at building construction sites in Hong Kong in July and August of 2011. Average recovery during rest was reported at 94% in 40 minutes, 93% in 35 minutes, 92% in 30 minutes, 88% in 25 minutes, 84% in 20 minutes, 78% in 15 minutes, 68% in 10 minutes, and 58% in 5 minutes. Yi and Chan (2013) used the field-based meteorological and physiological data reported by Chan et al. (2012) to model ideal rest breaks to minimize HRI. Based on a Monte Carlo simulation, the authors determined that a 15-minute break after 120 minutes of continuous work in the morning at 28.9°C (84.0°F) WBGT and a 20-minute break after 115 minutes of continuous work in the afternoon at 32.1°C WBGT (90.0°F) maximized productivity time while protecting the health and safety of employees.

III. Conclusions for Rest Breaks.

OSHA reviewed several studies examining the effectiveness of rest breaks in preventing heat strain that could lead to HRI and were of sufficient quality for drawing conclusions (Horn et al., 2013; Smallcombe et al., 2022; Meade et al., 2016b; Lamarche et al., 2017; Kaltsatou et al., 2020; Petropoulos et al., 2023). The studies, involving

individuals exposed to conditions of high heat stress, demonstrated the effectiveness of rest breaks in preventing measures of heat strain that can lead to HRI. Observational studies with detailed measurements of temperatures in firefighters doing training exercises and experimental studies in laboratory settings reported that rest breaks result in lower core or rectal temperatures during rest periods following work periods (Horn et al., 2013; Smallcombe et al., 2022), and lower rectal temperatures over the study period (Meade et al., 2016b; Lamarche et al., 2017), with all of the studies showing greater effectiveness of longer compared to shorter duration work breaks. Similarly, Chan et al. (2012) reported increased physiological recovery with longer rest periods. Uchiyama et al. (2022) reported little evidence of heat strain in participants exercising in hot conditions and provided rest breaks. The study by Lamarche et al. (2017) also found that rest breaks were effective in preventing heat exhaustion in a laboratory setting. OSHA also found evidence showing that rest breaks can reduce cardiovascular strain. For example, Horn et al. (2013) found that heart rates were lower in rest than in work cycles. One study done in participants in a laboratory setting showed that rest breaks can reduce autonomic stress that affects cardiovascular function (Kaltsatou et al., 2020). Those

findings are consistent with an observational study of employees in occupational settings that found an association between time spent on rest breaks and decreases in heart rate when adjusted for industry/company, job task, shift duration, liquid consumption, WBGT, and metabolic rate (Petropoulos et al., 2023).

In conclusion, OSHA preliminarily finds rest breaks to be effective in reducing the risk of HRI by modulating increases in heat and cardiovascular strain.

B. Shade.

Working or resting in shade reduces the risk of HRI by decreasing exposure to solar radiation and in turn reducing overall heat load. Studies evaluating the impact of shade on heat strain metrics have predominantly been conducted in controlled settings where participants exercise in conditions approximating shade and sun exposure. Studies evaluating the physiological benefits of exercising in shade versus sun are likely to underestimate the benefits of rest breaks taken in shade because metabolic heat generation would be slowed while resting.

A number of studies examining the effects of exercising under natural or simulated conditions of sun or shade have demonstrated benefits of shade. One group of investigators conducted studies where participants cycled under simulated laboratory conditions of sun or shade (Otani et al., 2016; Otani et al., 2021); both studies were conducted under conditions of 30°C (86°F) and 50% RH, and participants cycled at a rate of 70% maximum oxygen uptake until reaching full exhaustion. The Otani et al. (2021) study also involved exposures to low and high wind speeds. The same investigators conducted 45-minute, self-pacing cycling trials outdoors under various natural sunlight conditions, including clear skies or thick and thin cloud covers (Otani et al., 2019). These studies reported that higher exposure to solar radiation resulted in higher skin temperatures (Otani et al., 2016, 2019, 2021) and reduced work output (measured as endurance capacity/time-to-exhaustion (Otani et al., 2016; 2021) or power output (Otani

et al., 2019)). In increased sun conditions, Otani et al. (2021) reported higher rectal temperatures, heart rates, and thermal sensation. Otani et al. (2019) reported greater thermal sensations, and body heat gain from the sun, but no significant effects on rectal temperature or heart rate in increased sun conditions. Otani et al. (2016) reported no differences in rectal temperatures or heart rates in increased sun conditions. The authors speculated in their 2019 paper that the lack of rectal temperature increase in that study likely resulted from a reduction in self-regulated exercise under sunny conditions (Otani et al., 2019). They did not however speculate reasons for the lack of rectal temperature increases in their 2016 paper. OSHA notes that under equivalent (full sun) solar radiation levels the time it took participants to reach exhaustion in the Otani et al. (2021) study under low wind speeds (35.4 minutes) was longer than the time it took participants in the Otani et al. (2016) study to reach exhaustion (22.5 minutes), and OSHA expects that the disparate findings on rectal temperatures may have resulted from differences in total cycling time.

In a study by Nielsen et al. (1988) participants cycled at a fixed rate outdoors in the sun for 60 minutes, were shaded for 30 minutes while continuing to cycle, and then cycled again in the sun for another 30 minutes, for a total of 120 minutes. Study authors noted that cloud formation interrupted 3 of the 20 cycling trials. Average rectal temperatures rose sharply during the first period of cycling in sun, dropped slightly (non-significantly) during the period of cycling in shade, and then gradually increased again during the final cycling period in full sun. Skin temperatures remained fairly constant during the initial period of cycling in sun, dropped significantly by 1.5°C (2.7°F) while cycling in shade, and rose again sharply during the final cycling period in the sun. Heart rate, oxygen consumption, and sweat rate were significantly higher in the final cycling period in full sun, compared to the cycling period in shade. Study authors concluded that heat received from direct solar radiation "imposed a measurable physiological stress."

In a study examining work capacity in adults walking for one hour under various conditions of solar radiation (full sun or full shade), temperature (25°C through 45°C; 77°F through 113°F), humidity (20% or 80%), and clothing coverage, Foster et al. (2022b) reported that work capacity (calculated using treadmill speed and grade) was generally lower under full sun conditions than shaded conditions. Under humid conditions, work capacity was reduced by solar radiation for all scenarios. Under dry conditions, work capacity reduction varied by clothing coverage with those wearing full-body work coveralls showing reduced work capacity at temperatures ≥ 35°C (≥ 95°F) and those wearing minimal clothing showing reduced work capacity at temperatures ≥ 40°C (≥ 104°F). Skin temperature was generally higher under full sun conditions, and the authors speculated that a lack of effect on core body temperatures likely resulted from self-regulation during exercise.

Ioannou et al. (2021b) conducted a laboratory based randomized control trial in which seven participants completed cycling trials under full sun (800 W/m^2) and full shade (0 W/m^2) in hot (WBGT 30°C) and temperate (WBGT 20°C) conditions. The full sun condition was associated with increased skin temperature at both temperatures. Average core body temperature was similar between sunny and shaded conditions (37.7 and 37.6 °C for sun versus shade in hot conditions and 37.2 °C for both sun and shade in temperate conditions). Solar radiation had a small, positive relationship with heart rate (average heart rate of 114.0 and 109.1 bpm in sun versus shade in hot conditions and 102.6 and 95.4 bpm in sun versus shade in temperate conditions) (Ioannou et al., 2021b).

Although these experimental studies largely assessed the effects of shade during exercise and not rest periods, they do support the idea that shade reduces heat strain generally; therefore, OSHA preliminary concludes that it is reasonable to assume access to shade would also reduce heat strain during rest periods. This conclusion is also supported by evidence that shade reduces heat exposure (see discussion below) and that

heat exposure is positively associated with heat strain (see discussion in Section IV., Health Effects). OSHA identified no major limitations in these studies that would preclude their use in drawing conclusions about effectiveness. One aspect of all these studies that limit applicability to the larger workforce is that participants were all young and healthy and all or mostly male (age was not specified in Ioannou et al., (2021b)), and the studies were done for relatively short durations of time (2 hours or less). The authors of the Otani et al. (2021) and Foster et al. (2022b) studies that used artificial solar radiation noted that their studies would not reflect changes in the sun's position during the day or changes in radiation intensity levels, and that limitation would be relevant to the other studies using artificial sources of solar radiation at one intensity level.

There are also two observational studies in the peer-reviewed literature that have evaluated the association between shade and risk of HRI. In a case-control study of 109 acclimatized construction and agriculture workers, Ioannou et al. (2021b) monitored workers for four or more consecutive 11-hour shifts, in which environmental factors were continuously measured and work hours characterized by the same thermal stress but different solar radiation levels were isolated. Solar exposure was categorized as either indoors, mixed indoors and outdoors, or outdoors, and analyses were done for data collected during conditions of 30°C WBGT. Results included a positive association between sun exposure and skin temperature and a significantly higher risk for heat strain symptoms (relative risk (RR)=2.40, 95% CI: 1.78, 3.24) and reported weakness (RR=3.17, 95% CI: 1.76, 5.71) among workers exposed to solar exposure characterized as outdoors as compared to workers exposed to solar exposure characterized as indoors. Core body temperature, heart rate, and metabolic rate were not found to be associated with sun exposure. The authors attributed the lack of change in core temperature and heart rate to the effect of self-pacing. OSHA notes that the study did not control for confounding variables.

Fleischer et al. (2013) used population intervention modeling of self-reported HRI symptoms in farmworkers in Georgia to estimate that the prevalence of three or more HRI symptoms could have been reduced by 9.2% (95% CI: -15.2%, -3.1%) if workers could always or usually take breaks in the shade. There were limitations to this analysis, including the cross-sectional study design, the self-reported exposure and outcome data, and low participation rate.

Additional studies have evaluated differences in microclimatic conditions between shady and sunny environments, independent of heat strain metrics measured in human subjects. These studies provide clear evidence that shade reduces radiant heat (Cheela et al., 2021; do Nascimento Mós et al., 2022; Fournel et al., 2017; Karvatte et al., 2016, 2021; Klok et al., 2019; Lee et al., 2020; Middel and Krayenhoff, 2019; Sanusi et al., 2016; Zhang et al., 2022). As discussed above, indicators of heat strain (e.g., rectal temperature) often increase with exposure to solar radiation. These authors examined the impact of shade through direct measures that assess radiant heat (e.g., globe temperature, mean radiant temperature) or through thermal stress metrics (e.g., Universal Thermal Climate Index) that incorporate radiant heat in their calculation.

The magnitude of the reduction in radiant heat from shade, however, varies by local conditions, with notable factors including the type of shade (e.g., trees, buildings, canopies, and other urban structures such as solar arrays), percent shade cover, time of day, season, and ground cover (due to its role in radiant heat emission). Fournel et al. (2017) estimated an average 4.4°C decrease in black globe temperature using data from five studies that assessed different shade interventions, while study-specific reductions ranged from 2°C to 9°C. These included a study by Roman-Ponce et al. (1977), who observed a 9°C difference in Florida under an insulated metal roof, and a study by Fisher et al. (2008), who observed a 2°C difference in New Zealand under a shade cloth

structure. Examples of other studies that have evaluated the impact of shade on radiant heat include:

- Middel and Krayenhoff (2019) evaluated environmental conditions across 22 sites in Tempe, Arizona on the hottest day of the summer. They included diverse types of shade, including trees and urban structures. The authors concluded that trees decreased afternoon mean radiant temperature by up to 33.4°C and estimated that each 0.1 decrease in the sky view factor from trees (where a sky view factor of 1 is a completely open sky and 0 is fully blocked) resulted in an approximate decrease of 4°C in mean radiant temperature (Middel and Krayenhoff, 2019).
- Zhang et al. (2022) compared meteorological parameters among 12 locations in a coastal city in China. Mean globe temperature over the beach in full sun (40.9°C) was higher than mean globe temperatures in areas shaded by dense trees (28.9°C) or shaded by a pavilion canopy (30.8°C) (Zhang et al., 2022).
- Karvatte et al. (2016) evaluated the impacts of different types of natural shade (two densities of eucalyptus trees and isolated native trees) on environmental conditions in Brazil. Average black globe temperatures from 12 p.m. to 1 p.m. in the shade ranged from 33.2°C to 34.3°C, which were 2.4°C to 8.2°C lower than that measured in nearby sunny areas (Karvatte et al., 2016).
- do Nascimento Mós et al. (2022) evaluated the effectiveness of four different shade structures (native trees, black polypropylene netting, heat-reflective netting, and a combination of both types of netting) in the Brazilian savanna. Mean radiant temperature was consistently lower under shaded conditions. For example, at 11 a.m. and 12 p.m., the peak hours, the mean radiant temperatures were 16°C to 20°C lower in shady conditions than sunny conditions (do Nascimento Mós et al., 2022).

I. Conclusions for Shade.

In conclusion, measurements of environmental conditions indicate that exposure to radiant heat is greater in full sun than in shaded conditions (e.g., Middel and Krayenhoff, 2019; do Nascimento Mós et al., 2022). It is well known that radiant heat contributes to heat stress (NIOSH, 2016). Studies confirm that indicators of heat strain (e.g., increased heart rate, increased rectal temperature) are often higher in participants exercising in conditions with actual or simulated solar radiation versus shade (e.g., Otani et al., 2021). One study showed that a 30-minute period of exercising in shade, interspersed between two periods of exercising in full sun, resulted in improved physiological responses (e.g., lower heat rate, oxygen consumption, and sweat loss) compared to the two periods of exercising in full sun (Nielsen et al., 1988). OSHA expects that improvements in physiological function might have been even greater if the participants had rested in shade because resting slows the metabolic generation of heat.

OSHA preliminarily finds that resting in shade will reduce the risk of HRI by decreasing exposure to radiant heat that contributes to heat stress and can lead to heat strain and then HRI.

C. Fans.

Fans are engineering controls that increase air movement across the skin and under the right environmental conditions can increase the evaporation of sweat, resulting in greater heat loss from the body. However, they may not be appropriate for all environments, such as at higher temperatures. Research on the role of fans in HRI prevention largely focuses on non-occupational and athletic populations, however some chamber trials have been designed to mimic working conditions. A summary of the experimental literature is provided here, beginning with studies that evaluate the use of fans during physical activity, before or after activity, and while people are at rest, and then concluding with studies that model efficacy thresholds for fan use.

Studies by Saunders et al. (2005) and Otani et al. (2018, 2021) examined the effects of different air speeds on individuals cycling in heated chambers with no rest period included in the study design (Saunders et al., 2005: 33.0°C ± 0.4°C and 59% ± 3% RH; air speeds ranging from 0.2 km/hr to 50.1 km/hr; Otani et al., 2018: 30°C and 50% RH; air speeds ranging from 0 km/hr to 30 km/hr; Otani et al., 2021: 30°C and 50% RH; air speeds of 10 and 25 km/hr). In measures of work output, at higher air velocities Saunders et al. (2005) reported increased cycling time before participants' core temperature reached 40°C (criteria for terminating the trial) and Otani et al. (2018, 2021) reported increased time to exhaustion. In lower/no compared to higher air velocities, (1) Saunders et al. (2005) reported higher mean body temperature (weighted mean of skin and rectal temperature), higher rectal and skin temperature, increased heat storage (a measure that considers changes in body temperature, in addition to body weight and surface area), and lower evaporative capacity; (2) Otani et al. (2018) reported higher rectal, skin, and mean body temperature, and lower evaporative heat loss; while (3) Otani et al. (2021) reported no significant effect on skin temperature but higher rectal temperatures. Higher heart rates were also observed at lower/no versus higher air velocities (Saunders et al., 2005; Otani et al., 2018, 2021).

Other studies have examined the effectiveness of fans during both exercise and rest periods. In Jay et al. (2019), participants conducted arm exercises designed to mimic textile work at 30°C (86°F) and 70% RH, with and without fanning. In a study by Wright Beatty et al. (2015), participants cycled in a chamber at 35°C (95°F) and 60% RH, with air velocities of 0.5 m/s and 3.0 m/s. Wright Beatty et al. designed the study to mimic occupational conditions, like those for miners (both workload and clothing). Under the fan/high air velocity conditions: (1) Jay et al. (2019) observed a smaller increase in rectal temperature, and lower skin temperature, but there was no change in heart rate because the study was designed to maintain a constant heart rate; and (2) Wright Beatty et al.

(2015) observed lower rectal temperatures and heart rates. Jay et al. also compared effectiveness of fanning to the presence of air-conditioning (7°C lower temperature) and found higher work output and lower rectal temperature in both the fanning and air-conditioning groups (relative to the hot condition without fanning), while sweat loss was higher with fanning compared to air-conditioning (Jay et al., 2019). Wright Beatty et al. tested their conditions among both older (~59 years old) and younger (~24 years old) participants and observed similar benefits of higher air velocity among both age groups (Wright Beatty et al., 2015).

In a handful of other studies, researchers tested the efficacy of fan use during rest breaks, after subjects exercised under hot conditions (Sefton et al., 2016; Selkirk et al., 2004; Barwood et al., 2009; Carter, 1999). Conditions for these studies were (1) Sefton et al.: 32°C ± 0.5°C and 75% ± 3% RH, with shirt and under shirt removed during cooling, with and without misting fan; (2) Selkirk et al.: 35°C and 50% RH wearing firefighting protective clothing and breathing apparatuses during exercise and removal of protective gear during cooling periods with and without a misting fan; (3) Barwood et al.: 31°C ± 0.2°C and 70% ± 2% RH , with and without whole body fanning; and (4) Carter: 40°C and 70% RH wearing firefighting protective clothing and breathing apparatuses during exercise and removal or unbuckling of protective gear during cooling periods with and without a fan. In the study by Sefton et al. (2016), rectal temperatures rose during the cooling period, regardless of misting fan use, but heart rate was lower with misting fan use; the study authors noted that under the high humidity conditions of their study, misting fans could have increased the moisture in air, thereby reducing cooling through sweat evaporation. Other studies found fans or misting fans to be effective in improving body temperature or cardiac effects. In comparisons of normal recovery conditions (unbuckling of fire-fighting coat and no fan use during rest) to enhanced recovery conditions (fire-fighting coat was removed and fan used during rest), Carter (1999)

reported lower rectal and skin temperatures, heart rate, and oxygen consumption during enhanced recovery compared to normal recovery conditions. Selkirk et al. (2004) reported that the use of a misting fan during rest breaks compared to no fan use resulted in lower rates of rectal temperature increase, and lower skin temperatures and heart rates. Barwood et al. (2009) reported that reductions in rectal and skin temperatures during rest periods were greater with fan use than without, but there was no significant effect on heart rate. Selkirk et al. (2004) also found that participants were able to exercise longer when taking rest breaks with misting fans than they were when taking rest breaks without misting fans, and Barwood et al. (2009) found that participants were able to run farther distances following whole-body fanning.

Other studies examined the use of fans during breaks in areas cooler than where exercise took place. Hostler et al. (2010) conducted a study similar to that by Selkirk et al., described above, where subjects exercised on a treadmill while wearing firefighting protective gear under hot conditions (35.1 ± 2.7°C, RH not specified), but in contrast to Selkirk et al. (2004), rest periods took place at room temperature (24.0 ± 1.4°C) instead of in the heat chamber and a non-misting fan was used. In contrast to findings from Selkirk et al. (2004), Hostler et al. (2010) reported that fanning during breaks had no significant effects on core temperature, heart rate, or exercise duration, and they speculated that this was because rest breaks took place in a cooler area. The authors conclude that active cooling devices may not be needed if the temperature of the rest area is below 24°C (75.2°F). Tokizawa et al. (2014) reported that after pre-cooling in an area that was 28°C and had 40% RH, participants walking in a heat chamber (37°C and 40% RH) wearing protective clothing had lower rectal temperatures, heart rate, and weight loss when exposed to fans and water spray in the precooling period than the control condition without fans and water spray (Tokizawa et al., 2014).

Additional studies provide information on conditions and populations for which fans may or may not be effective. Ravanelli et al. (2015; 2017) found that participants (mean age 24 ± 3 years) were able to be exposed to higher levels of humidity at temperatures of 36°C or 42°C when using fans before increases in esophageal temperatures and heart rate were observed (i.e., inflection points) (Ravanelli et al., 2015; Ravanelli et al., 2017). At 42°C, the inflection points (when core temperature increases were observed) occurred at a relative humidity level of 55% with fans compared to 48% without fans. The relative humidity levels where heart rate increases were observed with and without fans, respectively, were 83% and 62% at 36°C and 47% and 38% at 42°C. The researchers found that heart rate was significantly lower at the end of the trials with fans compared to without fans (under 36°C conditions: 74±9 bpm vs. 84±9 bpm; under 42°C conditions: 87±9 vs. 94±9). This was also true for esophageal temperatures at the end of the trials (under 36°C conditions: 36.7±0.2°C vs. 36.8±0.2°C; under 42°C conditions: 37.2±0.3°C vs. 37.4±0.2°C). Rectal temperatures were higher with no fans at the end of the trials in both conditions (36°C and 42°C), but these differences were not statistically significant (Ravanelli et al., 2017). In contrast, Gagnon et al. (2016) found that use of fans did not improve heart rate or core temperature inflection points in response to increasing humidity levels, and heart rates and core temperatures were higher with use of fans during exposure of older adults (mean age 68 ± 4 years) at 42°C. Gagnon et al. speculated that lack of benefits may have resulted from age-related impairments to sweat capacity. Morris NB et al. (2019) found that, under hot and humid conditions (40°C, 50% RH; heat index of 56°C) fans reduced core temperatures and cardiovascular strain, but were detrimental to all outcome measures under very hot but dry conditions (47°C, 10% RH; heat index of 46°C). The authors use these findings to caution against using heat index alone for recommendations on beneficial versus harmful fan use.

While the fan efficacy studies discussed in this section so far have been interventional in design, modeling studies have estimated the temperature and RH thresholds at which fans are no longer effective at reducing heat strain. Jay et al. (2015) argue that public health guidelines for when fan use is harmful are too ambiguous and/or too low (e.g., “high 90s” from the CDC (CDC, 2022). Morris et al. (2021) modeled humidity-dependent temperature thresholds at which fans (3.5 meters/second wind velocity) become detrimental using validated calorimetry equations, which calculate net heat transfer between a person and their environment. Based on these equations and assumptions on reduction in sweat rates among older individuals and individuals taking anticholinergic medications, Morris et al. recommend that fans should not be used at a humidity-dependent temperature above 39.0°C (102.2°F) for healthy young adults, 38.0°C (100.4°F) for healthy older adults above the age of 65, and 37.0°C (98.6°F) for older adults taking anticholinergic medication (Morris et al., 2021). While the authors provide more exact numbers that account for humidity, they provide these thresholds as simple and easy guidelines that only require knowing the temperature. Some limitations of these studies include the use of assumptions in their models that may not be realistic (e.g., fan producing an air velocity of 3.5-4.5 meters/second sitting 1 meter away) and the use of simplified heat-balance models, which predict the potential for heat exchange rather than outcomes such as heat and cardiovascular strain metrics (e.g., core temperature, heart rate). There are many factors that influence an individual’s heat exchange potential, such as sex, hydration status, acclimatization status, and clothing, and these simplified models often do not account for these factors.

A recent article by Meade and colleagues criticized the simplified thresholds published in Morris et al. (2021) as being too high for general public health guidance (e.g., recommendations for the general public during heat waves) (Meade et al., 2024). The authors modeled core temperature changes rather than modeling potential for heat

exchange, arguing that Morris and colleagues did not consider in their conclusions that the potential for greater heat exchange does not always translate into increased sweat rates, particularly if core temperatures are not high enough to elicit that sweat response. Meade and colleagues modeled fan effectiveness under various hypothetical environmental conditions and reported the expected impacts on core temperatures for a young adult (18-40 years old) at rest wearing light clothing. They estimated that fans (versus no fan) would lead to an approximately 0.1°C increase in core temperature at ambient temperatures of 37°C/98.6°F (when RH is 60-90%), 38°C/100.4°F (when RH is 50-80%), and 39°C/102.2°F (when RH is 50-80%) (Meade et al., 2024; Figure 1). Fans were estimated to be of minimal impact (core temperature change of approximately 0.0°C) or beneficial (reduction in core temperature) compared to no fans in drier conditions at these ambient temperatures (37-39°C). In their model, fans were always minimally impactful or beneficial at temperatures below 37°C. Above 39°C, fans were more often harmful (increase in core temperature greater than 0.2°C). These model results were for strong fans (3.5-4.5 m/s air velocity), but in a sensitivity analysis, Meade and colleagues present predicted core temperature changes for slower fans (1 m/s air velocity) among young adults. While these fans are less beneficial than strong fans at low temperatures (e.g., below 34°C/93.2°F), they were predicted to lead to smaller core temperature increases at higher temperatures (e.g., 38°C) and humidities than the stronger fans (Meade et al., 2024; Figure 4). In another model, the researchers predicted the effects of fans combined with skin wetting (relative to no fan or skin wetting) among young adults and found this combination was much more beneficial than fans alone—they were beneficial or neutral in all combinations of humidity and ambient temperature when ambient temperature was 40°C/104°F or below (Meade et al., 2024; Figure 6). One major limitation of these model results is the assumption that the individual is at rest, rather than working. Fans may be used in work areas, and it would be expected that they

would be associated with greater heat exchange potential in these scenarios, as core temperature would be more likely to remain above levels that prompt a sweat response. In a sensitivity analysis, the authors assumed a range of metabolic rates, the highest being 90 W/m^2, which they describe as the equivalent to a seated person "performing moderate arts and crafts." In this scenario, fans were predicted to be more beneficial around 30-34°C and in drier conditions (RH less than 30%) up to 39°C. These numbers may not apply to workers, as evidenced in part by findings from a study described above (Carter, 1999), which found benefits to fans outside the range suggested by Meade et al.

Another study did evaluate fan efficacy among participants performing physical work (moderate to heavy workloads), collecting empirical evidence from fixed heart rate trials and modeling the effects of fans on heat storage at various temperatures and humidities (Foster et al., 2022a). Foster et al. conducted 300 trials among 23 participants (24 cool, 15°C reference trials, 138 hot trials with still air, and 138 hot trials with fans). The hot trials involved a range of temperatures and humidities (35–50°C in 5°C increments and 20–80% RH) and two clothing ensembles—low clothing coverage (shorts and shoes) and higher clothing coverage (full-body coverall, t-shirt, shorts, and shoes). For the fan trials, they used a fan with a speed of 3.5 meters/second. The work output from the cool reference trials was used as a baseline to calculate the change in work capacity in the hot trials, which was used to validate their biophysical model predicting change in heat storage (R-squared = 0.66). The authors created categories for the percent change in work capacity resulting from fan use relative to no fans—an increase of greater than 5% was termed "beneficial", a decrease of greater than 5% was termed "detrimental", and if the change was an increase or decrease of 5% or less, it was called "ineffective". In the hot trials, the researchers found fans to be beneficial or ineffective at both 35°C and 40°C (depending on the humidity) and ineffective at 45°C for the higher clothing coverage (Figure 1 of Foster et al., 2022a). For the low clothing coverage, the

researchers found that fans had the potential to be beneficial up to 45°C (at certain humidities), but also had the potential to be detrimental at temperatures as low as 35°C (specifically when RH was 20%).

The biophysical model predicting change in heat storage was only able to model the effects of fans for the low clothing coverage, however, the authors note that the effects of fans were similar across clothing groups except that fans weren't beneficial in the high clothing coverage at temperatures equal to or above 45°C. Foster et al. used a sweat rate in the model of approximately 1 liter per hour, which was the group average from the trials. In Figure 4, the authors present the output of their model, which suggests that fans become detrimental beginning at a temperature of 39°C (102.2°F) (at certain humidities). At increasing temperatures, fan use is detrimental at a wider range of humidity levels (both high and low humidity), but beneficial or ineffective at other humidity levels. Foster et al. also present model results with varying assumptions for sweat rate and fan speed (Figure 6).

As discussed above, in their consensus statement, Morrissey et al. (2021b) recommend the use of electric fans in an occupational setting when ambient temperatures are below 40°C/104°F.

I. Conclusions for Fans.

In conclusion, OSHA preliminarily finds that these studies show that use of fans during work and/or rest breaks will be effective in reducing heat strain in the majority of working age adults. Studies also show that there are certain conditions (e.g., at a temperature of 102.2°F and above, depending on the humidity) under which fans may not be beneficial and can be harmful to workers.

D. Water.

Working and sweating in the heat put workers at risk for dehydration and HRIs. Replacing fluids lost as sweat is necessary to maintain blood volume for cardiovascular

function and thermoregulation. Multiple studies have examined the efficacy of hydration interventions, while also considering various factors that may affect hydration such as the quantity of liquid consumed, timing of ingestion, and beverage temperature.

Studies in the peer-reviewed literature provide evidence that hydration interventions are effective at combating dehydration and HRI. For example, McLellan and Selkirk performed a series of heat stress trials with 15 firefighters in Canada wearing protective equipment at 35°C (95°F) and 50% relative humidity (McLellan and Selkirk, 2006). During the trials, participants conducted light exercise in a heat chamber and were provided one of four fluid replacement quantities: no fluid, one-third fluid replacement, two-thirds fluid replacement, or complete fluid replacement (based on previously determined sweat rates). Each participant completed two 20-minute exercise periods, separated by a 10-minute break for a simulated self-contained breathing apparatus (SCBA) change, and then followed by a 20-minute rest break. Cool water was provided during each break. Exercise continued until participants reached an endpoint, defined as a rectal temperature over 39.5°C (103.1°F), heart rate at 95% of maximum, experiencing dizziness or nausea, or other safety concerns. Participants who received either two-thirds or full fluid replacement tolerated approximately 20% more exposure time (including rest periods spent in the heat chamber) and approximately 25% more work time (calculated by excluding rest periods) than those without the fluid replacement. Most participants who were not provided fluids ended the trial upon experiencing lightheadedness when attempting to re-initiate exercise after a break, possibly related to low blood pressure. Those with two-thirds and full fluid replacement took significantly longer to reach an end point during work time and those with one-third, two-thirds, or full fluid replacement had significantly longer exposure time than those without fluid replacement. The full fluid replacement group also had higher rectal temperatures at their trial endpoint compared to those without fluid replacement, possibly indicating that hydration allowed them to

tolerate higher rectal temperatures. The authors state that these findings are consistent with previous literature that reports cardiovascular function to be compromised without fluid replacement, leading to exhaustion at lower core temperatures.

Ioannou et al. (2021a) advised intervention groups made up of agricultural workers in Qatar and construction workers in Qatar and Spain to consume 750 milliliters (mL) of water supplemented by one tablespoon of salt per hour over their work shift. Findings in the intervention group were compared to a "business as usual" (BAU) group, where workers followed their normal routine, that were unspecified for the agricultural industry and included shaded areas, water stations, and air-conditioned rest break areas for construction workers in Spain; those same BAU conditions were implemented for construction workers in Qatar, in addition to requiring workers to carry a water bottle, and education. Results included: (1) 13% to 97% reductions in prevalence of dehydration in each intervention group; (2) no significant differences in core temperatures for agricultural workers in Qatar; (3) significant reductions in core temperature in the construction intervention groups in Qatar and Spain, and (4) mixed findings on heart rate and skin temperature across the sites. One limitation with this paper is the use of BAU as a control group, as it is not always clear how these scenarios differed from the intervention. In addition, the quantity of fluid consumed was not measured.

Drinking adequate amounts of water may also reduce the risk of syncope. Schroeder et al. assessed the effects of water quantity on orthostatic tolerance (as time to presyncope, the symptomatic period right before fainting) in healthy individuals (n=13) (Schroeder et al., 2002). The authors used a controlled, crossover design to test the effects of consuming 500 versus 50 milliliters of water prior to attempting to induce presyncope by tilting the head-up and applying negative pressure to the lower body. They found that drinking the larger amount of water improved orthostatic tolerance by 5 minutes (+/- 1 minute), increased supine (lying down face up) mean blood pressure and peripheral

resistance, and was associated with smaller increases in heart rate. A recent study using a similar design found that the temperature of the water may also have an influence—cold water consumption was associated with increased systolic blood pressure, stroke volume (i.e., increased volume of blood pumped out of heart per beat), cerebral blood flow velocity, and total peripheral resistance, as well as reduced heart rate relative to consuming room temperature water (Parsons et al., 2023). They did not find differences in orthostatic tolerance between the groups. It should be noted that neither of these papers tested the participants under conditions of high heat, but as is discussed in Section IV., Health Effects, research has shown that exposure to heat independently increases the risk of syncope. In addition, both syncope from exposure to heat and the method used to induce presyncope in these studies can involve a mechanism in which blood pools in the lower body.

Public health guidance for workers (e.g., from NIOSH) often involves recommendations that workers consume 1 cup (237 mL) of water every 15-20 minutes or approximately 1 liter (711-948 mL) per hour. The goal is to replenish fluids lost through sweat and avoid a substantial loss in total body water content. Sweat rates vary between individuals and conditions. Research conducted among workers performing "moderate manual labor e.g. mining or construction work" in a controlled laboratory setting (35°C and 50% RH) demonstrated an average sweat rate of 410-470 mL per hour (depending on whether the trial was conducted in winter or summer), but a range of 100 mL to 1 liter per hour during the presumed unacclimatized trials (conducted in winter) (Bates and Miller, 2008). These recommendations are also in line with the Army's fluid replacement guidelines, which recommend 0.75-1 quart (1 quart is approximately 0.95 liters) per hour for "moderate work" (425 W) to "heavy work" (600 W) depending on the wet bulb globe temperature (Department of the Army, April 12, 2022; Table 3-2).

In a randomized crossover study, Pryor et al. (2023) had participants continuously walk for two hours at 6.4 km/hr in a heat chamber (34°C/93.2°F, 30% relative humidity) while either drinking 500 mL of water every 40 minutes or 237 mL of water every 20 minutes, followed by two hours of rest. Study authors found both hydration strategies to be similarly effective based on (1) no significant differences in body mass, percent change in plasma volume, plasma osmolality (i.e., volume of particles dissolved in plasma), body temperature, or heart rate and (2) no difference in thirst or total gastrointestinal symptom scores. The authors did note, however, that urine volume was significantly lower after the rest period in the group receiving 237 mL of water every 20 minutes compared to the group receiving 500 mL of water every 40 minutes.

Several studies have evaluated the impact of the temperature of drinking water on dehydration and other measures in occupational settings. Cold water may serve as a heat sink to cool off the body in addition to combatting dehydration. In their meta-analysis, Morris et al. (2020) (described above) considered the effect of cold fluid ingestion as a personal cooling method, distinct from maintaining hydration status. Morris and co-authors concluded that cold fluid ingestion was effective as a heat strain mitigation control.

A systematic review by Burdon et al. reported that palatability was higher for cold (32.0-50.0°F) or cool (50.0-71.6°F) beverages, as compared to warmer (greater than 71.6°F) beverages, during exercise (Burdon et al., 2012). The authors conducted a meta-analysis using data from five studies and found that participants drank roughly 50% more cold/cool beverages than warmer beverages. Another analysis of multiple studies found that when participants were provided cold/cool beverages rather than warmer ones, there was less of a mismatch between fluid intake and fluid lost through sweat (measured as percentage of body mass lost). Participants provided warmer beverages lost, on average, 1.3% more of their body mass (95% CI: 0.9%, 1.6%) (Burdon et al., 2012).

I. Conclusions for Water.

In conclusion, one experimental study reported that drinking adequate amounts of water while exercising in high heat prolonged the time of exposure before experiencing signs of heat strain or HRI (McLellan and Selkirk, 2006). In addition, studies in which participants were not exposed to high temperatures found that drinking adequate amounts of water reduced the risk of laboratory-induced presyncope (Schroeder et al., 2002), and drinking cool water improved cardiovascular function (Parsons et al., 2023). Studies have also reported increased palatability for cool or cold beverages (≤71.6°F) that is likely to increase consumption and prevent dehydration compared to warmer beverages (Burdon et al., 2012).

Based on these studies, OSHA preliminarily finds that drinking adequate amounts of water is an effective intervention for preventing heat strain that could lead to HRI, and that providing cool drinking water is especially beneficial. In addition, because cool or cold water was found to be more palatable than warm water, OSHA preliminarily finds that providing cool or cold water can lead to higher consumption of water and thereby reduce the risk of dehydration.

E. Acclimatization.

Heat acclimatization refers to the improvement in heat tolerance that occurs from gradually increasing the intensity and/or duration of work done in a hot setting. There are several studies examining the extent and effectiveness of acclimatization achieved on the job. The effects of acclimatization in allowing individuals to work safely in higher temperatures than unacclimatized individuals has been established for decades and is reflected by both the NIOSH REL and the ACGIH TLV (NIOSH, 2016; ACGIH, 2023).

Early research on the effectiveness of acclimatization was conducted in the 1950s and 1960s among gold mine workers in South Africa (Weiner, 1950; Wyndham et al., 1954, 1966). Weiner (1950) conducted three days of heat stress tests on eight

acclimatized mine workers, with three to six months experience working underground, and eight new, unacclimatized workers. Workers completed a four-hour protocol of step climbing sessions (30 mins) with sitting breaks (30 mins) in a mine shaft (dry bulb temperatures: 89.8°F-90.2°F, wet bulb temperatures: 88.8°F-89.1°F, air movement: 165-280 ft/min). Multiple unacclimatized workers were not able to complete the full protocol on the first day (based on symptomology, heart rate and rectal temperature), while all acclimatized workers were able to do so. Rectal temperatures and heart rates were higher among the unacclimatized workers than the acclimatized workers and sweat rate was lower (Weiner 1950).

Wyndham et al. (1954) describe a two-stage acclimatization protocol in which workers (n=110) shoveled rock for six days in a cooler section of the mine (saturated air temperature approximately 86.5°F, wind velocity approximately 100 feet/minute), before moving to a hot section of the mine (saturated air temperature between 91.5°F and 92.0°F, wind velocity 100 to 350 feet/minute) to complete the same task for six more days (Wyndham et al., 1954). Researchers measured rectal temperatures before the shift, at 9 a.m., at 11 a.m., and at 1 p.m. on each of the twelve days. Average rectal temperature was 101.0°F on the first day in the cooler conditions, which fell to 100.2°F on day six. When workers transitioned to the hot conditions, the average rectal temperature was 100.8°F on the first day and 100.0°F on the sixth day. The authors concluded that the acclimatization method was a success, as rectal temperatures were on average lower on the first day in full heat conditions (100.8°F) than on the first day of work in cooler conditions (101.0°F), and mean work output was also higher on the first day in the full heat (Wyndham et al., 1954). The researchers also compared the acclimatized workers to a prior cohort of eight new workers who worked immediately in hot conditions without any acclimatization—they had an average rectal temperature of 101.8°F on their first day. The authors noted that the two-stage acclimatization protocol likely resulted in complete

acclimatization, as earlier monitoring of the eight new workers over 23 workdays showed that rectal temperatures did not fall much lower than 100°F, the average temperature seen after the new two-phase acclimatization protocol (Wyndham et al., 1954).

In a later study, Wyndham et al. (1966) analyzed the rectal temperatures of 18 acclimatized men and groups of 20 unacclimatized men working at a moderate rate for four hours in varying environmental conditions (Wyndham et al., 1966). The authors found that the acclimatized men, on average, could work at higher effective temperatures (a heat metric that accounts for ambient temperature, humidity, and air movement) than the unacclimatized men while still maintaining a steady rectal temperature (Wyndham et al., 1966).

Van der Walt and Strydom analyzed fatal heat stroke cases among miners in South Africa from 1930-1974 (Van der Walt and Strydom, 1975). Changes in cooling, mechanization, and acclimatization practices occurred at different points in time. Van der Walt and Strydom divided 1930-1974 into four periods based on interventions implemented during each period. They discussed changes in heat stroke fatality in relation to the interventions that were implemented. During the earliest period (1930-1939), acclimatization practices were introduced and ventilation improved, and the annual heat stroke mortality rate decreased from 93 to 44 deaths/100,000 workers. During the following period, which coincided with the war and post-war time (1940-1949), mines continued and improved the practices introduced in the first period. There was a drop in mortality rate from approximately 26 to 16 deaths/100,000 workers. During the third period (1950-1965), mines began using two-stage acclimatization, and the annual heat stroke mortality rate decreased from 15 to 5.6 deaths/100,000 workers. During the fourth period (1966-1974), mines began using climatic room acclimatization, and the annual heat stroke mortality rate decreased even further to 2.3 deaths/100,000 workers (Van der Walt and Strydom, 1975). The authors concluded that the controls they

implemented over this period—namely introducing and improving their acclimatization procedures—were important in reducing the heat stroke fatality rates over time. However, they also introduced other controls during this time (ventilation and mechanization) so it is difficult to determine the efficacy of acclimatization independent of those controls (and other potential confounding factors).

Recent research on acclimatization has also included studies that assess acclimatization achieved while on the job. Lui et al. (2014) conducted a study to evaluate acclimatization among firefighters before and after a four-month wildland fire season, in May and September, respectively. The researchers assessed various physiological markers of heat acclimatization among a cohort of 12 U.S. male wildland firefighters and a group of 14 adults who were not firefighters, matched on age and fitness level. Participants completed a 60-minute walk at 50% of peak oxygen consumption (VO2) in a chamber at 43.3°C and 33% relative humidity. At 60 minutes, firefighters were found to have lower average core body temperatures after the wildfire season than before the season (after: 38.2°C ± 0.4; before: 38.5°C ± 0.3), while the comparison group showed no difference from the pre-season to post-season trials. Similarly, firefighters had significantly lower physiological strain index scores (a variable derived from core temperature and heart rate) after the wildfire season ($p<0.05$), while scores did not change for the comparison group. No pre- to post-season changes were observed for heart rate. The authors found no evidence of acclimatization in the comparison group over the study period. Study results suggest that the firefighters were acclimatized due to occupational exposures during the wildfire season rather than exposure to higher seasonal heat (Lui et al., 2014).

Dang and Dowell (2014) compared heat strain markers among acclimatized and unacclimatized potroom workers at an aluminum smelter in Texas in July as they conducted various smelting activities in high heat. Workers were defined as

unacclimatized if they had not been working or had been working solely outside of the potrooms for four or more consecutive days in the prior two weeks. WBGT values in work areas ranged from 83°F to 120°F. Among the eight unacclimatized workers and 48-50 acclimatized workers with heat strain measurements, unacclimatized workers had significantly higher average heart rates than acclimatized workers (118 bpm vs. 107 bpm, $p<0.01$). Unacclimatized workers also had higher average and average maximum core temperatures, but these differences were not significantly different (average maximum core temperature: 101.0°F vs. 100.7°F; average core temperature: 99.7°F vs. 99.6°F) (Dang and Dowell, 2014).

Watkins et al. (2019) evaluated the heat tolerance of fire service instructors (FSIs), which researchers describe as fire personnel who provide firefighting training courses and have more frequent fire exposure than firefighters. The researchers conducted two heat tolerance tests, separated by two months on a cohort of 11 FSIs and 11 unexposed controls (university lecturers), matched on age, sex, and body composition. Controls had not had more than three consecutive days of heat exposure (>25°C) or taken part in heat acclimatization training in the month prior to the study. On average, FSIs experienced five fire exposures in the two weeks prior to each heat tolerance test. Each test was composed of a 10-minute rest period (22.9 ± 1.2°C, 31.2 ± 6.8% RH) followed by a 40-minute walk in a heat chamber (50 ± 1.0°C, 12.3 ± 3.3% RH) wearing fire protective equipment. At the end of the first heat tolerance test, FSIs on average had significantly lower maximum rectal temperature (−0.42°C, $p<0.05$), less change in rectal temperature (−0.33°C, $p<0.05$), and reported less thermal sensation and, among males only, a higher sweat rate (+0.25 Liters/hour, $p<0.05$) than the controls. Heart rate, skin temperature, and physiological strain index did not differ between groups. Rectal temperature at the end of the heat test was negatively correlated with the number of fire

exposures experienced in the prior two weeks (r= −0.589, p=0.004) (Watkins et al., 2019).

The effectiveness of acclimatization in high heat conditions has also been an important topic for militaries. Charlot et al. (2017) studied the effects of training on acclimatization in 60 French soldiers who arrived in United Arab Emirates (UAE) in May of 2016, and were not stationed in a hot climate over the previous year. On day 1, all soldiers completed a heat stress test while running. On days 2–6, the 30 soldiers in the training group trained outdoors by running at 50% VO2 max, with durations of training sessions ranging from 32-56 minutes. Both the soldiers in the training group and 30 soldiers in a control group (no training; performed usual activities) spent approximately six hours outdoors per day conducting standard military tasks. The heat stress test was repeated on day 7, with WBGTs ranging from 1.1°C warmer to 0.9°C cooler compared to day 1. In both groups, rectal temperature, heart rate, sweat loss, sweat osmolality, perceived exertion, and thermal discomfort were lower after the stress test on day 7 compared to day 1. Compared to the control group, the training group had significantly greater decreases in heart rate (20±13 bpm lower versus 13±6 bpm lower), rate of perceived exertion, and thermal discomfort after the stress test on day 7 compared to day 1. Charlot et al. (2017) concluded that addition of short, moderate-intensity training sessions resulted in further heat acclimatization, beyond the acclimatization observed across all participants.

In another study of military trainees, Lim et al. (1997) assessed the degree to which passive heat exposure and military training resulted in the acclimatization of army recruits in Singapore across a 16-week military training program. Participants completed a heat stress test, while marching, at four time points: (1) before starting the program, (2) on the second week, (3) on the sixth week and (4) on the sixteenth/final week of the program. For the nine individuals who attended all tests, heart rate significantly decreased

across the study period, while results for skin temperature, tympanic temperature (i.e., within ear canal), and average body temperature were mixed, and there were no significant differences in sweat loss or sweat rate. Researchers interpreted these findings to mean that passive heat acclimatization from living in a hot climate had resulted in partial acclimatization, but that physical conditioning was necessary for triggering beneficial cardiovascular adaptations (Lim et al., 1997).

Sports teams have also evaluated the effectiveness of heat acclimatization among their athletes. Three studies conducted among professional soccer players found that athletes training in hot outdoor conditions experienced improvements in plasma volume, heart rate, rectal and skin temperature, and/or sweat sodium concentration over the course of their training (Buchheit et al., 2011; Racinais et al., 2012, 2014).

Acclimation (i.e., improvement in heat tolerance under laboratory conditions) was also studied in heat chamber studies. In a study using 90-minute treadmill sessions designed to mimic the metabolic rate of manual laborers, Chong et al. (2020) found that over the course of a12-day acclimatization period at 28°C WBGT or 30°C WBGT, peak core temperature, heart rate, and skin temperature decreased and sweat rate increased even before the end of the 12-day period (Chong et al., 2020). Zhang and Zhu (2021) acclimated participants using 10 daily 90-minute treadmill sessions (at a speed of 5 kilometers/hour) in 38°C and 40% RH and found that after acclimation, rectal temperature and heart rate during exercise increased at a slower rate, but there was no effect on skin temperature. OSHA notes that Zhang and Zhu (2021) did not gradually increase daily heat exposure, as is typically recommended.

Shvartz et al. (1977) studied the effects of work and heat on orthostatic tolerance among 12 trained men (i.e., trained three time a week in endurance sports) and 16 untrained men, none of whom were exposed to exercising in the heat in the two months before testing (Shvartz et al., 1977). The trained participants had better orthostatic

tolerance to laboratory-induced syncope compared to the untrained participants (2 vs. 8 fainting episodes after exercise in ambient conditions; 4 versus 9 fainting episodes after exercise in heat). Heat acclimation improved orthostatic response, as fainting episodes after exercise decreased in the 8 untrained participants who were later acclimated to heat for 7 additional days (4 versus 0 fainting episodes after exercising in temperate conditions and 4 versus 2 after exercising in hot conditions, before and after acclimation, respectively). At the end of the acclimation period for those 8 untrained participants, significant reductions were observed for heart rate and rectal temperature, while significant increases in sweat rate and maximum VO2 occurred. Shvartz et al. (1977) concluded that both general physical fitness and heat acclimation contributed to better orthostatic responses and fewer fainting episodes.

Parsons et al. (2023) evaluated the effects of heat acclimation in 20 endurance-trained athletes (15 males, 5 females) randomly assigned to a heat group that was acclimated for 8 days or control group that was not acclimated to heat. Heat stress testing (at approximately 32°C and 71% or 72% RH) revealed that in the post-intervention period, the heat group compared to the control group, had significantly decreased peak heart rate; resting, mean, and peak rectal temperature; and peak and mean skin temperature. No significant differences were observed in measures of sweat and hydration. Plasma volume was significantly increased in the heat compared to control group post intervention. Orthostatic tolerance (at approximately 32.0°C, 20% RH) determined by the time to laboratory-induced presyncope, was significantly increased in the heat group (pre: 28±9 min. vs. post: 40±7 min.) compared to control group (pre: 30±8 min. vs. post: 33±5 min.) post-intervention. The authors concluded that plasma volume expansion was the likely mechanism behind improved orthostatic tolerance; they further noted that participants were physically fit at baseline and that they would expect a less

robust acclimation regimen would likely yield beneficial results for populations with lower physical fitness (Parsons et al., 2023).

I. Evidence of Tenure as a Risk Factor.

Multiple investigations of occupational HRIs have identified tenure in the job as a risk factor. Workers who are new on the job are often overrepresented in HRI and heat-related fatality reports. In many of these cases, this apparent increased risk presumably results from not being acclimatized to hot working conditions. Studies documenting tenure as a risk factor include case series from OSHA reports, analyses of State workers' compensation databases, and research on military populations. For reference, the most recent (2023) monthly estimates of new hires in the U.S. suggest that over the summer months (June to September), the percent of workers who have been in their job for a month or less ranges from 3.7%-4.1% (BLS JOLTS 2023). Therefore, the percent of workers who are in their first day, first week, or first two weeks on the job would be expected to be lower than 3.7%-4.1%.

Several reports have evaluated OSHA enforcement cases of HRI and heat-related fatalities. Arbury et al. identified 20 citations involving indoor or outdoor HRIs and fatalities cited under the general duty clause in 2012 and 2013 (Arbury et al., 2014). Of the 13 fatalities, 4 (31%) occurred on the worker's first day on the job or after returning from time away, while 9 (69%) occurred in the first three days of the worker's tenure on the job. Arbury et al. expanded this work in a follow-on report that included all of OSHA's heat enforcement cases in both indoor and outdoor workplaces between 2012 and 2013 (n=84). Of the 23 cases involving a heat-related fatality, 17 (74%) occurred in the worker's first three days on the job and 8 (35%) on the worker's first day (Arbury et al., 2016). Tustin et al. (2018a) identified 66 HRI cases among OSHA enforcement investigations conducted between 2011 and 2016 for which OSHA's Office of Occupational Medicine and Nursing (OOMN) was consulted. Among the fatality cases

with job tenure information (n=22), 45.5% occurred on the first day of or returning to the job and 72.8% occurred during the first week. Among the non-fatal HRI cases with job tenure information (n=32), 3.1% occurred on the first day and 18.7% occurred during the first week. In a related analysis focusing on outdoor workers, Tustin et al. (2018b) evaluated 25 outdoor occupational HRI and fatalities investigated by OSHA between 2011 and 2016. Eleven (78.6%) of the 14 fatalities and one of the 11 non-fatal illnesses (9.1%) occurred in workers who had started the job within the preceding two weeks or returned from an absence of greater than one week (Tustin et al., 2018b).

Arbury et al. 2014, Arbury et al. 2016, Tustin et al. 2018a, and Tustin et al. 2018b are all retrospective case series that used OSHA databases to identify cases of HRI and heat-related fatalities. As such, they rely on previously collected information about working conditions and worker characteristics, which may not be complete or reflect all factors. In addition, there may be selection bias introduced by the type of cases referred to OSHA's OOMN for review (i.e., they may represent more severe cases).

Several studies and reports have used data from California to describe characteristics of occupational HRI and heat-related fatalities in the State. From May through November of 2005, there were 25 heat-related Cal/OSHA enforcement investigations (Prudhomme and Neidhardt, 2006). When combining fatal and non-fatal outcomes, most workers (80%) had been on the job for four or fewer days before their HRI event, and almost half (46%) occurred on the workers' first day on the job (Prudhomme and Neidhardt, 2006). In 2006, Cal/OSHA confirmed 46 cases of HRI in their 38 investigations of heat-related allegations (4 investigations involved more than 1 case) (Prudhomme and Neidhardt, 2007). 15% of the HRI events and fatalities occurred on the first day of work or the first day of a heat wave, while 30% occurred after working one to four days on the job or into a heat wave (Prudhomme and Neidhardt, 2007). It should be noted that both Cal/OSHA reports only capture cases investigated by

Cal/OSHA, and as such, may reflect more severe cases of HRI. They are also not expected to be exhaustive of all occupational HRIs occurring in the State during these time periods. Heinzerling et al. (2020) investigated occupational HRIs across industry sectors in California from 2000 to 2017 using the California Workers' Compensation Information System (Heinzerling et al., 2020) and identified 15,996 cases of occupational HRI. The authors reported that 1,427 cases (8.9%) occurred within two weeks of hire and 410 (2.6%) occurred on the first day on the job.

Several analyses of Washington State Department of Labor and Industries (WA L&I) data have also investigated job tenure in relation to heat-related workers' compensation claims. Bonauto et al. identified 308 claims between 1995 and 2005 with information on employment duration, 43 (14%) of which reported job tenure of one week or less (Bonauto et al., 2007). In comparison, across all claims (i.e., not just heat-related) with employment duration information during the same period, 3.3% of claims reported a job tenure of one week or less, suggesting that this pattern is more common among heat-related claims. A more recent analysis by WA L&I reports the percent of accepted HRI claims occurring during the first one and two weeks of work in Washington between 2006 and 2021 (SHARP 2022). Across all industries, 12.5% of accepted HRI claims were filed in the first week at a job and 16.1% of accepted HRI claims occurred during the first two weeks of work. The percentage of HRI claims filed in the first week and first two weeks of working at a job was higher than the percentage among all workers' compensation claims filed in the first week (2.2%) or two weeks (3.7%) on a job. Spector et al. conducted an analysis similar to Bonauto et al. 2007, but restricted to the agriculture and forestry sectors and included claims through 2009 (Spector et al., 2014). The researchers identified 84 HRI claims in the agriculture and forestry sectors, approximately 15% of which reported that claimants had been working at their job for less than two weeks at the time of the injury. As discussed in Section V.A., Risk

Assessment, occupational HRIs, particularly those not requiring medical treatment, are subject to underreporting in workers' compensation systems. Therefore, injuries and illnesses that are captured are likely to be more severe cases.

The U.S. military has also studied HRIs among its recruits extensively. Among all U.S. Marine recruits entering basic training at the Marine Corps Recruit Depot, Parris Island in South Carolina between 1988 and 1996, the number of HRI cases were higher in early training periods (processing week and weeks 1-4) compared to late training period (training weeks 5-12) for females but were similar for males (Wallace 2003). Among males, weeks 1, 8, and 9 of training had the highest numbers of HRI cases. Physical intensity of training varied each week during the 12 weeks of training, which likely had an impact on rates of HRI. Dellinger et al. reported on HRIs among more than 7,000 Army National Guard soldiers deployed to Illinois from July 5th to August 18th, 1993, in response to severe flooding (Dellinger et al., 1996). Researchers identified 23 heat-related medical claims, which excluded those treated by on-site first aid. 65% of the 23 HRI claims occurred during the first two weeks of the deployment; researchers note that this was also the period of greatest work intensity.

II. Conclusions for Acclimatization.

In conclusion, numerous studies have reported the benefits of heat acclimatization for employees in workplace settings. For example, adoption of workplace acclimatization protocols was followed by reduced rates of heat stroke-related fatalities in South African miners (Van der Walt and Strydom, 1975). Acclimatization was also reported to result in reduced signs of heat strain or improved physiological responses to heat for miners (Weiner, 1950; Wyndham et al.,1966), fire fighters (Lui et al., 2014; Watkins et al., 2019) and aluminum smelter potroom workers (Dang and Dowell, 2014). Similarly, studies in military personnel have reported responses to heat following physical training in hot climates (Charlot et al., 2017; Lim et al., 1997). Improvements in physiological responses

to heat were also observed in athletes after training in hot climates (Buchheit et al., 2011; Racinais et al., 2012, 2014) and participants exercising in heat chambers (Chong et al., 2020; Zhang and Zhu, 2021). Studies have also shown that heat acclimation while exercising reduces the risk of laboratory-induced syncope (Shvartz et al., 1977) or presyncope (Parsons et al., 2023).

Additionally, retrospective examination of limited data from State and Federal enforcement and surveillance cases demonstrates over-representation of workers during the first days or weeks of employment or return to work among HRI cases and fatalities (Arbury et al., 2014, 2016; Tustin et al., 2018a, b; Prudhomme and Neidhardt, 2006, 2007; Heinzerling et al., 2020; Bonauto et al., 2007; SHARP, 2022). This suggests that these workers are at increased risk of HRI and fatality, which may be (or at least in part) the result of lack of acclimatization.

Based on the evidence presented in this section, OSHA preliminarily finds acclimatization to be an effective intervention in reducing the risk of HRI and heat-related fatality by improving physiological responses to heat.

IV. Evidence on the Effectiveness of Multicomponent Interventions.

A. Civilian Workers.

OSHA identified a small number of studies that examined the effectiveness of multi-pronged interventions implemented at workplaces. Three evaluated the effectiveness of a multi-pronged intervention at reducing the risk of heat-related illness (McCarthy et al., 2019; Perkison et al., 2024) or self-reported symptoms of heat-related illness (Bodin et al., 2016) by comparing the same study population before and after an intervention was implemented. OSHA does note that the studies lacked a control group which received no intervention and would have allowed for the authors to examine the effect of potential temporal confounders that changed across the study period. In addition, there was no data to indicate how thoroughly the interventions were implemented or how

much employees adhered to them. However, the studies provide strong and consistent evidence of the effectiveness of multi-intervention programs in preventing heat-related illnesses and are supported on a mechanistic basis by the laboratory and other experimental evidence presented above.

McCarthy et al. (2019) compared HRI events and costs from workers' compensation data before and after a Heat Stress Awareness Program (HSAP) intervention among workers in a mid-sized city in Central Texas that was implemented in March 2011. The study population consisted of municipal workers whose jobs involved work in hot, humid conditions with moderate to heavy physical demands, excluding firefighters. The HSAP was based on NIOSH's *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments* (2016) and included in-person training of supervisors and workers, a medical monitoring program, and specific recommendations to supervisors such as providing unlimited access to water, sports drinks, and shade, as well as establishing acclimatization schedules, work-rest procedures, and first aid protocols. Before the intervention, workers completed a self-administered questionnaire to determine their level of HRI risk, which the researchers then used to categorize them into four risk levels (McCarthy et al., 2019). Those who reported two or more HRI risk factors (i.e., high body mass index, medication use, chronic illnesses, alcohol and energy drink use, history of prior HRI, work in a second hot job, and extensive skin pathology) but not an "unstable health condition" received individualized HRI prevention counseling or education.

McCarthy et al. (2019) compared the rates of heat-related illness across the study period of 2009-2017, before and after the HSAP intervention was implemented in 2011. In the pre-intervention period (2009-2010), the annual average claim rate for heat-related illnesses was 25.5 claims/1,000 workers. The average annual rate of HRI claims in fell by 37% in 2012-2014 (16 claims/1,000 workers) and by 96% in 2015-2017 (1 claim/1,000

workers) compared to the pre-intervention period. No workers' compensation claims for HRI were submitted in the final 2 years of the study period.

OSHA observes the potential for healthy worker selection bias in this study that might have occurred if employees with medical conditions were more likely to leave their job and therefore the cohort during the study period.

Perkison et al. (2024) reported that the program in the central Texas Municipality employees (referred to in this study as the heat illness prevention program (HIPP)) and described by McCarthy et al. 2019) ended in 2017 and was replaced by a modified HIPP (mHIPP) that included only employee and supervisor training and employee acclimatization. In an analysis to determine the impact of dropping medical surveillance from the HIPP, the study authors reported that the rate of heat illness and injury, which averaged 19.5/1,000 employees during the first four years of the HIPP (2011-2014), fell to 1.0/1,000 employees over the next three years (2015-2017), but increased to 7.6 per 1,000 workers during the mHIPP (2018-2019). Although heat-related illness claim rates increased during implementation of the mHIPP, the rate of heat-related illness during implementation of the mHIPP (7.6/1,000) was still 70% lower than the period with no intervention (25.5/1,000).

Bodin et al. (2016) reported on productivity, HRI symptoms, and hydration practices before and after a water-rest-shade (WRS) and efficiency intervention among sugarcane cutters in El Salvador. The intervention began two months into the 5-month harvest season of 2014-2015. The WRS intervention included: 3-liter water bladders carried in backpacks and refilled during breaks; an initial 1.5 to 2-hour work interval followed by a 10 to 15-minute break, then hour-long work periods with 10 to 15-minute rest breaks and a 45-minute lunch break; and a portable shade canopy for breaks. The efficiency intervention consisted of a machete with an improved blade and handle, fewer rows cut, and a stacking method to reduce workload. Due to challenges during data

collection, a relatively small sample size of 41 workers completed follow-up. Bodin et al. (2016) reported that, among those 41 sugarcane cutters, average daily water intake (5.1 liters pre-intervention, 6.3 liters post-intervention) and average daily production (5.1 tons pre, 7.3 tons post) increased after the intervention. An analysis of self-reported heat stress and dehydration-associated symptoms showed that reporting of most symptoms decreased after the intervention, such as feeling feverish (40% to 10%), exhaustion (37% to 14%), nausea (35% to 12%), very dry mouth (49% to 26%), very little urine (37% to 19%), cramps (30% to 17%), diarrhea (14% to 0%), disorientation (12% to 0%), and fainting (5% to 2%). However, self-reported rates of vomiting (9% to 10%) and dysuria (i.e., pain during urination) (42% to 45%) remained similar in pre- and post-intervention periods (Bodin et al., 2016) (Communication with David Wegman, November 2023).

B. Military Personnel.

OSHA also identified studies which examined the effectiveness of interventions in reducing risk of heat-related illness among military personnel. OSHA acknowledges differences between military personnel and typical civilian worker populations, such as health status, fitness levels, and the types of physical activities performed by military personnel (e.g., long-distance running). The military also employs certain controls that aren't typically used in workplaces, such as work stoppage criteria. However, OSHA finds the studies in military personnel useful for showing that multi-component interventions can reduce the risk of heat-related illness.

Kerstein et al. (1986) conducted a randomized control trial in military reservists exposed to hot and humid conditions and found that the incidence of heat illness was 54% lower in a group exposed to intervention measures. Those measures included a lecture on water as prevention, training on and use of portable WBGT monitors, and a special briefing for Commanding Officers. Incidence rates of HRI (defined as "any person with heat symptoms, including exhaustion, cramps, and headaches that the

corpsman could clearly relate to the environment and cause the individual to be non-functional for at least one hour or more") were 13 out of 306 participants in the intervention group (4.2%) and 20 out of 220 in the control group (9.1%).

Stonehill and Keil examined the number of heat stroke cases at Lackland Air Force Base in San Antonio, Texas after they implemented a series of interventions over a period from 1956 through 1959 (Stonehill and Keil, 1961). Interventions that were implemented before 1958 included education on heat illness and prevention, pausing training based on dry bulb temperatures, shifting harder exercises to cooler hours, treating heat rash, providing clothing with better ventilation, improving personal hygiene, providing special advice for overweight individuals, and implementing immediate medical treatment for heat stroke. Despite these measures, they still observed 39 cases of heat stroke in 1957 (a rate of 0.87/1,000). After making improvements to their prevention measures in the summer of 1958 (increased water and salt tablet availability, removing fatigue shirts inside classrooms, using WBGT to determine when to pause training, and avoiding intense outdoor training in the first week of training), they observed only 2 heat stroke cases that summer (a rate of 0.05/1,000), a reduction of 95% from 1957.

Minard (1961) evaluated the effectiveness of interventions in reducing HRIs in a study of the Marine Corps Recruit Depot in Parris Island, South Carolina. During the summer of 1952, the mean weakly HRI incidence rate was 53 per 10,000 recruits. A program to address HRI was adopted in 1954 and later modified in 1956. Minard reported a lower mean weekly HRI rate with the enhanced interventions in 1956 (4.7 per 10,000 recruits) compared to the initial intervention in 1955 (12.4 per 10,000 recruits), despite higher temperatures in 1956. Initial interventions included curtailing physical activity during high heat and numerous behavioral changes, such as modifications to uniforms and leadership training; while the most substantial changes to enhance the interventions included curtailing physical activity based on WBGT and differentiating

physical activity guidance for acclimatized versus unacclimatized recruits. Later enhancements to the intervention included conditioning recruits with substandard fitness, shade for outdoor classrooms, cooling for indoor classrooms, modification of the clothing policy to allow for only t-shirts, light duty status for recently vaccinated recruits, one hour rest or classroom instruction after meals, better ventilation in barracks to improve sleep, and strategies to increase water and salt intake. The mean weekly HRI rate for all summers with the enhanced intervention (1956-1960) was 4.3 per 10,000 recruits. Four fatalities from heat stroke occurred from 1951 to 1953, but no fatalities occurred since 1953.

C. Conclusions for Multicomponent Interventions in Civilian and Military Employees.

In conclusion, three studies in civilian worker populations found that multicomponent heat stress interventions reduced the incidence of HRI claims and self-reported heat strain and dehydration symptoms and increased work output. The findings of these studies are supported by studies among military personnel, which also found multicomponent interventions to be effective in reducing incidence of HRI, as well as data on the effectiveness of individual control measures reported in laboratory and experimental studies, which are summarized above. The findings of these multicomponent intervention studies are summarized in table V-3.

Table V-3 Summary of evidence of the effectiveness of multicomponent interventions in reducing HRIs and heat-related symptoms

Evidence	Notes
Multi-component Interventions	
McCarthy et al. (2019): In a comparison of heat-related illness claims before and after the implementation of a heat stress awareness program that began in 2011 in a Texas municipality, the average annual rate of HRI claims fell [by 37%] in 2012-2014 (16 claims/1,000 workers) and [by 96%] in 2015-2017 (1 claim/1,000 workers) compared to the pre-intervention period (25.5 claims/1,000 workers).	• The program involved medical monitoring and training • Recommendations made to supervisors included unlimited access to water, sports drinks, and shade, as well as establishing acclimatization schedules, work/rest procedures, and first aid protocols • It is not known if and to what extent recommendations were implemented

Perkison et al. (2024). The program in Texas municipality workers reported by McCarthy et al. (2019) was modified in 2017 to include only training and acclimatization, and no longer include medical surveillance. Rate of heat-related illness did increase after these changes (to 7.6 claims/1,000 workers) but remained [70%] lower than when no program was implemented.	• The study authors concluded "medical surveillance may be an important component in lowering workforce heat-related illness," but noted the small sample size and short evaluation period
Bodin et al. (2016) reported that three months after implementation of interventions, self-reported heat stress and dehydration-associated symptoms decreased as follows: feeling feverish (40% to 10% [↓76%]), exhaustion (37% to 14% [↓62%]), nausea (35% to 12% [↓66%]), very dry mouth (49% to 26% [↓46%]), very little urine (37% to 19% [↓ 49%]), cramps (30% to 17% [↓45%]), diarrhea (14% to 0% [↓100%]), disorientation (12% to 0% [↓100%]), and fainting (4.7% to 2.4% [49%]) Rates of vomiting and dysuria were similar.	• Most of the interventions were consistent with the main interventions of the proposed standard (i.e., providing drinking water, and shaded rest breaks and a lunch break) • Ergonomic improvements were also implemented • Non-U.S. workers (El Salvador) in sugar cane industry
Kerstein et al. (1986) reported a [54%] decrease in heat illnesses in military reservists after an intervention.	• Military study • Intervention: A lecture on water as prevention, training on and use of portable WBGT monitors, and a special briefing for Commanding Officers
Stonehill and Keil (1961) reported the number of heat stroke cases and the number of troops in the summers of 1957 and 1958, before and after additional protective measures were implemented • The heat stroke rate in summer 1958 after implementing additional protective measures was [95%] lower [0.05/1,000 troops] than the summer before [0.87/1,000 troops]	• Military study • Intervention being tested: In addition to existing prevention measures, they added increased water and salt tablet availability, removing fatigue shirts inside classrooms, using WBGT to determine when to pause training, and avoiding intense outdoor training in the first week of training
Minard (1961) study of military recruits: • The rate of HRI after implementation of the program (12.4/10,000 recruits) was [77%] lower than before the program was implemented (53/10,000) recruits • The rate of HRI after enhanced interventions (4.7 per 10,000 recruits) was [62%] lower than the rate after initial interventions (12.4 per 10,000 recruits) and [91%] lower	• Military study • Examples of intervention measures: curtailing physical activity during high heat, modifications to uniforms, leadership training, curtailing physical activity based on WBGT, differentiating physical activity guidance for acclimatized versus unacclimatized recruits, conditioning recruits with substandard fitness, shade for outdoor classrooms,

than the period before the program (53/10,000).	cooling for indoor classrooms, modification of the clothing policy to allow for only t-shirts, light duty status for recently vaccinated recruits, one hour rest or classroom instruction after meals, better ventilation in barracks to improve sleep, and strategies to increase water and salt intake.

Numbers in brackets calculated and rounded by OSHA.

V. Governmental and Non-Governmental Organizations' Requirements and Recommendations.

A number of governmental and non-governmental organizations recommend or require heat injury and illness prevention programs or multiple controls to address risks related to occupational heat exposure. This shows that OSHA's proposal continues to reflect the growing consensus that HRIs can be avoided or minimized when employers address conditions that have been shown to increase the risk of HRI. OSHA's proposal also continues to reflect a consensus that, to be most effective, an HRI prevention program should incorporate multiple interventions.

A. Governmental Requirements and Recommendations.

As of April 2024, five States had heat injury and illness prevention standards, reflecting a recognition by these States that certain measures can reduce heat-related risks posed to workers. These standards have many of the same types of controls OSHA is proposing (e.g., a written heat safety plan, emergency response protocols, rest breaks, training on HRI recognition and prevention). For a more detailed discussion of existing State standards see Section III., Background. In addition, numerous States have published heat illness and injury prevention guidance for workers.

NIOSH has issued a number of guidance products and provided expert advice on heat injury and illness prevention and developed a programmatic approach to reduce the risks associated with heat for workers. For example, in 2016, NIOSH updated its *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments,*

first published in 1972 and updated in 1986, stating, “compliance with this recommended standard should prevent or greatly reduce the risk of adverse health effects to exposed workers.” NIOSH recommends that employers “establish and implement a written program to reduce exposures to or below the applicable RAL or REL” (which considers exposure to environmental heat and metabolic heat (i.e., work intensity) for unacclimatized and acclimatized employees, respectively) with engineering and work practice controls. Examples of engineering controls include ventilation to increase air movement, air-conditioning, screening, and insulation. Examples of administrative controls include rest breaks to decrease exposure time and metabolic heat loads, increasing distance from radiant sources, and implementing acclimatization protocols, health and safety training, medical screening for heat intolerance, and a heat alert program. If engineering and administrative controls do not reduce exposure below the applicable RAL or REL, NIOSH also recommends cooling clothing/PPE. NIOSH states, “the reduction of adverse health effects can be accomplished by the proper application of engineering and work practice controls, worker training and acclimatization, measurements and assessment of heat stress, medical monitoring, and proper use of heat-protective clothing and personal protective equipment (PPE)” (NIOSH, 2016).

In another example of NIOSH guidance, NIOSH investigated a number of heat-related workplace fatalities to assess the hazards and propose recommendations for preventing similar fatalities, as part of the Fatality Assessment and Control Evaluation (FACE) Program. In four heat fatality investigations that affected landscapers (NIOSH, 2015), farm workers (NIOSH, 2007), firefighters (NIOSH, 1997), and construction laborers (NIOSH, 2004), collective recommendations related to heat included: development, implementation and training on a safety and health program that is made available to all workers; providing rest breaks and accessible hydration; training workers and supervisors on recognizing HRI; providing prompt medical assistance for HRI;

monitoring of worker symptoms by supervisors; implementing acclimatization programs; informing workers of drinks (e.g., alcoholic) that can increase risk; having medical providers inform workers taking certain drugs or with certain medical conditions of their increased risk; and factoring in clothing and weather to determine firefighter workloads.

Additionally, there is a recognition amongst other Federal regulatory agencies that employers can implement control measures to reduce heat-related risks and harms. The Mine Safety and Health Administration (MSHA) first published heat guidance for mines in 1976, and most recently published "Heat Stress in Mining" which provides guidance on reducing heat stress (MSHA, 2012). The report states that a combination of engineering controls, administrative controls and work practices, and PPE can reduce heat and prevent employee's core temperatures from rising. MSHA recommendations include mine planning to provide cool rest areas, implementing exhaust ventilation and air-conditioning in mines, using canopies in the sun, using skillful blasting procedures to reduce excessive heat, using automation/remote controls to reduce metabolic heat, implementing work-rest regimens with frequent breaks, pacing work tasks, performing heavy tasks in cooler areas or at cooler times, rotating personnel through hot work tasks, providing readily accessible, cooler rest areas and drinking water, acclimatizing new and returning employees, and ensuring employees and supervisors are knowledgeable about heat related topics such as risk, prevention, and symptoms.

In 1993, the EPA published "A Guide to Heat Stress Management in Agriculture" to "help private and commercial applicators and agricultural employers protect their workers from heat illness" (EPA, 1993). The guide outlines the development of a basic program to control heat stress which includes: designating one person to manage the heat stress program; training workers and supervisors on heat illness prevention; acclimatizing workers when they begin to work under hot conditions; evaluating weather conditions, workload, necessary protective equipment or garments, and the physical condition of the

employee; managing work activities by setting up rest breaks, rotating tasks among workers, and scheduling heavy work for cooler hours; establishing a drinking water program; taking additional measures such as providing special cooling garments, shade or air-conditioned mobile equipment; and giving first aid when workers become ill (EPA, 1993).

In 2023, the U.S. Army updated its Training and Doctrine Command (TRADOC) Army Regulation 350–29 which "prescribes policy and provides guidance to commanders in preventing environmental (heat or cold) casualties." It includes requirements for rest in shade and water consumption according to specific WBGT levels and work intensity, and consideration of heat stress when planning training events (Department of the Army, June 15, 2023). In 2022, the U.S. Department of the Army issued the technical heat stress bulletin "TB MED 507: Heat Stress Control and Casualty Management" that contains measures to prevent indoor and outdoor HRIs in soldiers, with recommendations for acclimatization planning, work-rest cycles, fluid and electrolyte replacement, and cooling methods (e.g., shade, fans for prevention, and iced sheets and ice water immersion for treatment) (Department of the Army, April 12, 2022).

The U.S. Department of the Navy has published additional guidance on heat injury and illness prevention particular to naval conditions (Department of the Navy, 2023). When Navy personnel are "afloat", they use Physiological Heat Exposure Limits (PHEL) curves to manage heat stress based on exposure limits/stay times for acclimatized personnel under various conditions of environmental heat and work intensity. The PHEL curves were designed to allow core body temperature to rise to 102.2°F (39°C) among healthy and acclimatized individuals who have rested and recovered from prior heat exposures.

In 2023, the Heat Injury and Illness Prevention Work Group of the National Advisory Committee on Occupational Safety and Health (NACOSH) presented to OSHA

recommendations on potential elements of a proposed heat injury and illness prevention standard. The Work Group recommended that OSHA include the following measures in a potential standard: a written exposure control plan (heat illness prevention plan); training on heat illness prevention; environmental monitoring; provision of water, breaks, and shade or cool-down areas; other administrative controls (e.g., rotating workers through work tasks and implementing a communication system for regular check-ins); other engineering control measures (e.g., ventilation, exhaust fans, and portable cool-down mechanisms including fans, tents, shielding/insulation, proactive misting); workplace practice controls (e.g., providing coolers with ice and scheduling work during the coolest part of day); personal protective equipment; acclimatization procedures; worker participation in planning activities; and emergency response procedures (NACOSH, May 31, 2023).

B. National Non-Governmental Organizations.

ACGIH first recommended a standard for heat stress in 1971 (ACGIH, 2021), and most recently updated it in 2023 (ACGIH, 2023). The TLV is a value that is determined with the goal of maintaining thermal equilibrium for healthy acclimatized employees and is based on WBGT adjusted for work intensity and clothing/PPE. An action limit (AL) considers those same factors for unacclimatized employees. ACGIH recommends that whenever heat stress among workers is suspected (based on factors such as environmental conditions, work demands, work-rest patterns, and acclimatization states), employers have a Heat Stress Management Program (HSMP) that includes written plans for "General Controls" and as appropriate, "Job Specific Controls" (Table 5 of the Heat Stress and Strain section of the TLV Booklet). ACGIH states "The principal objective of a HSMP is the prevention of excessive heat strain among workers that may result in heat-related disorders." General controls include environmental surveillance, medical clearance and counseling by a healthcare provider, training, acclimatization planning,

fluid replacement, symptom monitoring, breaks in the shade, and an emergency response plan. Job specific controls include engineering controls (e.g., air movement, shade, radiant heat shields), administrative controls (e.g., limiting exposure time and allowing for enough recovery time), personal cooling, and physiological monitoring.

In 2024, the American National Standards Institute/American Society of Safety Professionals A10 Committee (ANSI/ASSP) released the American National Standard A10.50 Standard for Heat Stress Management in Construction and Demolition Operations. The voluntary consensus standard "establishes procedures for the management of heat stress hazards and the selection and use of appropriate controls and practices to reduce risks presented by heat stress and prevention of heat illnesses for all work environments." The standard recommends that employers develop and implement the following: heat stress management program; acclimatization plan; workplace surveillance/risk assessment; provision of water and sodium electrolyte supplements; provision of rest breaks and shaded break locations; buddy system; first aid and emergency action plan; medical surveillance; employee participation; implementation of heat stress controls including engineering controls such as air-conditioning, radiant heat control (barrier), convection controls (cooling), evaporative controls such as misting fans, and metabolic controls (e.g., mechanical equipment or tools to reduce metabolic demands of work tasks); administrative controls such as scheduling for cooler times and allowing self-paced work; personal protective equipment; and training on heat illness prevention (ANSI/ASSP, 2024). More specific recommendations (e.g., frequency of rest breaks; monitoring employees) are provided when certain triggers are exceeded.

In 2021, the American Society for Testing and Materials (ASTM) finalized its Standard Guide for Managing Heat Stress and Heat Strain in Foundries (E3279-21) which establishes "best practices for recognizing and managing occupational heat stress and heat strain in foundry environments." The standard outlines employer responsibilities

and recommends elements for a 'Heat Stress and Heat Strain Management Program.' Employer responsibilities include evaluating temperature and issuing heat alerts; ensuring control measures are in place; and reviewing heat exposure incidents to implement corrective actions. Program elements include worker preparation (i.e., only assigning workers to tasks involving heat exposure "who are prepared for work in those environments and can tolerate the heat exposure associated with the assignments") and workplace and work preparation (i.e., implementing controls that reduce heat stress through process heat emission control and ventilation of work areas, adjusting work schedules, providing heat relief crews (e.g., crew rotation), providing personal protective equipment, employing personal and portable cooling devices, providing readily available water, and providing cooled location for work break) (ASTM, 2021). The standard also recommends employers and workers monitor heat strain and establish emergency response protocols.

C. Conclusion on Governmental and Non-Governmental Recommendations.

In closing, a number of governmental and non-governmental groups have either promulgated regulations or published recommendations for protecting workers from HRI. Many of those regulations or recommendations contain components that are consistent with protections in the proposed rule, including plans to prevent heat stress, rest breaks in shaded or cooled areas, cool drinking water, ventilation or cooling methods (e.g., fans exhaust), acclimatization, observation of symptoms in workers, environmental monitoring, and emergency response procedures. Many of these protections have been recognized for decades as being effective in reducing the risk of HRI in workers. This shows that OSHA's proposal continues to reflect the growing consensus that HRIs can be avoided or minimized when employers address conditions that have been shown to increase the risk of HRI and incorporate these protections as part of a program that is tailored to each workplace.

VI. Conclusion.

OSHA reviewed a number of studies that provided quantitative evidence of the effectiveness of multi-component interventions in reducing heat-related illness or HRI; the results of those studies are summarized in table V-3 above. Studies among Texas municipality employees show that a multi-component intervention approach reduced HRI claims by 37 to 96 percent compared to pre-intervention levels, depending on the period of intervention and the types of interventions applied (McCarthy et al., 2019; Perkison et al., 2024). Implementation of multi-component interventions in military studies resulted in slightly lower reductions in HRI from pre- to post-intervention (54–95 percent), again depending on the types of interventions applied in different implementation periods (Kerstein et al., 1986; Minard, 1961; Stonehill and Keil, 1961).

OSHA acknowledges that several of the interventions implemented among the Texas municipality employees and military personnel differ from the interventions in the proposed standard. However, interventions focusing on water, rest, and shade among sugar cane employees in El Salvador resulted in similar reductions for several common (i.e., occurring in 30% or more of employees pre-intervention) symptoms of heat-related illness (e.g., 45% reduction in cramps, 46% reduction in very dry mouth, 49% reduction in very little urine, 62% reduction for exhaustion, 66% reduction for nausea, 76% reduction for feeling feverish) (Bodin et al., 2016; communication with David Wegman, November 2023). Because of the small number of workers completing the study (n=41), results regarding less common symptoms (reported in less than 15% of workers pre-intervention) are more uncertain, but Bodin et al. reported a decrease in fainting and no incidents of diarrhea or disorientation after the interventions were implemented. Therefore, the study by Bodin et al. (2016) supports the finding that a multi-intervention approach that includes several interventions in common with the proposed standard is likely to result in substantial reductions in HRI symptoms.

Despite several limitations that were acknowledged for these multi-intervention studies, the results for all are of a large magnitude and consistently show effectiveness for multi-component interventions in preventing HRIs. In addition, the results are mechanistically supported by experimental studies showing the effectiveness of individual interventions in preventing signs and symptoms related to heat strain. OSHA finds the studies looking at multi-component approaches to be more relevant for looking at quantitative reductions in HRI because each individual component would contribute to the overall effect.

In addition to studies showing effectiveness of multi-component interventions in preventing HRIs, two studies also show that effective treatments are available to prevent death if heat stroke does occur. As reported in more detail under the *Explanation of Proposed Requirements for paragraph* (g)(3), *Heat illness and emergency response and planning,* studies examining the effectiveness of treating individuals suffering from exertional heat stroke reported 99.8% survival in military personnel treated with ice sheets (bed sheets soaked in water) (DeGroot et al., 2023) and 100% survival in marathon runners doused with cold water and massaged with ice bags (McDermott et al., 2009a).

OSHA preliminarily finds that the totality of the evidence reviewed supports that the approach outlined in the proposed standard, which consists of a heat injury and illness prevention plan and the application of multiple control measures, will result in a substantial reduction in HRIs (range: 37-96%) and heat-related fatalities (range: 99.8-100%) in employees who would be covered under the proposed standard.

VII. Requests for Comments.

For the controls proposed, OSHA requests information and comment on the following questions and requests that stakeholders provide any relevant data, information, or additional studies (or citations) supporting their view, and explain the reasoning or recommendations for including such studies:

- OSHA recognizes that a number of States (e.g., California, Oregon, Washington) have implemented standards to prevent HRIs and heat-related fatalities among workers. OSHA is aware that there are existing and emerging data on the efficacy of the State standards in preventing and reducing HRIs and heat-related fatalities. OSHA welcomes proposed analytical methods or analyses of existing data (see e.g., discussion in V.A., Risk Assessment of existing data sources, www.dir.ca.gov/dosh/reports/State-OSHA-Annual-Report-(SOAR)-FY-2022.pdf) or unpublished data that may be used to estimate the effects of these State standards on heat-related injury, illness, and fatality rates among workers. OSHA is also interested in comments on how to account for the differences (some of which are significant) between the State standards and OSHA's proposed standard in estimating efficacy of OSHA's proposed standard. Are there studies, data, or other evidence that demonstrate the efficacy of and/or describe employers' or workers' experiences with these heat-specific State standards?
- Has OSHA adequately identified and documented the studies and other information relevant to its conclusion regarding the effectiveness of these controls in reducing heat strain and the risk of HRIs, and are there additional studies OSHA should consider?
- Are there additional studies or evidence available that identify appropriate frequencies and durations of rest breaks for reducing heat strain and risk of HRIs?
- Are OSHA's conclusions about the effectiveness of controls in preventing HRI reasonable?

VI. Significance of Risk

As explained in Section II., Pertinent Legal Authority, prior to the issuance of a new standard, OSHA must make a threshold finding that a significant risk of material harm exists, and that issuance of the new standard will substantially reduce that risk.

In Section IV., Health Effects, OSHA presents data and information demonstrating the range of heat-related injuries and illnesses (HRIs) that can be caused by occupational exposure to heat. This discussion demonstrates that HRIs often result in material harm, as they are potentially disabling, can result in lost work time, require medical treatment or restricted work, and in certain cases, can lead to death. In Section V., Risk Assessment, OSHA presents the best available evidence on the risk of incurring these heat-related material health impairments among workers in the U.S., which clearly demonstrates that there exists a significant risk of material harm to workers from occupational exposure to heat. As OSHA's analysis of BLS data shows, there was an average of 40 heat-related deaths (2011-2022) and 3,389 HRIs involving days away from work (2011-2020) among U.S. workers per year. Additionally, based on OSHA's review of workers' compensation claim data, OSHA found that workers in sectors and industries where they are likely exposed to heat in their job (and therefore are more likely to be covered by this standard) have far higher estimated incidence of HRI than the national average, indicating that the risk to heat-exposed workers is much higher than nationwide data suggests. Furthermore, both the annual and working lifetime incidence rates underestimate the true risk for heat-exposed workers given underreporting of workplace injuries and illnesses. Thus, as explained in sections A and B below, OSHA preliminarily determines that a significant risk of material harm from occupational exposure to hazardous heat exists, and issuance of this standard would substantially reduce that risk.

A. Material Harm.

As discussed in Section IV., Health Effects, the risks posed by exposure to workplace heat hazards are significant and can result in serious HRIs or even death. As discussed in Section IV.B., General Mechanisms of Heat-Related Health Effects, heat stress can result in increased core body temperature and blood flow being shunted towards the skin and away from major organs (e.g., brain, liver, kidneys) and muscles.

Sweating, which is a healthy and normal response to heat stress, can also contribute to a reduction in circulating blood volume if fluids are not adequately replaced. This increase in core body temperature and reduced blood flow can lead to health effects like heat stroke, heat exhaustion, heat syncope, and rhabdomyolysis. If not treated promptly, heat stroke can cause permanent organ damage and lead to death. Treatment often requires hospitalization and time away from work (see discussion in Section IV.E., Heat Stroke). Other health effects, such as heat exhaustion, may also require time away from work if recommended by a medical professional. Many heat-related health effects, such as heat cramps and heat exhaustion, can impair a worker's functional capacity while on the job. Heat syncope can pose additional dangers to workers if they are in precarious work environments, such as on rooftops or while operating machinery. Heat exhaustion can also rapidly progress to heat stroke if not recognized and treated early. As discussed in Section IV.P., Heat-Related Injuries, heat-induced impairments in functional capacity on the job can lead to traumatic injuries, which are more likely to occur on hot days.

The studies that OSHA relied on in Section V.A., Risk Assessment leverage data from multiple surveillance databases (e.g., BLS SOII, workers' compensation claims databases, and hospital discharge data) that have inclusion criteria that OSHA preliminarily concludes would clearly indicate that captured cases of HRIs represent material impairment of health. For example, the estimated number of work-related HRIs reported in the BLS SOII capture only those that involved days away from work (Note: For 2021-2022 biennial data, SOII additionally reports cases involving job restriction or transfer). Similarly, hospital discharge datasets would represent only cases that involved an emergency department visit and/or inpatient hospitalization. While workers' compensation eligibility varies, all of the claims would involve either a visit with a medical professional and/or lost worktime. HRIs resulting in lost work time and/or the need for medical care beyond first aid clearly constitute material harm.

However, HRIs constituting material harm are not limited to those rising to the level of lost work time and/or the need to seek care from a medical professional. Based on the evidence discussed in this and other sections of this preamble, OSHA has preliminarily concluded that many of the HRIs associated with workplace exposure to heat hazards constitute material harm, even if they are not captured in the databases OSHA relied on in its risk assessment. OSHA recognizes that many of these HRIs may be reversible, particularly if early intervention is provided. Nonetheless, OSHA presents evidence in Section IV., Health Effects that these HRIs can be debilitating. In addition to lost work time and the need for treatment by a medical professional, HRIs can cause reduction or loss of the worker's normal functional capacity in work tasks and loss of productivity. Additionally, where preventive action or early treatment is not provided, these disorders can rapidly progress to more serious conditions, and have the potential to result in permanent damage to organs, causing short-, medium-, and long-term health effects, or death. Thus, while some of the health effects OSHA has identified may not rise to the level of material harm in all cases, the agency believes that each can be material in severe cases.

B. Significant Risk.

Peer-reviewed studies and State or national statistics are available to demonstrate the high incidence of work-related HRIs occurring among workers exposed to heat hazards at work. Estimates of the risk of harm confronting exposed workers can be based directly on the rates of work-related HRIs currently being reported.

In Section V.A., Risk Assessment, of this preamble, OSHA evaluated the risk to workers of a heat-related injury, illness, or fatality. OSHA's analysis of BLS data indicated an annual average of 40 heat-related deaths (2011-2022) and 3,389 HRIs involving days away from work (2011-2020) among U.S. workers. These annual heat-related death and HRI numbers alone clearly constitute a significant risk and are in line

with OSHA's significant risk findings in previous safety standards (see, e.g., Confined Spaces in Construction, 80 FR 25366, 25371 (May 4, 2014); Electric Power Generation, Transmission, and Distribution; Electrical Protective Equipment, 79 FR 20316, 20321-20322 (April 11, 2014); Cranes and Derricks in Construction, 75 FR 47906, 47913 (Aug. 9, 2010)). However, as discussed in Section V.A., Risk Assessment, many of the sources that OSHA reviewed reported HRI data in terms of incidence rates, and OSHA has considered these rates in assessing significant risk, to the extent they capture populations that are actually exposed to hazardous occupational heat.

Unfortunately, the available data is insufficient to precisely estimate the risk to only workers who are exposed to hazardous occupational heat. But by examining incidence estimates derived from various datasets, including State workers' compensation systems, OSHA was able to determine a range of HRI incidence rates among workplaces where employees are likely to be exposed to heat in their job. In Section V.A., Risk Assessment, OSHA identified various sector incidence estimates of HRI over a working lifetime (i.e., 45 years), including: 234 to 1,737 cases per 100,000 workers in agriculture, forestry, fishing, and hunting; 63 to 545 cases per 100,000 workers in construction; 131 to 396 cases per 100,000 workers in administrative and support and waste management and remediation services; 49.5 to 171 cases per 100,000 workers in transportation and warehousing; and 513 cases per 100,000 workers in utilities, among others. The working lifetime incident rates were even higher in specific industries, such as an estimated 3,479 cases of HRI per 100,000 workers for farm labor contractors and crew leaders and 2,439 cases per 100,000 structural steel and precast concrete workers over a working lifetime of 45 years (see Section V. A., Risk Assessment, table V-1). OSHA preliminarily concludes that these incidence rates, though as explained below substantially underestimate actual risk, are the best available evidence and sufficient to make a finding of significant risk of HRIs among workers who are exposed to occupational heat.

While the data are not sufficient to develop a single point estimate of the risk posed to heat-exposed workers, OSHA has preliminarily determined that the available data from BLS and workers' compensation claims support an estimate of working lifetime risk of HRI ranging from 135 cases per 100,000 workers (calculated based on the BLS average estimated annual incidence of HRIs for all workers for 2011-2020) to 3,479 cases per 100,000 workers (based on workers' compensation claims). Even the lowest estimate within this range exceeds the 1/1000 threshold that OSHA has historically found to clearly constitute a significant risk.

As noted above, OSHA believes that these data from BLS and workers' compensation claims substantially understate the true risk to workers. For one, the inclusion criteria for the surveillance systems used to estimate incidence would exclude a large proportion of HRI cases. For instance, prior to this year, the BLS SOII only reported the estimated number of HRIs that involved days away from work, which may be less than 50% of all OSHA-recordable work-related HRIs (see, e.g., BLS, IIF Latest Numbers for 2022, *https://www.bls.gov/iif/latest-numbers.htm*). Additionally, the majority of incidence estimates identified by OSHA are based on the risk of HRIs confronting an entire working population (e.g., all workers in a particular industry or sector), both exposed and non-exposed. Clearly, the risk of experiencing a work-related HRI is considerably higher among the subset of workers exposed to heat hazards in their jobs than it is for the rest of the working population. For example, the annual BLS incidence estimates are susceptible to understating risk in this way because when BLS calculates annual incidence estimates, it captures the entire U.S. workforce in the denominator, which includes a large number of unexposed workers (e.g., office workers in climate-controlled buildings). Consequently, the working lifetime risk of HRI estimate based on BLS's annual incidence estimates (i.e., 135 cases per 100,000 workers), also substantially underestimates the true risk for heat-exposed workers. There is also a large

body of literature demonstrating the general underreporting of work-related injuries and illnesses, the findings of which OSHA believes would also apply to HRIs. See Section V.A., Risk Assessment, for additional discussion of underreporting of heat-related fatalities and HRIs.

As discussed in Section V.C., Risk Reduction, dozens of peer-reviewed studies and multiple authoritative bodies (e.g., NIOSH, ACGIH, ANSI/ASSP) indicate that the provisions outlined in this proposed rule would, if promulgated, substantially reduce risk to workers. A large body of data demonstrates that workplace interventions—such as rest breaks, cool drinking water, acclimatization, shade, and fans—can be very effective in reducing heat strain, which is responsible for causing HRIs. This reduction in heat strain and/or reduction in HRI risk has been shown in studies that have examined the impact of interventions in an experimental setting, as well as studies that have documented reductions in HRI prevalence following the implementation of heat injury and illness prevention measures. OSHA preliminarily concludes that implementation of the proposed standard will result in a substantial reduction in HRIs (range of estimates: 37-96%) and heat-related fatalities (range of estimates: 99.8-100%) in employees who would be covered under the proposed standard.

C. Preliminary Conclusions.

OSHA preliminarily concludes that HRIs associated with workplace exposure to heat hazards constitute material harm. Further, based on the evidence discussed in this section, the agency preliminarily concludes that heat-exposed workers are at significant risk of experiencing a work-related HRI or heat-related death, and compliance with the proposed standard would substantially reduce that risk.

VII. Explanation of Proposed Requirements

A. Paragraph (a) Scope and application.

Paragraph (a) establishes the scope of the proposed standard. Paragraph (a)(1) would require all employers subject to OSHA's jurisdiction—including general industry, construction, maritime, and agriculture—to comply with the proposed requirements, subject to the exemptions in proposed paragraphs (a)(2) and (3). The scope of the proposed standard applies to a wide range of sectors that include both indoor and outdoor work areas. The proposed standard aims to provide protections while accounting for the different work areas, anticipated exposures, and other conditions in these sectors.

Paragraph (a)(2) describes the exemptions for the proposed standard based on work activities. Employers would be responsible for determining which work activities are covered by the standard. Although an employer may have some work activities exempt from the proposed standard, other activities may be covered (except for organizations whose primary function is the performance of firefighting. See the discussion of paragraph (a)(2)(iii) below). Under paragraph (a)(3), if an employer's employees exclusively perform the work activities in paragraphs (a)(2)(i) through (vi), then that employer would be exempt from this proposed standard.

Paragraph (a)(2)(i) would exclude work activities for which there is no reasonable expectation of exposure at or above the initial heat trigger. This exception recognizes that some workplaces would not reasonably be expected to reach or exceed the initial heat trigger (e.g., because of their location and/or seasonal variations in temperature). This exclusion may apply to work activities such as operating seasonal businesses outdoors (e.g., during winter months), when temperatures are lower than the initial heat trigger. For instance, if a business that exclusively operates an outdoor holiday market during the winter season in a location where daily high temperatures are always below the initial heat trigger, this standard would not apply to work activities performed at that market.

Paragraph (a)(2)(ii) would exclude short duration employee exposures at or above the initial heat trigger of 15 minutes or less in any 60-minute period. OSHA has

preliminarily concluded that intermittent exposures within this duration are not likely to significantly raise core body temperature and result in heat-related injuries and illnesses (HRIs). Numerous studies (many described in Section V.C., Risk Reduction) evaluated the effect of hotter temperatures on participants' core body temperatures under various scenarios (e.g., clothing type, level of activity, work/rest periods, acclimatization status) of different durations. Overall, evidence suggests that heat exposure of 15 minutes or less does not tend to cause an elevation of at least 1°C (1.8°F) in participants' core body temperatures, which would be indicative of potential heat stress (McLellan & Selkirk, 2006; Meade et al., 2016b; Lamarche et al., 2017; Seo et al., 2019; Kaltsatou et al., 2020; Notley et al., 2022a; Notley et al., 2022b).

This exemption recognizes that while typical work activities may take place below the initial heat trigger, employees may experience short exposures to heat at various times during their shift. For example, an employer who is otherwise exempt from the standard but has employees who occasionally walk to collect mail outside in temperatures at or above the initial heat trigger for 15 minutes or less in any 60-minute period, would still be exempt. This exemption is consistent with the scope exemptions of Colorado, Washington, and Oregon's State standards (7 Colo. Code Regs. section 1103-15:3 (2023); Wash. Admin. Code 296-307-09710 (2023); Or. Admin. R. 437-002-0156 (2024)).

In addition, in order for this exemption to apply for employees whose work activities are primarily performed in air-conditioned vehicles, employers must ensure employees are not exposed to temperatures at or above the initial heat trigger for more than 15 minutes in any 60-minute period. For instance, where an employee who drives an air-conditioned vehicle repeatedly exits the vehicle to deliver product in temperatures at or above the initial heat trigger, this activity would only be exempt from the standard if cumulative exposure in any 60-minute period at or above the initial heat trigger is for 15

minutes or less. If delivery tasks, such as unloading product from the vehicle and moving product to its destination, occur at or above the initial heat trigger for more than 15 minutes in any 60-minute period, these work activities would be covered by the standard.

Paragraph (a)(2)(iii) would exclude organizations whose primary function is the performance of firefighting. It would also exclude emergency response activities of workplace emergency response teams, emergency medical services (EMS), or technical search and rescue[4]; and any emergency response activities already covered under 29 CFR 1910.120, 1910.146, 1910.156, part 1915, subpart P, 1926.65, and 1926.1211. Fire departments, workplace emergency response teams, EMS, and technical search and rescue are covered by OSHA's proposed Emergency Response standard (89 FR 7774, Feb. 5, 2024), which would replace the existing Fire Brigades standard, 29 CFR 1910.156. The update to 29 CFR 1910.156 would expand coverage from only fire brigades, industrial fire departments, and private or contractual type fire departments, to include protections for all employees who perform firefighting, EMS, or technical search and rescue, as part of their regularly assigned duties as well as employees who are members of a workplace emergency response team. If the Emergency Response standard is finalized before this proposed standard, OSHA intends to revise this exemption to reflect the updated 29 CFR 1910.156.

The exemption would apply to all activities (including, e.g., training activities) at organizations whose primary function is the performance of firefighting. In order to comply with the proposed updates to 29 CFR 1910.156, firefighting organizations would have programs in place that address heat-related hazards for their employees.

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[4] "Technical search and rescue" refers to a type of emergency service that utilizes special knowledge and skills and specialized equipment to resolve unique or complex search and rescue situations, such as rope rescue, vehicle/machinery rescue, structural collapse, trenches, and technical water rescue. OSHA intends the phrase to have the same meaning as used in the proposed Emergency Response standard (see 89 FR 7804).

For employers with employees who perform emergency response activities as members of workplace emergency response teams (i.e., groups of employees who prepare for and respond to emergency incidents at their workplace as a collateral duty to their regular daily work assignments; see 89 FR at 7803), or who perform emergency medical services or technical search and rescue, this exemption would only apply when employees are performing emergency response activities. This means during periods while these employees are performing other duties unrelated to emergency response, employers would be required to comply with the provisions of the standard, unless subject to another exemption. For example, employees who are part of a manufacturing plant's emergency response team would be exempt from the standard while responding to an incident, such as a medical emergency, but would be covered by the standard when performing their regular daily work assignments. All other employees not engaged in emergency response would also be covered by this proposed standard. Although OSHA is proposing to exempt fire departments entirely, the agency is not proposing to entirely exempt organizations that have employees who perform EMS or technical search and rescue. This is because many organizations who perform EMS (e.g., hospitals) or technical search and rescue also conduct many other activities unrelated to emergency response and OSHA intends these other activities to be covered by this proposed standard unless another exemption applies.

The Emergency Response proposal includes several hazard assessment and risk management requirements that would encompass heat hazards faced by emergency responders (see 89 FR at 7813-7814). Further, in the NPRM for Emergency Response, OSHA noted this rulemaking on heat illness prevention and invited comment on whether the agency should include specific requirements related to heat for some non-emergency activities of emergency responders. At the same time, the agency recognized that at times emergency responders must perform their duties regardless of environmental conditions

(89 FR at 7801). OSHA has preliminarily concluded that it is appropriate to address any heat-related hazards posed by emergency response activities in this separate rulemaking.

This proposed standard would also not apply to employees when they are undertaking emergency response activities under 29 CFR 1910.120, 1910.146, 1910.156, subpart P, 1926.65, and 1926.1211. Many of these standards provide employees protection from heat exposure during emergency activities. In addition, OSHA believes that the emergency nature of these activities warrant special consideration and the agency is therefore exempting them from this proposed standard. However, this proposed standard would otherwise apply to these employees during non-emergency regular operations unless another exemption applies. For example, with regard to the Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) (29 CFR 1910.120 and 1926.65), which covers employees who are exposed or potentially exposed to hazardous substances and engaged in one of the operations as specified by 29 CFR 1910.120(a)(1)(i) through (v) and 1926.65(a)(1)(i) through (v), such as clean-up operations, employees would only be exempt when responding to emergency situations and would be covered by the standard when participating in general hazardous waste operations.

Paragraph (a)(2)(iv) would exclude work activities performed in indoor work areas or vehicles where air-conditioning consistently keeps the ambient temperature below 80°F. OSHA specifies using ambient temperature, as most heating, ventilation, and air-conditioning (HVAC) systems automatically report ambient temperature. Properly functioning HVAC units also regulate indoor humidity levels, which would result in similar measures of ambient temperature and heat index.

This exemption would only apply to indoor work areas and vehicles that are consistently below an ambient temperature of 80°F. The employer must ensure that the air-conditioning system consistently maintains an ambient temperature below 80°F

during work activities for the exemption to apply. OSHA recognizes that there may be unexpected malfunctions of air-conditioning systems that result in periods of time without air-conditioning before a system is repaired. In these situations, OSHA would expect that the employer takes steps to expeditiously repair the air-conditioning system and return the workplace to an ambient temperature below 80°F.

Paragraph (a)(2)(v) would exclude telework (i.e., work done from home or another remote location of the employee's choosing). OSHA generally does not hold employers liable for employees' home offices and conditions of the telework environment (see CPL 02-00-125, available at *https://www.osha.gov/enforcement/directives/cpl-02-00-125*). However, only the work activities employees perform while teleworking would be exempt and employers would be required to comply with the standard when employees are on site if other exemptions do not apply. For example, the standard would not cover work activities conducted at an employee's home on Tuesdays and Thursdays in a given week but would cover the employee's work activities at their employer's office on Mondays, Wednesdays, and Fridays (unless another exemption applies).

Paragraph (a)(2)(vi) would exclude sedentary work activities at indoor work areas that only involve some combination of the following: sitting, occasional standing and walking for brief periods of time, and occasional lifting of objects weighing less than 10 pounds. The exemption is intended to apply to work sites such as offices where employees perform sedentary work activities for extended periods of time (e.g., all or most of the workday). This exemption only applies to indoor work activities, which are not generally subject to factors such as solar radiation, which are common in outdoor exposures. OSHA preliminarily concludes that employees engaged in indoor sedentary work activities are at lower risk of heat-related injury and illness, as production of metabolic heat is not substantially elevated. Experimental studies of groups exposed to

heat (111.4°F (44°C), 30% relative humidity) while resting in a seated position indicate core body temperature does not rise more than 1°C (1.8°F) over multiple hours (Kenny et al., 2017; Notley et al., 2020). In addition to sitting, the exemption allows for indoor work activities to include occasional standing and walking for brief periods of time, and occasional lifting of objects weighing less than 10 pounds. When using the term "occasional" OSHA means up to one-third of the workday (BLS, 2021), however these activities could only be performed for brief periods of time over the course of the day for the exemption to apply. For example, work activities performed at a desk indoors, where the employee is seated and performing computer work for the majority of their shift, but with occasional standing, as well as walking short distances (e.g., to use the photocopier, to collect office mail), would be exempt from the standard.

In addition, this exemption would apply to indoor operation of vehicles while seated. For example, operation of a forklift inside of a warehouse while seated would be considered an indoor sedentary work activity and would be exempt. However, if a forklift operator's duties involved loading and unloading heavy objects (greater than 10 pounds), they would not be exempt from the standard. Other examples of activities that would be exempt include indoor operation of reach trucks, tow trucks, pallet trucks, golf carts, and other vehicles where employees are seated.

This exemption would apply where employees are engaged in sedentary work activities regardless of indoor temperature. While employees performing these activities are likely at lower risk of experiencing heat-related injury and illness, OSHA seeks comment as to whether the sedentary work activities exemption should be limited to work activities performed in indoor environments below a specified threshold temperature (e.g., the high heat trigger) or whether this exemption should account for certain workplace conditions. For example, should this exemption cover an employer

with employees who meet the criteria in this proposed exemption, but whose work area is near a heat generating process and impacted by radiant heat?

Paragraph (a)(3) specifies that employers whose employees all exclusively perform activities described in paragraphs (a)(2)(i) through (vi) are exempt from this standard. Employers may have employees who would be exempt from the standard (e.g., employees working indoors where air-conditioning consistently keeps the ambient temperature below 80°F), as well as employees who would be covered by the standard (e.g., employees harvesting produce outdoors). These employers would be required to comply with the provisions of the standard for the employees who perform work activities that are covered by the standard. However, some employers may only have employees that exclusively perform work activities that are exempt from the proposed standard. For example, an employer with employees who all either telework from home or other locations of their choosing or work inside a building with air-conditioning that consistently keeps the ambient temperature below 80°F would be exempt from the standard.

I. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether any of the proposed exclusions of emergency response activities already covered under the standards listed in proposed paragraph (a)(2)(iii) should be covered by this proposed standard. If so, provide evidence and describe reason for why these activities should not be excluded;
- Where an employer relies on the exemption in proposed paragraph (a)(2)(iv) to exclude work activities performed in indoor work areas or vehicles where air-conditioning consistently keeps the ambient temperature below 80°F, whether the standard should address situations where the air-conditioning system does not function properly and the ambient temperature reaches or exceeds 80°F; for

example, should certain requirements of the standard apply in this scenario? Additionally, whether the standard should specify how long the air-conditioning system can be out of order before the exemption no longer applies;

- Whether the description of sedentary work in the proposed standard is appropriate, and if not, what revisions would be appropriate;
- Whether the standard should exempt all sedentary work activities indoors or limit the exemption to only activities performed below an upper limit (e.g., below the high heat trigger) at or above which the exemption would no longer apply, and if so, what the upper limit should be and what evidence exists demonstrating that even sedentary work performed indoors can be a hazard to workers at or above that limit; and
- Whether the exemption for sedentary work activities should be expanded to include work performed outdoors.

B. Paragraph (b) Definitions.

Paragraph (b) defines several terms used in the proposed standard. First, it defines *Acclimatization* to mean the body's adaptation to work in the heat as a person is exposed to heat gradually over time, which reduces the strain caused by heat stress and enables a person to work with less chance of heat illness or injury.

Section V.C., Risk Reduction contains more information on effectiveness of acclimatization. This definition is included because paragraph (e)(7) of the proposed standard establishes requirements to protect new and returning employees who are not acclimatized. Proposed paragraph (e)(7) requires that employers implement one of two acclimatization protocols for new and returning employees when the initial heat trigger is met or exceeded. Under paragraph (j), employers must implement acclimatization protocols at no cost to the employee. In addition, proposed paragraph (h)(1)(iii) requires that employees be trained that lack of acclimatization is a risk factor for HRI.

Ambient temperature means the temperature of the air surrounding a body. Other terms for ambient temperature include "air temperature" or "dry bulb temperature." Ambient temperature is measured by a standard thermometer and often what people refer to when using the term "temperature." Ambient temperature is defined because it is used in the definitions for *heat index* and *wet bulb globe temperature,* in addition to proposed paragraphs *(a) Scope and application, (d) Identifying heat hazards, (e) Requirements at or above the initial heat trigger,* and *(f) Requirements at or above the high heat trigger*.

Cooling personal protective equipment (PPE) means equipment that is worn to protect the user against heat-related injury or illness. This definition is included to clarify the requirement under proposed paragraph (e)(1) that if the employer provides employees with cooling PPE, the cooling properties must be maintained during use.

Cooling PPE is gear designed to help maintain a safe body temperature for individuals working in hot environments or engaged in physically demanding activities. Cooling PPE typically employs various technologies to facilitate heat dissipation and enhance comfort, such as water absorption crystals or phase change materials (PCM) which draw heat away from the wearer. Cooling bandanas and neck wraps are worn around the neck and can be soaked in cold water. Additionally, other types of clothing may incorporate materials that have cooling properties.

Heat index means the National Weather Service heat index, which combines ambient temperature and humidity. It provides a number that can be used to indicate how hot it feels. There are several tools for measuring heat index in both indoor and outdoor work areas. For outdoor work areas, the OSHA – NIOSH Heat Safety Tool app and other phone-based weather apps can be used to show the heat index by location as well as hourly forecasts. For indoor work areas, employers can enter measurements of humidity and ambient temperature into the NOAA Heat Index Calculator. There are also monitoring devices that report heat index. *Heat index* is defined because the term is used

in definitions of *high heat trigger* and *initial heat trigger.* The term is also used in proposed paragraphs *(c) Heat injury and illness prevention plan, (d) Identifying heat hazards,* and *(e) Requirements at or above the initial heat trigger.*

High heat trigger means a heat index of 90°F or a wet bulb globe temperature (WBGT) equal to the NIOSH Recommended Exposure Limit. See explanations for the definitions of *wet bulb globe temperature (WBGT)* and *Recommended Exposure Limit (REL)* for more information about those terms. OSHA is including a definition for high heat trigger because exposures at or above the high heat trigger would require the implementation of a number of controls, in addition to the controls that would be implemented under the initial heat trigger in proposed paragraph (e). The controls implemented under the initial heat trigger are described below under the definition for *Initial Heat Trigger*. The additional controls that would be implemented under the high heat trigger under proposed paragraph (f) include required rest breaks, observation for signs and symptoms, hazard alerts, and warning signs for excessively high heat areas. See Section VII.F., Explanation of Proposed Requirements for more information on these controls. The scientific basis supporting the establishment of the high heat trigger at a heat index of 90°F or a WBGT equal to the NIOSH REL is explained in in Section V.B., Basis for Initial and High Heat Triggers.

Indoor/indoors means an area under a ceiling or overhead covering that restricts airflow and has along its entire perimeter walls, doors, windows, dividers, or other physical barriers that restrict airflow, whether open or closed. Possible examples for indoors include work in a garage, even if the garage door is open; the interior of a warehouse, even if multiple doors are open on loading docks; and a shed with four walls and a ceiling, even if the windows are open. Construction activity is considered to be work in an indoor environment when performed inside a structure after the outside walls and roof are erected. This definition is included because the term is used in definitions for

outdoor/outdoors, and proposed paragraphs *(a) Scope and application, (d) Identifying heat hazards, (e) Requirements at or above the initial heat trigger, (f) Requirements at or above the high heat trigger,* and *(i) Recordkeeping.*

Initial heat trigger means a heat index of 80°F or a WBGT equal to the NIOSH Recommended Alert Limit (RAL). See explanations for the definitions of *wet bulb globe temperature (WBGT)* and *Recommended Alert Limit (RAL)* for more information about those terms. OSHA is including a definition for *initial heat trigger* because exposures at or above the initial heat trigger would require the implementation of a number of controls under proposed paragraph (e), including requirements for drinking water, break area(s) for indoor and outdoor work sites, indoor work area controls, acclimatization of new and returning employees, rest breaks if needed to prevent overheating, effective communication, and maintenance of PPE cooling properties if PPE is provided. See Section VII.E., Explanation of Proposed Requirements for more information on these controls. The scientific basis supporting the establishment of the initial heat trigger at a heat index of 80°F or a wet bulb globe temperature (WBGT) equal to the NIOSH RAL is explained in detail in Section V.B., Basis for Initial and High Heat Triggers.

Outdoor/outdoors means an area that is not indoors, as defined above. The definition also specifies that vehicles operated outdoors are considered outdoor work areas for purposes of this standard unless exempted by paragraph (a)(2). Examples of outdoor work include tasks performed in agricultural fields and under canopies and pavilions. This term is defined because it is used in proposed paragraphs *(d) Identifying heat hazards, (e) Requirements at or above the initial heat trigger,* and *(h) Training.*

Radiant heat means heat transferred by electromagnetic waves between surfaces. This definition further notes that sources of radiant heat include the sun, hot objects, hot liquids, hot surfaces, and fire.

Radiant heat is transferred from a hotter object to a cooler object. The transfer of radiant heat can occur across distances and does not require objects to touch each other. Infrared radiation is a common source of radiant heat that is encountered in foundries, and in iron, steel, and glass industries (NIOSH, 2016). Sources of exposure to radiant heat in the workplace can include furnaces, ovens, and combustion. *Radiant heat* is defined because it is included in the definition for *wet bulb globe temperature (WBGT)* and is used in paragraph *(e) Requirements at or above the initial heat trigger.*

Recommended Alert Limit (RAL) means the NIOSH-recommended heat stress alert limits for unacclimatized workers. OSHA is proposing to incorporate by reference NIOSH Publication No. 2016-106 Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments (NIOSH, 2016). OSHA is including a definition for RAL because the initial heat trigger incorporates the NIOSH RAL. Thus, several provisions of the standard are triggered by either a heat index of 80°F or a wet bulb globe temperature (WBGT) equal to the NIOSH RAL. See *Explanation of Proposed Requirements* for *Definitions (initial heat trigger, wet bulb globe temperature)* and proposed paragraph (e), *Requirements at or above the Initial heat trigger* for more details.

NIOSH (2016) developed the RAL to protect most healthy non-acclimatized employees from adverse effects of heat stress and recommends that total heat exposure for non-acclimatized employees be controlled to maintain combinations of environmental and metabolic heat below the applicable RAL in order to maintain thermal equilibrium. Environmental exposures are based on WBGT, which accounts for the contributions of ambient temperature, radiant heat, humidity, and wind speed. Metabolic heat production is estimated by workload. The RAL assumes employees are wearing “the conventional one-layer work clothing ensemble,” but NIOSH provides guidance for adjusting the

WBGT based on the types of clothing or PPE worn. The formula for calculating the RAL is: RAL [^{o}C-WBGT]=59.9-14.1 $\log_{10}$M[W], where M is metabolic rate in watts (W).

Recommended Exposure Limit (REL) means the NIOSH-recommended heat stress exposure limits for acclimatized workers. OSHA is proposing to incorporate by reference NIOSH Publication No. 2016-106 Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments (NIOSH, 2016). OSHA is including a definition for REL because the high heat trigger incorporates the NIOSH REL. Thus, several provisions of the standard are triggered by either a heat index of 90^{o}F or a wet bulb globe temperature (WBGT) equal to the NIOSH REL. See *Explanation of Proposed Requirements* for *Definitions (high heat trigger, wet bulb globe temperature)* and proposed paragraph (f), *Requirements at or above the high heat trigger* for more details.

NIOSH (2016) developed the REL to protect most healthy acclimatized employees from adverse effects of heat stress and recommends that total heat exposure for acclimatized employees be controlled to maintain combinations of environmental and metabolic heat below the applicable REL in order to maintain thermal equilibrium. Environmental exposures are based on WBGT, which accounts for the contributions of ambient temperature, radiant heat, humidity, and wind speed. Metabolic heat production is estimated by workload. The REL assume employees are wearing "the conventional one-layer work clothing ensemble," but NIOSH provides guidance for adjusting WBGT based on the types of clothing or PPE worn. The formula for calculating the REL is: REL [^{o}C-WBGT]= 56.7-11.5 $\log_{10}$M[W], where M is metabolic rate in watts (W)

Shade is defined as the blockage of direct sunlight, such that objects do not cast a shadow in the area of blocked sunlight. This definition is included to clarify the requirements for use of shade as a control in outdoor break areas under proposed paragraph (e)(3)(i). Shade can be artificial or naturally occurring. See *Explanation of Proposed Requirements* for paragraph (e)(3).

Signs and symptoms of heat-related illness means the physiological manifestations of a heat-related illness and includes headache, nausea, weakness, dizziness, elevated body temperature, muscle cramps, and muscle pain or spasms. This term is used throughout the proposal to refer to a range of signs and symptoms that may result from a variety of heat-related illnesses (see Section IV., Health Effects for a detailed discussion of heat-related illnesses and the accompanying symptoms). This term is defined to provide clarity about scenarios for which an employer must develop procedures for responding to employees experiencing signs and symptoms of heat-related illness in their heat emergency response plan, as well as the scenarios that an employer would be required to take specific actions to aid affected employees under proposed paragraph (g). This definition also provides clarity on the requirements to train employees on signs and symptoms of heat-related illness (see proposed paragraph (h)(iv)) and monitor employees for signs and symptoms of heat-related illness (see proposed paragraph (f)(3).

Signs and symptoms of a heat emergency means the physiological manifestations of a heat-related illness that require emergency response and include loss of consciousness (i.e., fainting, collapse) with excessive body temperature, which may or may not be accompanied by vertigo, nausea, headache, cerebral dysfunction, or bizarre behavior. This could also include staggering, vomiting, acting irrationally or disoriented, having convulsions, and (even after resting) having an elevated heart rate. This term is defined to provide clarity about scenarios for which an employer must develop procedures to respond to employees experiencing signs and symptoms of a heat emergency in their heat emergency response plan, as well as the scenarios in which an employer would be required to take specific actions to aid affected employees under proposed paragraph (g). This definition also provides clarity on the requirements to train

employees on signs and symptoms of heat-related illness and which ones require immediate emergency action (see proposed paragraph (h)(iv)).

Vapor-impermeable clothing means full-body clothing that significantly inhibits or completely prevents sweat produced by the body from evaporating into the outside air. The definition further indicates that examples include encapsulating suits, various forms of chemical resistant suits, and other forms of non-breathable PPE. This definition is included because under proposed paragraph (c)(3) employers that have employees who wear vapor-impermeable clothing would be required to evaluate heat stress hazards resulting from these clothing and implement policies and procedures based on reputable sources to protect employees while wearing this clothing. Vapor-impermeable clothing is also referred to as "vapor barrier" clothing. It is a type of protective clothing that employers may provide to employees to protect them from chemical, physical, or biological hazards for work tasks such as hazardous waste clean-up. Examples include metallic reflective clothing or chemical resistant clothing made from plastics such as vinyl or nylon-reinforced polyethylene (Mihal, 1981). Materials made from 100% high density polyethylene (e.g., Tyvek®) that allow water vapor and gases to pass through are not vapor-impermeable, but lamination of the materials with some substances such as polyvinyl chloride (PVC) can change the breathability of the materials and render them vapor-impermeable (DuPont, 2024; Paull and Rosenthal, 1987). Because the proposed definition indicates "full-body clothing", it would not include vapor-impermeable PPE that covers small areas of the body (e.g., gloves, boots, aprons, leggings, gauntlets). However, clothing such as boots and gloves made from vapor-impermeable materials such as rubber may be part of whole-body, vapor-impermeable clothing ensembles (Mihal, 1981; Paull and Rosenthal, 1987). Employers could check product information provided by manufacturers to determine if clothing worn by their employees qualifies as vapor-impermeable clothing.

Vehicle means a car, truck, van, or other motorized means of transporting people or goods. Other examples may include a forklift, reach truck, tow truck, pallet truck, or bus, among others. In addition, vehicles may also include equipment such as a bulldozer, road grader, farm tractor, or crane. Under the proposed definitions, a vehicle would be a *work area* when a worker's work activities occur in the vehicle.

Wet Bulb Globe Temperature (WBGT) is a heat metric that takes into account ambient temperature, humidity, radiant heat from sunlight or artificial heat sources, and air movement. It can be measured in both indoor and outdoor work areas, however there are separate formulas depending on whether the device is being used indoors or outdoors. WBGT is used by NIOSH and ACGIH in their guidance for evaluating occupational heat stress. The term is defined because it is used in the definitions for the high and initial heat triggers and in proposed paragraphs *(c) Heat injury and illness prevention plan* and (d) *Identifying heat hazards*.

Work area means an area where one or more employees are working within a work site. This includes any area where an employee performs any work-related activity. A work area may be located at the employer's premises or other locations where an employee may be engaged in work-related activities or is present as a condition of their employment. Work area is defined because it is referenced in several provisions of the proposed standard, including *(a) Scope and application, (c) Heat injury and illness prevention plan (HIIPP), (d) Identifying heat hazards, (e) Requirements at or above the initial heat trigger, (f) Requirements at or above the high heat trigger,* and *(i) Recordkeeping.*

Work site means a physical location (e.g., fixed, mobile) where the employer's work or operations are performed. It includes outdoor and indoor areas, individual structures or groups of structures, and all areas where work or any work-related activity occurs (e.g., taking breaks, going to the restroom, eating, entering or exiting work). The

work site includes the entirety of any space associated with the employer's operations (e.g., workstations, hallways, stairwells, breakrooms, bathrooms, elevators) and any other space that an employee might occupy in arriving, working, or leaving. A work site may or may not be under the employer's control. Work site is defined because it is referenced in several provisions of the proposed standard including Heat Injury and Prevention Plan (HIIPP) (proposed paragraph (c)), Identifying heat hazards (proposed paragraph (d)), Requirements at or above the initial heat trigger (proposed paragraph (e)), Requirements at or above the high heat trigger (proposed paragraph (f)), Heat illness and emergency response and planning (proposed paragraph (g)), and Training (proposed paragraph (h)).

I. Requests for Comments.

OSHA requests comments as to whether the proposed definitions are appropriate, and whether any additional terms should be defined in the standard.

C. Paragraph (c) Heat injury and illness prevention plan.

Proposed paragraph (c) includes provisions for the development and implementation of a work site heat injury and illness prevention plan, referred to as a "HIIPP" or "plan" for the remainder of this section, as well as requirements regarding what would need to be in the plan. The development of a HIIPP, including comprehensive policies and procedures, is necessary to ensure that all affected employees, including exposed workers, supervisors, and heat safety coordinators, understand where heat hazards exist at the workplace and the workplace-specific measures that must be utilized to address those hazards. The NIOSH Criteria Document provides information on the importance of a HIIPP to reduce the risk of heat-related injuries and illness (NIOSH, 2016). Requiring a HIIPP is also consistent with regulations from several of the States that have enacted or proposed heat-specific standards. There is a plan requirement in existing heat standards from California (Cal. Code of Regs. tit. 8, section 3395 (2005)), Washington (Wash. Admin. Code sections 296-62-095 through

296-62-09560; 296-307-097 through 296-307-09760 (2023)); and Oregon (Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)). Maryland and Nevada proposed heat standards that would also require a HIIPP (MD, 2024; NV, 2022). Additionally, this requirement aligns with the recommendations from the NACOSH Heat Injury and Illness Prevention Work Group, where the group provided a list of potential elements to include in a HIIPP. All the requirements in paragraph (c) would have to be included in the employer's HIIPP.

Paragraph (c)(1) would require employers to develop and implement a comprehensive HIIPP for each work site. Under proposed paragraph (b), a work site is defined as a physical location (e.g., fixed, mobile) where the employer's work or operations are performed. If an employer has multiple work sites that are substantially similar, the HIIPP may be developed by work site type rather than by individual work sites so long as any site-specific information is included in the plan (e.g., phone numbers and addresses or site-specific heat sources). For example, if an employer has developed a corporate HIIPP that includes information about job tasks or exposure scenarios that apply at multiple work sites, this information can be used in the development of HIIPPs for individual work sites. When employees are in work areas not controlled by the employer (like private residences), employers would need procedures for how they will ensure compliance with the standard (e.g., ensure that effective communication is being maintained (proposed paragraph (f)(3)(iii)) and employees are receiving hazard alerts to remind them of protections such as the importance of drinking plenty of water, their right to take breaks, and locations of break sites and drinking water (proposed paragraph (f)(4)). These employers must include such policies and procedures in their HIIPP to protect their employees entering those locations not controlled by the employer.

Proposed paragraph (c)(2) specifies the contents of the HIIPP. Proposed paragraph (c)(2)(i) would require the HIIPP to include a comprehensive list of the types

of work activities covered by the plan. For example, a landscaping company could indicate that all employees conducting outdoor work at or above the initial heat trigger for at least 15 minutes in any 60-minute period (e.g., lawn care workers, gardeners, stonemasons, and general laborers) would be covered by the HIIPP. (See proposed paragraphs (a)(2)(i), (ii), and (iv) and *Explanation for Proposed Requirements* for Paragraph (a) *Scope and Application* for more detail about coverage under the standard.) Paragraph (c)(2)(ii) would require the inclusion of the policies and procedures that are necessary to comply with the requirements of this proposed standard. See *Explanation of Proposed Requirements* for paragraphs (d) through (j) for examples of how employers could comply with the proposed provisions. OSHA understands that a HIIPP must be adaptable to the physical characteristics of the work site and the job tasks performed by employees, as well as the hazards identified by the employer when designing their HIIPP. Employers could also include other policies, procedures, or information necessary to comply with any applicable Federal, State, or local laws, standards, and guidelines in their HIIPPs. Paragraph (c)(2)(iii) would require that employers identify the heat metric (i.e., heat index or wet bulb globe temperature) that the employer will monitor to comply with paragraph (d). For more information on heat metrics, see *Explanation for Proposed Requirements* for Paragraph (b) *Definitions for heat index and WBGT.*

Paragraph (c)(3) would require that, in cases where employees wear vapor-impermeable clothing (also called vapor barrier clothing), employers must evaluate heat stress hazards resulting from this clothing and implement policies and procedures based on reputable sources to protect employees while wearing these clothing. The employer must include these policies and procedures and document the evaluation in the HIIPP. Under proposed paragraph (b), *vapor-impermeable clothing* is defined as full-body clothing that significantly inhibits or completely prevents sweat produced by the body from evaporating into the outside air. The definition further indicates that examples

include encapsulating suits, various forms of chemical resistant suits, and other forms of non-breathable PPE. For more information on vapor-impermeable clothing, see the *Explanation for Proposed Requirements* for paragraph (b) *Definitions*. This attention to vapor-impermeable clothing is essential given that significant or complete inhibition of sweat evaporation can greatly increase the potential for heat stress and resulting heat strain and HRI (Mihal, 1981).

The requirement that employers evaluate heat stress and develop policies and procedures to protect employees based on reputable sources allows for flexibility, given that there is variability in duration of use of the vapor-impermeable clothing and that workload also varies across job tasks and occupations. Examples of reputable sources employers can consult to assess heat stress and develop policies and procedures to protect employees wearing vapor-impermeable clothing include recommendations by NIOSH (2016) and ACGIH (2023). An example of a policy employers might adopt to protect employees wearing vapor-impermeable clothing is implementing the protections in the standard at a lower temperature threshold. Such an approach has been used in State standards such as the Washington heat standard for outdoor workplaces (Wash. Admin. Code 296-307-09747 (2023)). In Washington State's heat standard, employers must implement certain controls when employees are wearing vapor barrier clothing, and the temperature is above 52°F. Paragraph (c)(3) does not apply to vapor-permeable clothing or PPE such as cotton coveralls, SMS polypropylene or polyolefin coveralls, double layer woven clothing, or wool shirts (ACGIH, 2023; ACGIH, 2017; NIOSH, 2016).

Paragraph (c)(3) would require the employer to document in the HIIPP the hazard evaluation performed to comply with this provision and to include in the HIIPP the policies and procedures developed to protect employee's wearing vapor-impermeable clothing. Although OSHA is not specifying a particular form for the required hazard evaluation, an effective hazard evaluation would include a review of environmental heat

exposures, a review of the high-risk area(s), tasks, and occupations, and an evaluation of the length of time and intensity of task when wearing vapor-impermeable clothing. Policies and procedures should include communication of the status of planned or completed actions to employees who may have to wear vapor-impermeable clothing to complete work tasks. For more information on identifying heat hazards, see *Explanation of Proposed Requirements* for paragraph (d) below.

Under proposed paragraph (c)(4), an employer with more than 10 employees would be required to develop and implement a written HIIPP. While OSHA has concluded that a HIIPP is necessary for all employers covered by the standard, OSHA has determined that only employers with more than 10 employees need to have a written plan. This cutoff of 10 employees is consistent with OSHA's practice of allowing employers with 10 or fewer employees to communicate their emergency action plans (29 CFR 1910.38) and fire prevention plans (29 CFR 1910.39) orally to employees. OSHA expects that small employers with 10 or fewer employees are likely to have less complicated HIIPPs and will communicate with employees verbally. The agency does not believe that there is a high likelihood of misunderstanding when employers communicate their HIIPPs to employees verbally. As a result, OSHA does not believe the added burden on small employers of establishing a written plan is necessary. However, small employers may opt to create a written HIIPP if they find doing so is helpful in developing and implementing their plans.

In contrast, the agency is concerned that when employers have more than 10 employees, there is likely sufficient complexity in the employer's operation that putting the HIIPP in writing is necessary to establish clear expectations and prevent miscommunication. For example, employers with more than 10 employees may have employees working in multiple locations or on multiple shifts, increasing the likelihood that verbally communicating the employer's HIIPP will be ineffective. Therefore, OSHA

preliminarily finds that having a written HIIPP that employees of larger employers can easily access is essential to ensure those employees are informed about policies, programs, and protections implemented by their employers to protect them from hazardous heat exposure.

An employer may have already developed and implemented a HIIPP. Existing plans may fulfill some of the requirements in this section. It is not OSHA's intent for employers to duplicate current effective HIIPPs, but each employer with a current HIIPP would have to evaluate that plan for completeness to ensure it satisfies all the requirements of this section. Employers with existing plans would be required to modify and/or update their current HIIPP plans to incorporate any missing required elements and provide training on these new updates or modifications to all employees (see the *Explanation of Proposed Requirements* for Paragraph (h) *Training*). Employers with more than 10 employees would have to ensure their existing HIIPP is in writing.

Paragraph (c)(5) would require the employer to designate one or more workplace heat safety coordinators to implement and monitor the HIIPP. Any employee(s) capable of performing the role who receives the training required by proposed paragraphs (h)(1) and (2) can be designated heat safety coordinator(s). This employee(s) does not need to be someone with specialized training. The heat safety coordinator(s) could be a supervisor or an employee that the employer designates. The heat safety coordinator(s) must have the authority to ensure compliance with all aspects of the HIIPP. This requirement would ensure heat safety coordinators can take prompt corrective measures when hazards are identified. Proposed paragraph (c)(5) would also require that for employers with more than 10 employees, the identity of the heat safety coordinator(s) must be documented in the written HIIPP. Employers must designate a heat safety coordinator(s) to implement and monitor the HIIPP plan, but the exact responsibilities of a heat safety coordinator(s) may vary based on the employer and work site. Some

possible duties of the heat safety coordinator(s) could include conducting regular inspections of the work site to ensure the HIIPP is being implemented appropriately and to monitor the ongoing effectiveness of the plan. During such inspections, the heat safety coordinator(s) could observe employees to ensure they are protecting themselves by frequently drinking water or taking rest breaks that employers would be required to provide.

Under proposed paragraph (c)(6), the employer would be required to seek the input and involvement of non-managerial employees and their representatives, if any, in the development and implementation of the HIIPP. An employer could seek feedback from employees through a variety of means, including safety meetings, a safety committee, conversations between a supervisor and non-managerial employees, a process negotiated with the exclusive bargaining agent (if any), or any other similarly interactive process. The method of soliciting employee input is flexible and may vary based on the employer and the work site. For example, a large employer with many employees may find a safety committee with representatives from various job categories combined with anonymous suggestion boxes to be more effective than individual conversations between supervisors and non-managerial employees. In the case of a unionized workplace, a safety committee established through a collective bargaining agreement may be the appropriate source for this input, based on the definition and scope of the committee's work. In contrast, a small employer might determine that an ongoing interactive process between the employer and employees (e.g., regular safety meetings) is a more effective means of soliciting employee feedback. OSHA understands employees often know the most about potential hazards associated with their jobs. As such, employee participation is a key component of effective safety and health programs.

Paragraph (c)(7) would require the employer to review and evaluate the effectiveness of the HIIPP whenever a heat-related injury or illness occurs that results in

death, days away from work, medical treatment beyond first aid, or loss of consciousness, but at least annually. Following each review, the employer would be required to update the HIIPP as necessary. The employer would have to seek input and involvement of non-managerial employees and their representatives, if any, during any reviews and updates. OSHA preliminarily finds that a heat-related illness or injury that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness warrants an evaluation of the HIIPP because it could potentially indicate a deficiency of the HIIPP. Additionally, the heat safety coordinator might learn of a deficiency during an inspection or from another employee. OSHA expects that employers would immediately address any identified deficiencies and update the HIIPP accordingly. Under proposed paragraph (h)(4)(iv), all employees would have to be retrained following a heat-related injury or illness that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness, and under proposed paragraph (h)(4)(ii) employees would have to be retrained if identification of a deficiency results in an update to the HIIPP. OSHA preliminarily finds that effective heat injury and illness prevention plans would require periodic evaluation to ensure they are implemented as intended and continue to achieve the goal of preventing heat injury and illness and promoting workplace safety and health. This re-evaluation can result in improvements in controls to help reduce hazards.

Paragraph (c)(8) would require the employer to make the HIIPP readily available at the work site to all employees performing work at the work site. The HIIPP would have to be readily accessible during each work shift to employees when they are in their work area(s). Paper copies, electronic access (i.e., accessible via smart phone) and other alternatives to maintaining paper copies of the HIIPP are permitted as long as no barriers to immediate employee access in each work site are created by such options.

Paragraph (c)(9) would require the employer to ensure the HIIPP is available in a language each employee, supervisor, and heat safety coordinator understands. Under

proposed paragraph (c)(4), this would require written translations of the plan in all languages that employees, supervisors, and heat safety coordinators understand. Employers could comply with this requirement by utilizing one of the numerous translator programs available online if the employer has a way to ensure accuracy of the translated materials. In cases where an employee, supervisor, or heat safety coordinator can read and comprehend English, but prefers to read in another language, the employer would have no obligation to provide a written translation of the plan in that individual's preferred language. If one or more employees are not literate, the employer would have to ensure that someone is available to read the written plan in a language that each employee understands. Likewise, for employers who have less than 10 employees, the employer would have to ensure that someone is available to explain the plan in a language that each employee, supervisor, and heat safety coordinator understands. OSHA expects that an individual who speaks employees' languages will be available in all workplaces since effective communication between individuals such as employers, supervisors, and employees would need to occur in order for employees to understand the details about the work tasks they need to complete.

I. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- The approaches that stakeholders are taking to assess heat stress and prevent HRI in employees wearing vapor-impermeable clothing;
- Whether OSHA should specify a temperature that would trigger all or certain requirements of the standard for employees wearing vapor-impermeable clothing;
- Additional approaches that OSHA should consider to protect employees wearing vapor-impermeable clothing;
- Whether the proposed requirement to seek input and involvement from non-managerial employees and their representatives under paragraph (c)(6) is

adequate, or whether the explanation should be expanded or otherwise amended (and if so, how and why);

- Whether OSHA should define "employee representative" and, if so, whether the agency should specify that non-union employees can designate a non-employee third-party (e.g., a safety and health specialist, a worker advocacy group, or a community organization) to provide expertise and input on their behalf;
- Whether it is reasonable to require the HIIPP be made available in a language that each employee, supervisor, and heat and safety coordinator understands;
- What methods and programs are available to provide employees documents and information in multiple languages, whether there are languages for which these resources are not available, and how employers can provide adequate quality control to ensure that the translations are done properly; and
- Whether individuals are available at workplaces to provide verbal translations of the plan for employees who are not literate or do not speak English.

D. Paragraph (d) Identifying heat hazards.

Proposed paragraph (d) sets forth requirements for assessing where and when employees are exposed to heat at or above the initial and high heat triggers. It would require employers with outdoor work sites to monitor heat conditions at outdoor work areas by tracking local heat index forecasts or measuring the heat metric of their choosing (heat index or wet bulb globe temperature (WBGT)). It would require employers with indoor work sites to identify work areas where there is a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger and implement a plan for monitoring these areas to determine when exposures above the initial and high heat triggers occur, using the heat metric of their choosing (heat index or WBGT). Determining when employees are exposed to heat at or above the initial and

high heat triggers is critical for ensuring that employees are provided with appropriate protections (outlined in paragraphs (e) and (f)).

Proposed paragraph (d)(1) would require employers whose employees perform work outdoors to monitor the heat conditions at the work areas where employees are working. Employers would have two options for complying with this requirement—tracking local heat index forecasts provided by National Weather Service (NWS) or other reputable sources or making on-site measurements using monitoring device(s).

Employers who choose to track local forecasts would need to consult a reputable source for local heat index forecasts such as their local NWS Weather Forecast Office, the OSHA-NIOSH Heat Safety Tool cell phone application, or another weather forecast website or cell phone application. When using these sources, employers would need to accurately enter the location of the work area. The OSHA-NIOSH Heat Safety Tool (and other cell phone applications) will automatically use GPS to determine the user's location, so the forecast may be inaccurate if using the tool at home and employers will need to manually enter the work area location in these situations.

Employers who choose to conduct on-site monitoring would need to set up monitoring devices at or as close as possible to the work area. This could mean setting up the device(s) on a tripod a few yards away from an employee. When there are multiple work areas at the same work site, the employer could use a single monitoring device to measure heat exposure for multiple work areas if there is no reasonable anticipation that the heat exposure will differ between work areas. For example, if employees are harvesting crops on different fields but are within a mile of one another under similar work conditions, the employer could use a single monitoring device. If there is reasonable anticipation that employees at a work site have different levels of exposure, employers could measure the exposure at the work area of the employee(s) reasonably

expected to have the highest exposure and apply that value to all employees at the work site instead of measuring the exposure for each work area.

Employers using heat index as their heat metric could either use heat index monitors or measure temperature and humidity with separate devices. In the latter situation, these employers would need to use a heat index calculator, such as the one provided on the NWS website (NWS, 2023), to calculate heat index from the separate temperature and humidity readings. Employers using WBGT as their heat metric would need to take into account differences in solar radiation and wind between work areas when deciding whether a single measurement could be used for multiple work areas. For example, measurements of WBGT in a work area in the shade should not be applied to another work area that is not in the shade. Regardless of which metric they choose to use, employers conducting on-site monitoring should consult user manuals and ensure devices are calibrated and in working order. Employers should follow the device manufacturer's manual when conducting monitoring.

Proposed paragraph (d)(2) would require employers whose employees perform work outdoors to consult the weather forecast or their monitoring device(s)—whichever they are using to comply with paragraph (d)(1)—frequently enough to determine with reasonable accuracy when conditions at the work area reach the initial and high heat triggers. Employers consulting forecasts would need to check the forecast as close to the start of the work shift as possible to determine whether and when the heat index at the work area may be at or above the initial or high heat triggers. Depending on the forecast or conditions at the work site, the employer then may or may not need to conduct further monitoring during the day. If, for example, the employer consulted the OSHA-NIOSH Heat Safety Tool before the work shift and it indicated that the heat index would exceed the initial heat trigger but not the high heat trigger during the last four hours of the work shift, the employer would need to either: 1) implement control measures in accordance

with paragraph (e) for those four hours, or 2) consult the Heat Safety Tool again later in the day and implement control measures in accordance with paragraph (e) only for the hours during which real-time conditions reported by the application exceed the initial heat trigger (which may be more or less than four hours if the forecast earlier in the day underestimated or overestimated the heat index). However, if the employer consulted the OSHA-NIOSH Heat Safety Tool before the work shift and it indicated that the heat index would be close to the initial heat trigger but not exceed it, employers would need to check the forecast again later in the day to determine whether the trigger was exceeded. Employers would need to use short-term forecasts (i.e., hourly) rather than long-term forecasts (e.g., weekly, monthly) to comply with proposed paragraphs (d)(1) and (2). Ultimately, the employer is responsible for ensuring that the controls required at the initial and high heat trigger are in place when those triggers are met, and they should make decisions regarding the frequency of monitoring with this in mind.

Likewise, employers who conduct on-site monitoring in order to comply with paragraph (d)(1) will need to develop a reasonable measurement strategy that is adapted to the expected conditions. If forecasts provide no suggestion that the initial heat trigger could be reached during the work shift, an employer may not need to take any measurements. Where temperatures are expected to approach the initial or high heat triggers, several measurements may be necessary, particularly as the hottest part of the day approaches. For example, if the employer measures at 10 a.m. and the heat index is very close but below the initial heat trigger, the employer would likely need to either check again sometime shortly thereafter or assume that the trigger is exceeded. WBGT accounts for additional parameters—air speed and radiant heat—so employers using WBGT may need to make additional measurements when these conditions change at the work site.

Proposed paragraphs (d)(3)(i) and (ii) outline the requirements for assessing heat hazards in indoor work sites, which differ slightly from the requirements for outdoor work sites, in that employers would need to identify the work areas where they reasonably expect employees to be exposed to heat at or above the initial heat trigger and then create a monitoring plan to determine when employees in those work areas are exposed to heat at or above the initial and high heat triggers.

Employers could determine which work areas are expected to have employee exposure at or above the initial heat trigger by consulting various data sources, such as previously collected monitoring data, site or process surveys, employee interviews and input, and heat injury and illness surveillance data. Work areas near heat-generating machinery are one example of where there may be a reasonable expectation of employee exposure at or above the initial heat trigger. In addition to heat-generating equipment, employers must determine whether there is a reasonable expectation that an increase in the outdoor temperature would increase temperatures in their indoor work site, thereby exposing employees to heat at or above the initial heat trigger.

Employers would be required to develop a monitoring plan that covers each work area they identified in the prior step. The monitoring plan is intended to determine when employees are exposed (e.g., specific times of day, during certain processes, certain months of the year) to heat at or above the initial and high heat triggers for each work area. When developing a monitoring plan(s), employers would need to take into account the circumstances that could impact heat conditions specific to each work area and work site. The monitoring plan(s) would need to be included in the employer's HIIPP.

In complying with proposed paragraph (d)(3)(ii), employers would need to outline in their monitoring plan how they will monitor either heat index or WBGT using on-site monitors that are set up at or as close as possible to the work area(s) identified under paragraph (d)(3)(i). OSHA intends the phrase "as close as possible" to mean the closest

possible location that won't otherwise create inaccurate measurements. The employer should ensure that their monitoring plan outlines the appropriate frequency of measurements, which should be of sufficient frequency to determine with reasonable accuracy employees' exposure to heat. For example, if the employer determines there is only a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger when a certain process is happening or during certain times of the year, then they would only need to monitor when that process is happening or during that time of the year.

Employers using heat index as their heat metric could either use heat index monitors or measure temperature and humidity with separate devices. In the latter situation, these employers would need to use a heat index calculator, such as the one provided on the NWS website (NWS, 2023), to calculate heat index from the separate temperature and humidity readings. Employers using WBGT as their heat metric would need to take into account differences in radiant heat and air movement between work areas when deciding whether a single measurement can be used for multiple work areas. For example, measurements of WBGT in a work area without a radiant heat source should not be applied to another work area that is near a radiant heat source. Regardless of which metric they choose to use, employers should consult user manuals and ensure devices are calibrated and in working order. Employers should follow the device manufacturer's manual when conducting monitoring.

If there are multiple work areas where there is a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger at a work site, the employer could conduct representative sampling instead of taking measurements at each individual work area. If using this approach, the employer would be required to sample the work area(s) expected to be the hottest. For example, this may involve monitoring the work area closest to a heat-generating process. The employer cannot put a

monitoring device in a work area known or expected to be cooler and consider that representative of other work areas.

If any changes occur that could increase employee exposure to heat (i.e., a change in production, processes, equipment, controls, or a substantial increase in outdoor temperature which has the potential to increase heat exposure indoors), proposed paragraph (d)(3)(iii) would require that the employer must evaluate any affected work area(s) to identify where there is reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger. Examples of changes that could increase employee exposure to heat include the installation of new equipment that generates heat in a work area that didn't previously have heat-generating equipment or a local heat wave that increases the heat index in a warehouse without air-conditioning. The employer would be required to update their monitoring plan or develop and implement a monitoring plan, in accordance with paragraph (d)(3)(ii), to account for any increases in heat exposure.

Proposed paragraph (d)(3)(iv) would require employers to involve non-managerial employees (and their representatives, if applicable) in the determination of which work areas have a reasonable expectation of exposing employees to heat at or above the initial heat trigger (which is described in paragraph (d)(3)(i)). Employers would also be required to involve non-managerial employees (and their representatives, if applicable) in developing and updating the monitoring plan(s) outlined in paragraph (d)(3)(ii) through (iii). One example of this involvement would be employees providing input in identifying processes or equipment that give off heat and times of the day or year when certain areas of the building feel uncomfortably hot and warrant monitoring. Employees are often the most knowledgeable about the conditions in which they work and their involvement will help ensure the accuracy and sufficiency of the employer's monitoring plan(s).

Proposed paragraph (d)(4) specifies that the heat metric (i.e., heat index or WBGT) that the employer chooses to monitor determines the applicable initial and high heat triggers under the standard. Specifically, as defined in paragraph (b), if the employer chooses to monitor heat index, they would be required to use the initial heat trigger of 80°F (heat index) and the high heat trigger of 90°F (heat index). If the employer chooses to use WBGT, they would be required to use the NIOSH Recommended Alert Limit (RAL) as the initial heat trigger and the NIOSH Recommended Exposure Limit (REL) as the high heat trigger. As outlined in paragraph (c), the employer would be required to identify which heat metric they are monitoring in their HIIPP. If they do not do this, proposed paragraph (d)(4) specifies that the initial and high heat trigger will be based on the heat index.

Proposed paragraph (d)(5) would provide an exemption from monitoring requirements for employers who choose to assume that their employees are exposed to heat at or above both the initial and high heat triggers. In these cases, employers would not need to conduct monitoring, but they would be required to provide all controls outlined in paragraphs (e) and (f) while making this assumption. For the period of time that employers choose to make this assumption and are therefore exempt from monitoring requirements, they would not be required to keep records of monitoring data (see paragraph (i), Recordkeeping).

I. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether the proposed requirement to monitor outdoor work areas with "sufficient frequency to determine with reasonable accuracy employees' exposure to heat" is adequate or whether the standard should specify an interval of monitoring (and if so, what frequency and why);

- Whether OSHA should specify an interval of monitoring for indoor work areas (and if so, what frequency and why);
- Whether the standard should include a specific increase in outdoor temperature that would trigger the requirements in paragraph (d)(3)(iii) for indoor work areas, rather than the trigger being a "substantial increase", and if so, what magnitude of increase;
- Whether there could be situations in which a lack of cellular service prevents an employer from using weather forecasts or real-time predictions, and if so, what alternatives would be appropriate;
- Whether the standard should require specifications related to monitoring devices (e.g., in accordance with user manuals, properly calibrated) and whether the standard should specify a permissible accuracy level for monitoring devices; and
- Whether the standard should further specify which sources of forecast data employers can use to comply with paragraph (d)(1)(i) and if so, what criteria should be used.

E. Paragraph (e) Requirements at or above the initial heat trigger.

I. Timing.

Paragraph (e) of the proposed standard would establish requirements when employees are exposed to heat at or above the initial heat trigger. As discussed in Section V.B., Basis for Initial and High Heat Triggers, OSHA has preliminarily determined that the experimental and observational evidence support that heat index triggers of 80°F and 90°F are highly sensitive and therefore highly protective of employees. Exposures at or above the initial heat trigger, a heat index of 80°F or a corresponding wet bulb globe temperature equal to the NIOSH Recommended Alert Limit, would require the employer to provide the protections outlined in paragraphs (e)(2) through (10).

The employer would only be required to provide the specified protections during

the time period when employees are exposed to heat at or above the initial heat trigger. In many cases, employees may only be exposed at or above the initial heat trigger for part of their work shift. For example, employees who work outdoors may begin work at 9a.m. and finish work at 5 p.m.. If their exposure is below the initial heat trigger from 9 a.m. until 12 p.m., and at or above the initial heat trigger from 12 p.m. to 5 p.m., the employer would only be required to provide the protections specified in this paragraph from 12: p.m. to 5 p.m.. Additional protective measures, outlined in paragraph (f) *Requirements at or above the high heat trigger,* would be required when employees are exposed to heat at or above the high heat trigger.

II. Drinking water.

Paragraph (e)(2) of the proposed standard would establish requirements for drinking water when employees are exposed to heat at or above the initial trigger. The proposed requirements of paragraph (e)(2) are in addition to the requirements in existing OSHA sanitation standards applicable to the employer, including the general industry sanitation standard (29 CFR 1910.141); construction industry sanitation standard (29 CFR 1926.51); field sanitation standard (29 CFR 1928.110); shipyard employment sanitation standard (29 CFR 1915.88); marine terminals sanitation standard (29 CFR 1917.127); and temporary labor camp standard (29 CFR 1910.142). In addition to requirements for drinking water, these standards require access to toilet facilities, which is important to ensure that employees are not discouraged from drinking adequate amounts of drinking water. As discussed in Risk Reduction, Section V.C., drinking water has been shown to be an effective intervention for preventing dehydration, heat strain, and HRI. It allows employees to replace fluids lost by sweat and is necessary to maintain blood volume for cardiovascular function and thermoregulation.

Proposed paragraph (e)(2)(i) would require that employers provide access to potable water that is placed in locations readily accessible to employees. To ensure

employees have sufficient drinking water whenever needed, the drinking water should be located as close as possible to employees, to facilitate rapid access. Employers could comply with this provision by providing water coolers or food grade jugs on vehicles if drinking water fountains or taps are not nearby, or by providing bottled water or refillable water bottles so that employees always have access to water. Employers supplying water through a common source such as a tap or jug would have to provide a means for employees to drink the water. This could include providing disposable cups or single-user refillable water bottles. Under OSHA's sanitation standards, common drinking cups or other shared utensils are prohibited. Open containers such as barrels, pails, or tanks for drinking water from which water must be dipped or poured, whether or not they are fitted with a cover, are also prohibited under these standards. In cases where employers provide single-user, refillable water bottles, they should keep extra bottles or disposable cups on hand in case employees misplace or forget to bring the bottle the employer provided them.

OSHA notes that water would not be readily accessible if it is in a location inaccessible to employees (e.g., the drinking water fountain is inside a locked building or trailer). Water would also not be readily accessible if it is placed at a distant or inconvenient location in relation to where employees work. OSHA expects that employers will have incentive to place the drinking water as close to employees as feasible to minimize the amount of time needed to access water, which must be paid. Explanation of Proposed Requirements for paragraph (j) *Requirements implemented at no cost to employees*).

Proposed paragraph (e)(2)(ii) would require that employers provide access to potable water that is suitably cool. As discussed in Risk Reduction, Section V.C., the temperature of drinking water impacts hydration levels, as cool or cold water has been found to be more palatable than warm water, thus leading to higher consumption of cool

water and decreased risk of dehydration. Additional evidence highlighted in Risk Reduction, Section V.C., shows that cool fluid ingestion has beneficial effects for reducing heat strain. The requirement that drinking water be "suitably cool" is consistent with OSHA's existing field sanitation standard (29 CFR 1928.110(c)(1)(ii)) and with California's heat standard for outdoor workplaces (Cal. Code Regs. tit. 8, section 3395). OSHA has previously stated that to be suitably cool, the temperature of the water "must be low enough to encourage employees to drink it and to cool the core body temperature" (Field Sanitation, 52 FR 16050, 16087 (May 1, 1987)). Employers could comply with this provision by providing drinking water from a tap or fountain that maintains a cooler temperature, providing water in coolers or by providing ice or ice packs to keep drinks cool.

In addition to providing palatable and potable water, the NACOSH Heat Injury and Illness Prevention Work Group recommended that employers consider providing electrolyte supplemental packets that can be added to water or electrolyte-containing sports drinks (NACOSH Working Group on Heat, 2023). While employers could choose to offer electrolyte supplements or electrolyte-containing sports drinks, they would not be required under the standard. Providing electrolyte supplements or sports drinks alone would not meet the proposed requirement. OSHA has preliminarily determined that electrolyte supplementation may not be necessary in a majority of situations if workers are consuming adequate and regular meals (NIOSH, 2017a). OSHA has also received feedback from stakeholders that some workers may be unable to consume certain electrolyte supplements or solutions due to their sugar content.

Proposed paragraph (e)(2)(iii) would require that employers provide access to one quart of drinking water per employee per hour. Employers could comply with this provision by providing access to a drinking water tap or fountain that has a continuous supply of drinking water, or providing coolers or jugs that are replenished with water as

the quantity diminishes. As discussed in more detail in Section V.C., Risk Reduction, that volume of water intake ensures adequate replenishment of fluids lost through sweat to avoid a substantial loss in total body water content for employees working in the heat. OSHA is specifying the amount of water that employers need to provide to employees, not an amount that employees need to drink. However, as discussed in the Explanation of Proposed Requirements for paragraphs (f)(3) and (h), the employer must inform employees of the importance of drinking water to prevent HRIs during initial training, annual refresher training, and whenever the high heat trigger is met.

Finally, in accordance with paragraph (j) of the proposed standard, all drinking water requirements must be implemented at no cost to employees. Accordingly, employers may not charge employees for the drinking water required by paragraph (e)(2) nor for the equipment or supplies needed to access it.

A. Requests for Comments.

OSHA requests comments and information on the following:

- Whether OSHA should require a specific temperature or ranges of temperature for drinking water as some State regulations do (e.g., Colorado requires that drinking water is kept 60°F or cooler);
- Whether the agency should require the provision of electrolyte supplements/solutions in addition to water;
- Whether the requirement to provide a minimum of 1 quart per hour per employee is appropriate; and
- Whether there are any challenges to providing the required amount of drinking water (e.g., for employees who work on foot in remote areas) and, if so, alternatives that OSHA should consider.

III. Break area(s) at outdoor work sites.

Paragraph (e)(3) contains the proposed requirements for outdoor break areas when temperatures meet or exceed the initial heat trigger. Adequate break areas where employees can hydrate, remove PPE, and cool down is considered a vital component in preventing HRIs and necessary part of a multilayered strategy to control exposure to high heat. The requirements for both outdoor and indoor break areas in this proposed standard are in addition to employers' obligations under OSHA's sanitation standards (29 CFR 1910.141, 1915.88, 1917.127, 1918.95, 1926.51, 1928.110). Because the sanitation standards address workplace hazards other than heat exposure, employers must continue to comply with their obligations under those standards. OSHA highlights these sanitations standards because employees are likely to eat and drink water in the indoor break areas, which may implicate certain provisions of these standards.

Specifically, proposed paragraph (e)(3) requires employers to provide one or more employee break areas at outdoor work sites that can accommodate the number of employees on break, is readily accessible to the work area(s) and has either shade (paragraph (e)(3)(i)), or air-conditioning if in an enclosed space (paragraph (e)(3)(ii))). As explained more in detail in Section V.C., Risk Reduction, shade reduces exposure to radiant heat which can contribute to heat stress and lead to heat strain and HRI. Further, air-conditioning is effective in reducing heat stress and resulting heat strain because it reduces exposure to heat. Accordingly, OSHA has preliminarily determined that requirements for break areas, including the use of controls to facilitate cooling while employees are on break, are effective at preventing HRIs among workers and should be included in the proposed standard. This determination is supported by NIOSH's criteria for a recommended standard, several State standards, and existing guidance (Cal. Code Regs. tit. 8, section 3395 (2024); 7 Colo. Code Regs. section 1103-15:3 (2023); Or. Admin. R. 437-002-0156 (2024); Or. Admin. R. 437-004-1131 (2024); Wash. Admin. Code 296-307-09747 (2023); NIOSH, 2016).

Proposed paragraph (e)(3) would require the employer to ensure the break area(s) can accommodate all employees on break. This provision is intended to ensure that all employees taking rest breaks that employers would need to provide under proposed paragraphs (e)(8) and (f)(2) are able to do so in an appropriate break area(s). If the break area cannot accommodate the number of employees on break, some employees may not have access to adequate cooling controls while on break, increasing their risk of HRIs. In addition, adequate space allows for ventilation and airflow, contributing to a more effective cooling.

While OSHA is not proposing a minimum square footage requirement per employee, break areas that can only fit the anticipated number of employees on break if employees stand shoulder to shoulder, or in such close proximity that heat cannot dissipate, would not be large enough to accommodate the number of employees on break. Break areas that are not large enough to allow employees to move in and out freely or access necessary amenities, such as water and air-conditioning or shade, would also not be considered large enough to accommodate the number of employees on break.

Proposed paragraph (e)(3) does not require that the break area(s) be able to accommodate an employer's entire workforce at the same time. However, the employer must evaluate the needs of the work site and ensure the break area(s) is large enough to accommodate all employees reasonably expected to be on break at the same time. When making this determination, employers would need to consider factors such as how many employees are reasonably expected to be taking breaks to prevent overheating under proposed paragraph (e)(8) at any given time, as well as the breaks required under proposed paragraph (f)(2) (e.g., are paragraph (f)(2) breaks staggered or will large groups of employees be taking them at the same time?). However, the minimum frequency and duration of breaks under paragraph (f)(2) must be met.

Similarly, where an employer has multiple break areas on-site, OSHA does not expect each of these multiple break areas to be able to accommodate an employer's entire workforce. Instead, OSHA expects that employers who utilize multiple break areas will determine the number of employees anticipated to access each break area and ensure the break areas are sufficient in size to accommodate the need for break space in each location. When making this determination, employers would need to consider factors such as the distribution of employees across different areas and any employee movement throughout the areas during a work shift.

OSHA also acknowledges that some employers may have facilities where both outdoor and indoor work occurs. OSHA requests comments on whether the agency should permit all employees in these facilities to utilize indoor break areas.

Proposed paragraph (e)(3) would require that break areas be readily accessible to the work area(s). It is important that break areas be readily accessible to ensure that employees can take breaks promptly, particularly in situations where employees are experiencing early symptoms of HRIs, as quick access to a break area can help limit the further progression of illness. In addition, break areas within close proximity to employees encourages use. OSHA does not expect the employer to have break areas located immediately adjacent to every employee and understands that exact distance may vary depending on factors such as the size and layout of the workplace, the number of employees, and the nature of the work being performed.

Locations that are so far from work area(s) that they deter employees from taking breaks would not be considered readily accessible. When determining the location of the break area(s), the employer would be expected to evaluate the duration of travel to the area. Break areas requiring more than a few minutes to reach would increase the heat stress on employees as they walk to the area and thus not be considered reasonably accessible. The break area must be situated close enough to work areas to minimize the

time and effort required for employees to access it. Break areas should be as close as possible to employees so that an employee in distress could easily access the area to promptly cool down. OSHA expects that employers will have incentive to place the break areas as close as practical to the work areas to minimize travel time, which must be paid (see Explanation of Proposed Requirement for paragraph (j) *Requirements implemented at no cost to employees*).

For mobile work sites, such as in road construction or utility work, the employer would be expected to relocate the break area as needed to ensure it is readily accessible to employees or ensure each work site has its own break area for use. This requirement would also apply to large work sites where employees are continually changing their work area, such as in agricultural work. The employer would be required to pay employees their normal rate of pay for time to get to the break area, as well as the time on break (see the *Explanation of the Proposed Requirements* for paragraph (j)).

In addition to ensuring the break area(s) is large enough to accommodate all employees on break and readily accessible to the work area(s), employers would have to provide at least one of the following: shade (paragraph (e)(3)(i)); or air-conditioning, if in an enclosed space (paragraph (e)(3)(ii)). As discussed above, break areas are intended to provide employees a spot to cool down and reduce body temperature. Also, controls such as shade and air-conditioning are proven methods to prevent HRIs. Without controls such as these in place, break areas could become uncomfortable and even continue to expose individuals to the risk of HRI. OSHA understands that the scope of the standard includes a broad variety of outdoor industries, and that even within one industry, workplaces can be vastly different. The proposed requirements for outdoor break areas give employers flexibility in their compliance.

Paragraph (e)(3)(i) of the proposal outlines the requirements for employers who use shade. The provision would require that the break area have artificial shade (e.g., tent,

pavilion) or natural shade (e.g., trees), but not shade from equipment, that provides blockage of direct sunlight and is open to the outside air. By incorporating shade into break areas, whether through natural foliage, awnings, or umbrellas, employees are able to reduce exposure to radiant heat and benefit from conditions that are more conducive to increasing evaporative cooling as air moves across the skin. The benefits of shaded break areas have also been recognized by several States and incorporated into State standards, including California, Colorado, Oregon, and Washington (Cal. Code Regs. tit. 8, section 3395 (2024); 7 Colo. Code Regs. section 1103-15:3 (2023); Or. Admin. R. 437-002-0156 (2024); Or. Admin. R. 437-004-1131 (2024); Wash. Admin. Code 296-307-09747 (2023)).

To ensure shade is effective, OSHA would require the shade to block direct sunlight for the break area. OSHA does not expect employers to measure shade density using shade meters or solarimeters. As defined under proposed paragraph (b) *Shade* means the blockage of direct sunlight, such that objects do not cast a shadow in the area of blocked sunlight. Therefore, verifying that employees' shadows are obstructed from being visible due to the presence of shade would be sufficient. In addition, shaded break area(s) must be open to the outside air. To satisfy this requirement, the shaded break area must be sufficiently open to the outside air to ensure that air movement across the skin (promoting the evaporation of sweat) can occur and to prevent the buildup of humidity and heat that can become trapped due to limited airflow and stagnant air. For example, a pop-up canopy with one enclosed side would comply with the provisions for a shade structure; however, a closed trailer having four sides and a roof would not. Employers could also incorporate other cooling measures, such as fans or misting devices, in their shaded break area, although the proposed standard does not require them to do so.

Both portable and fixed shade would be permitted to comply with the proposed requirements under (e)(3)(i). However, as stated above, employers must ensure shaded

break areas remain readily accessible to employees. At mobile work sites or work sites where employee move to various locations throughout the day, such as, but not limited to those commonly found in agriculture, landscaping, forestry, and utility work, employers would need to ensure that shade structures are relocated near the work area as needed or that natural sources of shade (e.g., from trees) are readily available at each work location. OSHA understands that in some mobile outdoor work environments shade structures may not be practical and employers may wish to utilize the flexibility of shade provided by large vehicles that are already on-site. Large vehicles such as trucks and vans which are used to transport employees or goods to the work site, but not as part of the work itself could be used as shade as long as the vehicle is not running. OSHA is not allowing the use of equipment used in work process, such as tractors, for shade due to the risk of accidental run-overs caused by the start-up and movement from operators who are not aware of the presence of workers nearby. Additionally, equipment used in work processes is likely to emit radiant heat after use, which may impede employee cooling. However, shade provided by buildings could be used, provided it is reasonably accessible to employee work areas. Additionally, as previously explained, the break area(s) must be large enough to accommodate all employees on break. Therefore, employers utilizing shade cast by buildings or trees would need to consider the path of shade movement throughout the day to ensure adequate areas of shade coverage are maintained and the shade is able to accommodate all employees on break.

Paragraph (e)(3)(ii) of the proposal describes the requirements for the use of air-conditioned break areas. Specifically, the proposed provision indicates that a break area could be an area that has air-conditioning if that area is in an enclosed space like a trailer, vehicle, or structure. As with the shaded areas, the air-conditioned break area would need to be large enough to accommodate the number of employees on rest breaks and be readily available. The use of air-conditioned spaces is consistent with State requirements

and existing guidance. In their State regulations, both Colorado and Washington include the use of an air-conditioned site, such as a vehicle or structure, as an alternative to providing shade for employee rest breaks (7 Colo. Code Regs. section 1103-15:3 (2023); WA, 2008b; Wash. Admin. Code 296-307-09747 (2023). It is well established that the use of air-conditioned spaces reduces the air temperature employees are exposed to (NIOSH, 2016).

Employers using air-conditioned vehicles as a break area would need to ensure that the vehicle remains readily available during work periods when the initial heat trigger is met or exceeded. For mobile employees, such as delivery drivers, employers could have employees take breaks in an air-conditioned convenience store, restaurant, or similar establishment as long as all other requirements for break areas are met.

A. Requests for Comments.

OSHA seeks comments and additional information whether it should further specify break area requirements (e.g., square footage per employee), and what those requirements should be. Also, OSHA seeks additional comments on break areas where employers have both indoor and outdoor work areas including:

- Whether OSHA should maintain separate break area requirements for these employees;
- Whether OSHA should allow outdoor employees in these facilities to utilize indoor break areas under paragraph (e)(4); and
- Whether OSHA should limit the use of indoor break areas to those that are equipped with air-conditioning.

OSHA seeks comments and additional information regarding the use of shade, including:

- Whether OSHA appropriately defined shade; if not, how should OSHA define shade for outdoor break areas;

- Whether there are situations where shade is not protective and should not be permitted; and in these cases, what should be required for break areas;
- Whether there are additional options for shade that are protective, but which OSHA has not included;
- Whether there are situations when trees are not appropriate for use as shade and other measures should be required;
- Whether there are situations when employers should be permitted to use equipment as shade; in those situations, how would employers mitigate other safety concerns such as run-over incidents;
- Whether there are situations when employers should not be able to use large vehicles as shade or concerns, including those related to safety, with generally allowing the use of large vehicles for shade; and
- Whether there are situations when artificial shade should not be permitted, such as during high winds.

OSHA seeks comments and additional information regarding the use of air-conditioned spaces, including:

- Whether OSHA should define or specify the levels at which air-conditioning must operate; and
- Whether OSHA should require that break rooms and vehicles used for breaks be pre-cooled prior to the start of the employee's break.

OSHA seeks comments and additional information regarding the use of other cooling strategies (beside shade and air-conditioning) that could be used in break areas, including:

- Whether there are other control options that would be both as effective as shade at reducing heat strain and feasible to implement;

OSHA seeks comments and additional information regarding break area requirements for mobile workers:

- OSHA did not include separate requirements and seeks additional information on the feasibility and effectiveness of the proposed controls listed under paragraph (e)(3) including the use of vehicles as a break area; and
- Whether there are control options OSHA should require for vehicles, either when used for work activities or when used as a break area.

IV. Break area(s) at indoor work sites.

Paragraph (e)(4) of the proposed standard outlines the requirements for break areas at indoor work sites. Specifically, it would require that the employer provide one or more area(s) for employees to take breaks (e.g., break room) that is air-conditioned or has increased air movement and, if appropriate, de-humidification; can accommodate the number of employees on break; and is readily accessible to the work area(s). As explained above in the *Explanation of Proposed Requirements* for paragraph (e)(3), the requirements for both outdoor and indoor break areas in this proposed standard are in addition to employers' obligations under OSHA's sanitation standards (29 CFR 1910.141, 1915.88, 1917.127, 1918.95, 1926.51, 1928.110).

Information regarding compliance with the requirements that break area(s) be large enough to accommodate all employees on break and readily accessible can be found in the *Explanation of Proposed Requirements* for paragraph (e)(3). Break area(s) at indoor work sites will often likely be specific rooms in a facility (e.g., a break room). To ensure that the break areas are readily accessible, employers would need to make sure that employees can enter the break areas for heat-related breaks (e.g., keep the break room unlocked).

At indoor work sites, the break area(s) must be air-conditioned or have a combination of increased air movement and, if appropriate, de-humidification. The

importance and effectiveness of air-conditioning and air movement in preventing HRIs were explained above in the *Explanation of Proposed Requirements* for paragraph (e)(3). OSHA is requiring de-humidification, if appropriate, in addition to increased air movement because humidity levels directly impact the body's ability to cool itself through evaporation. Humidity control is integrated into modern air-conditioning units and therefore OSHA is only requiring de-humidification to be implemented in high temperature and high humidity environments when employers are relying on increased air movement to comply with this requirement. To determine when de-humidification may be appropriate in the context of fan use, employers should consult the *Explanation of Proposed Requirements* for paragraph (e)(6).

To comply with the requirements under proposed paragraph (e)(4), employers who operate in arid environments could use evaporative or "swamp" coolers as a form of air-conditioning. Note, however, that such coolers are not effective in humid environments. It is also important to note that OSHA is not requiring employers install a permanent cooling system. The use of portable air-conditioning units or high-powered fans and portable dehumidifiers in designated break areas could also be used to comply with requirements for break areas under the proposed standard. As discussed in the *Explanation of Proposed Requirements* for paragraph (e)(6), fan use when ambient temperatures exceed 102°F has been demonstrated to be harmful under some conditions and employers must evaluate humidity levels to determine if fan use should be avoided.

Under the proposal, indoor break area(s) do not necessarily need to be located in a separate room but can be integrated within the main workspace. For example, in a manufacturing facility, there could be a designated corner or section within the main production area where employees could take their breaks. This break area could be demarcated by partitions, screens, or signage to distinguish it from the active work zones and be equipped with fans. Alternatively, an employer, who is unable to establish a break

area in their main workroom because of sensitive or hazardous work equipment or processes, can establish a break area in a separate area away from the work zone, provided that area is readily accessible to employees. Regardless of where a break area is located, the break area must allow employees to cool down effectively and drink water to hydrate.

For indoor workplaces that experience temperatures above the heat triggers but have employees who spend part of their time in air-conditioned control booths or control rooms and part of their time in other, hotter areas of the facility, the employer could utilize the control booth/room as a break area and would not need to provide a separate break area for those employees. Control booths/rooms are commonly found in industries such as manufacturing, food processing, electronics assembly, processing facilities, power plants, water treatment plants, and more. Furthermore, these spaces would qualify as break areas for other employees provided that the requirements for size and location are met. Control booths/rooms that are locked or have restricted accessibility would not be acceptable under the proposal.

A. Requests for Comments.

OSHA seeks comments and additional information regarding the use of engineering controls for indoor break areas, including:

- Whether OSHA should specify how effective engineering controls need to be in cooling the break area(s), including other measures determining effectiveness beyond temperature and humidity;
- Whether OSHA should define a temperature differential between work areas and break areas; and
- Whether OSHA should specify a temperature that break areas must be kept below.

OSHA seeks comments and additional information regarding the use of other cooling strategies (besides fans and air-conditioning) that could be used in break areas, including:

- Whether there are other control options that would be both effective at reducing heat strain and feasible to implement.

OSHA did not include an option for the use of outdoor break areas for indoor work sites and seeks comment and information on the use of outdoor break areas for employees in indoor work sites, including:

- Whether there are situations where an outdoor break area could be more effective at cooling and should be permitted; and
- Whether certain conditions must be provided for these outdoor break areas.

OSHA seeks additional comments on break areas where employers have both indoor and outdoor work areas. See *Explanation of Proposed Requirements* paragraph (e)(3)*, Requests for Comments.*

V. Indoor work area controls.

Paragraph (e)(5) contains the proposed requirements for indoor work area controls when temperatures meet or exceed the initial heat trigger. Indoor work areas would be required to be equipped with a combination of increased air movement and, if appropriate, de-humidification (paragraph (e)(5)(i)); air-conditioning (paragraph (e)(5)(ii)); or, in the case of radiant heat sources, other cooling measures that effectively reduce employee exposure to radiant heat in the work area (paragraph (e)(5)(iii)). The importance and effectiveness of air-conditioning and air movement (including dehumidification) in preventing HRIs were explained above in the *Explanation of Proposed Requirements* for paragraphs (e)(3). In addition to these, OSHA is permitting the use of other control measures for radiant heat sources because these controls result in less heat being radiated to employees.

As discussed above in the *Explanation of Proposed Requirements* for paragraph (d)(3)(i), employers would be expected to determine which work areas of indoor work sites, if any, are reasonably expected to meet or exceed the initial heat trigger. For work areas at or above the trigger, such as those near heat-generating machinery, paragraph (e)(5) would require employers to implement work area controls. OSHA understands that effective control methods can vary based on workspace circumstances and the nature of the heat source and is therefore giving employers options regarding indoor work area controls. However, each work area with exposures at or above the initial heat trigger would need be to be equipped with at least one control option. Additionally, employers could choose to use a combination of control measures.

Employers could use increased air movement (e.g., fans) and, if appropriate, de-humidification, or air-conditioning to cool the work area under paragraphs (e)(5)(i) and (ii). Under paragraph (e)(5)(i), fans could be used to increase the air movement in the work area. Employers could use overhead ceiling fans, portable floor fans, or other industrial fans to comply. Employers could also increase the air flow using natural ventilation by opening doors and windows, or vents, to allow fresh air to flow into the space, but only when doing so would be comparable to the use of fans. Natural ventilation would not be acceptable if it does not produce air movement equivalent to a fan, or if the outdoor temperature is such that natural ventilation increases the work area temperature.

Depending on the type of work being done and the location of employees in a facility, employers could choose to use ventilation to cool the entire space or just those areas where employees are present. Although paragraph (e)(5) only applies to work areas, it may be more efficient for the employer to implement the control for an entire space. With either strategy, the employer should consider the facility layout, equipment placement, and potential obstructions to ensure optimal airflow when determining where

to place fans. For example, an employer could use fans to cool a warehouse by strategically positioning them near entrances and exits to create airflow and facilitate the circulation of fresh air into the warehouse. Additionally, utilizing high-velocity fans along aisles or in areas where employees are concentrated can help dissipate heat and provide a cooling effect. Conversely, if employees only work in a discrete area(s) of a facility, an employer may choose to only provide fans in those work areas. For example, the employer could place fans in the area where employees are stationed. Adjustable fans or fans with oscillating features could be used in those areas to allow employers to direct airflow where it is most needed. Additionally, employers could consider installing overhead fans or mounting fans on adjustable stands to ensure optimal coverage and airflow distribution.

As discussed in the *Explanation of Proposed Requirements* for paragraph (e)(4), employers using fans or relying on natural ventilation in humid environments would still be expected to decrease humidity levels where appropriate. OSHA is not proposing a specific temperature or humidity level be maintained in the work areas; however, employers should ensure that the combination of air movement and humidity level effectively reduces employees' heat strain. As discussed in the *Explanation of Proposed Requirements* for paragraph (e)(6), OSHA has preliminarily determined that under some conditions, fan use may be harmful when ambient temperatures exceed 102°F and employers must evaluate humidity levels to determine if fan use is harmful when temperatures reach this threshold. Employers should consult the *Explanation of Proposed Requirements* for paragraph (e)(6) to determine when de-humidification may be appropriate in the context of fan use.

Under paragraph (e)(5)(ii) employers could use air-conditioning to meet the requirement for controlling heat exposures in indoor work areas. In arid environments, evaporative coolers, also known as "swamp coolers," could be used and would be

considered air-conditioners, even if portable. It is important to note that while an employer may choose to provide air-conditioning to the entire facility, they would not be required to do so under the proposed standard. Employers who choose to provide air-conditioning under paragraph (e)(5)(ii) would only need to implement it in areas where employees work and are exposed to temperatures above the initial heat trigger. Similar to fan use, if employees only work from fixed or designated locations in the workplace, the employer would only need to provide air-conditioning to those spaces under paragraph (e)(5)(ii). For example, if employees work only from a control booth or control room, employers could choose to install air-conditioning in the control booth or control room to comply with paragraph (e)(5)(ii). Similarly, portable air-conditioning units could be used throughout the facility to cool smaller areas where employees work. For example, an employer could position portable evaporative coolers near the entrance of a loading dock to provide immediate relief from the heat when an employee is loading or unloading goods inside the building, or a machine shop may choose to use portable air-conditioners around the workstation to cool the employee. Alternatively, a manufacturing facility may choose to install a small, air-conditioned control booth for operators to work from. All of these options would be acceptable under the proposal.

Under paragraph (e)(5)(iii), in indoor work areas with radiant heat sources, employers could choose to implement other measures that effectively reduce employee exposure to radiant heat in the workplace. Paragraph (e)(5)(iii) would allow the use of controls such as shielding or barriers, isolation, or other measures that effectively reduce employee exposure to radiant heat, in areas where employees are exposed to radiant heat created by heat-generating processes. The use of control methods for radiant heat is consistent with guidance issued by Minnesota regarding the implementation of their heat standard (MNOSHA, 2009). Options for complying with this proposed provision could include installing shielding or barriers that are radiant-reflecting to reduce the amount of

radiant heat to which employees would otherwise be exposed; isolating the source of radiant heat, such as using thermal insulation on hot pipes and surfaces; increasing the distance between employees and the heat source; and modifying the hot process or operation.

If the employer chooses to utilize radiant heat controls under paragraph (e)(5)(iii) in lieu of air-conditioning or fan use, the controls would need to effectively reduce employee exposure to radiant heat. For example, in facilities with industrial ovens, kilns, or process heat, employees may be exposed to radiant heat during loading, unloading, or maintenance tasks. Installing shielding around these heat sources can help protect employees from radiant heat during these tasks. In another example, an employer may choose to install heat-resistant barriers or insulating materials around welding stations to contain heat and prevent its transmission to adjacent work areas.

A. Requests for Comments.

OSHA seeks comments and additional information regarding the use of engineering controls for indoor work areas, including:

- Whether the standard should specify how effective engineering controls need to be in cooling the work area(s);
- Whether there are other control options (besides fan use or air-conditioning) that would be both effective at reducing heat strain and feasible to implement in cases where indoor employees are exposed to ambient heat; and
- Whether there are work areas where maintaining a high ambient temperature is necessary for the work process and, if so, how OSHA should address these work areas in the standard.

VI. Evaluation of fan use.

Paragraph (e)(6) of the proposed standard would require employers using fans under certain conditions to determine if fan use is harmful. Specifically, when ambient

temperatures exceed 102°F (39.0°C), employers using fans to comply with paragraphs (e)(4) or (5) would be required to evaluate the humidity levels at the work site and discontinue the use of fans if the employer determines that fan use is harmful.

As discussed in Section V.C., Risk Reduction, researchers in the past 10 years have increasingly evaluated the conditions under which fan use becomes harmful, using both experimental and modeling approaches. Most of this work has assumed individuals are seated and at rest; to OSHA's knowledge, only one paper has evaluated the threshold at which fans become harmful for individuals performing physical work (Foster et al., 2022a). The impact of fans is determined by both air temperature and humidity, as well as factors influencing sweat rates. Researchers have demonstrated that neither heat index nor ambient temperature alone can be used to determine beneficial versus harmful fan use; instead, ambient temperature and relative humidity must both be known (Morris NB et al., 2019; Foster et al., 2022a).

The 102°F threshold in proposed paragraph (e)(6) is derived from Figure 4 of Foster et al. 2022a and represents the lowest ambient temperature at which fan use has been demonstrated to be harmful in the researchers' model. As proposed, paragraph (e)(6) does not specify how employers must make the determination whether fan use is harmful above this threshold. However, using the other results from Figure 4 of Foster et al. 2022a, OSHA has developed the following table which identifies scenarios where the agency believes fan use would or would not be harmful:

	Fan Speed: 3.5 m/s	
Ambient Temperature	**Humidity Range:** ***Fan Use Allowed***	**Humidity Range:** ***Turn Off Fans***
102.2°F (39°C)	15-85%	< 15% or > 85%
104.0°F (40°C)	20-80%	< 20% or > 80%
105.8°F (41°C)	30-65%	< 30% or > 65%
107.6°F (42°C)	30-65%	< 30% or > 65%

109.4°F (43°C)	35-60%	< 35% or > 60%
111.2°F (44°C)	35-55%	< 35% or > 55%
113.0°F (45°C)	40-55%	< 40% or > 55%
>113.0°F (>45°C)	Discontinue all fan use	Discontinue all fan use

Using the information from this table, an employer could identify the row most closely matching the ambient temperature of the work or break area and then find the corresponding humidity range for when fans are acceptable to use. For example, if the ambient temperature of the work or break area is 104°F and the relative humidity is 50%, fans could be used. However, if the ambient temperature of the work or break area is 108°F and the relative humidity is 70%, fans should not be used.

A. Requests for Comments.

OSHA recognizes that there are several limitations with the analyses by Foster et al. 2022a, and the application of those results for this purpose. For one, the model results reported by Foster et al. assume "light clothing" only and not "work clothing," which would be more similar to a typical work uniform than the "light clothing." While the empirical evidence that the researchers collected on individuals wearing "work clothing" is largely consistent with the modeled results presented for "light clothing," there are some differences, such as the finding that fans are never beneficial at or above an ambient temperature of 45°C (113.0°F) when wearing "work clothing" (which OSHA has reflected in the table). The authors' recommendations for fan use also included a category that represented scenarios in which fans have a "minimal impact" (i.e., the effect of fans on body heat storage is close to zero). OSHA has combined this category with the category for scenarios in which fans are beneficial to produce the table above. Another limitation is the assumption of a sweat rate of approximately 1 liter per hour (the group average from empirical trials in the same study). However, factors such as acclimatization status, age, and medical history can influence sweat rates, which would

influence when fan use is beneficial (see Figure 6 [panels a and b] from Foster et al., 2022a). Finally, Foster et al. tested a fan with a velocity of 3.5 meters per second. OSHA has preliminarily determined that this is a reasonable assumption but acknowledges that varying wind velocity would also influence when fan use is beneficial (see Figure 6 [panel c] from Foster et al., 2022a).

OSHA understands the complexity and uncertainty around an evaluation of fan use and is therefore considering a simplified approach for employers to use. OSHA is requesting comments on this simplified approach and the assumptions underlying it.

More specifically, OSHA requests comments regarding its preliminary determinations on fan use and seeks the following information:

- Whether OSHA has appropriately derived recommendations for fan use from Foster et al., 2022a, and whether additional data or research should be used to supplement or revise the recommendations;
- Whether OSHA should include the above table derived from Foster et al., 2022a, or a similar table, in paragraph (e)(6), either as a mandatory requirement or as a compliance option; and,
- Whether the standard should require alternative methods for cooling employees when fans are harmful, and if so, what alternative control measures should be used.

VII. Acclimatization.

Paragraph (e)(7) of the proposed standard would establish requirements to protect new and returning employees who are not acclimatized. Evidence indicates that new and returning employees are at increased risk for HRIs. As explained in Section V.C., Risk Reduction, employees who are new on the job are often overrepresented in HRI and heat-related fatality reports. Additionally, the NACOSH Heat Injury and Illness Prevention Work Group recommended acclimatization protections for new and returning employees,

such as heightened monitoring (NACOSH Working Group on Heat, 2023), and NIOSH recommends an acclimatization plan that gradually increases new employees' work in the heat starting with 20% of the usual work duration and increasing by no more than 20% on each subsequent day (NIOSH, 2016). For returning employees, NIOSH recommends an acclimatization plan that starts with no more than 50% of the usual work duration of heat exposure that then gradually increases on each subsequent day (NIOSH, 2016). Therefore, OSHA has preliminarily determined that the requirements in paragraph (e)(7) are important for preventing HRIs and fatalities from occupational heat exposures among these employees.

Proposed paragraph (e)(7)(i) would require that employers implement one of two options for an acclimatization protocol for new employees during their first week on the job. The first option that an employer may choose, under proposed paragraph (e)(7)(i)(A) (Option A), is a plan that, at a minimum, includes the measures required at the high heat trigger set forth in paragraph (f), when the heat index is at or above the initial heat trigger during the employee's first week of work. Proposed paragraph (f)(2) requires a minimum 15-minute paid rest break at least every two hours in the break area that meets the requirements of the proposed standard, proposed paragraph (f)(3) requires observation for signs and symptoms of heat-related illness, and proposed paragraph (f)(4) requires providing hazard alerts with specified information about heat illness prevention and how to seek help if needed. See the *Explanation of Proposed Requirements* for paragraph (f)*, Requirements at the high heat trigger*, for a detailed explanation of the requirements of that section. Option A gives employers flexibility to choose an option that works best for their work site while still making sure that employees are informed, are under observation, and receive breaks, all of which will help better equip employers and employees to monitor and mitigate the effects of heat exposure in situations where the gradual acclimatization option may not be practical. While this option does not require

gradual exposure, OSHA believes that, in situations where gradual exposure may not be practical, rest breaks, observation, and hazard alerts will help protect new workers as they adjust to heat during their first week of work.

The second option that an employer may choose, under proposed paragraph (e)(7)(i)(B) (Option B), would require a gradual exposure to the heat at or above the initial heat trigger to allow for acclimatization to the heat conditions of the workplace. The gradual exposure protocol would involve restricting employee exposure to heat to no more than 20% of a normal work shift exposure duration on the first day of work and increasing exposure by 20% of the work shift exposure duration on each subsequent day from day 2 through 4. This is consistent with NIOSH's recommended acclimatization plan for new employees (NIOSH, 2016).

Employers may satisfy Option B requirements by utilizing some of the employees' work time in ways that do not require exposure to heat at or above the initial heat trigger. Examples include completing training activities or filling out work-related paperwork in an air-conditioned building. Employers may also fulfill this requirement through task replacement, whereby an employee completes another necessary task in an area that does not require exposure at or above the initial heat trigger (e.g., office work).

Additionally, if the temperature of the work site fluctuates such that the initial heat trigger is only exceeded for a portion (e.g., 2 hours) of the work shift on some or all of the days during the initial week of work, employers choosing Option A would only be required to implement the requirements of paragraph (f) during those time periods. If they choose the gradual heat exposure option for acclimatization, employers would need to coordinate the employees' heat exposure for those days with the parts of the day that are expected to meet or exceed the initial heat trigger.

Under proposed paragraph (j), employers would be required to implement the acclimatization protocols at no cost to employees. This means that employers could not

relieve employees from duty after the allotted time of heat exposure under the acclimatization protocol and not pay them for the remainder of the work shift. Because benefits would also be considered compensation, this would mean that an employer could not use an employee's paid leave to cover the hours not worked during the acclimatization period.

Proposed paragraph (e)(7)(ii) would require that employers implement one of two options for an acclimatization protocol for returning employees who have been away from the job for more than 14 days, during their first week back on the job.

The first option that an employer may choose, under proposed paragraph (e)(7)(ii)(A) (Option A), is an employer-developed plan, that at a minimum, includes the measures that would be required under proposed paragraph (f) whenever the initial heat trigger is met or exceeded, during the employee's first week of returning to work. See explanation above for new employees and the *Explanation of Proposed Requirements* for paragraph (f), *Requirements at the High Heat Trigger*, of the proposed standard for a detailed explanation of the requirements of that section.

The second option that an employer may choose under proposed paragraph (e)(7)(ii)(B) (Option B), is a protocol that requires a gradual exposure to heat at or above the initial heat trigger to allow for acclimatization to the heat conditions of the workplace. The gradual exposure protocol would restrict employee exposure to heat to no more than 50% of a normal work shift exposure duration on the first day of work, 60% on the second day of work, and 80% of the third day of work. This is consistent with NIOSH's recommended acclimatization plan for returning employees (NIOSH, 2016). Employers may satisfy these requirements by utilizing employees' work time in ways that do not require heat exposure at or above the initial heat trigger, as described above for new employees.

For occupations where returning employees may have shift schedules such as two weeks on and then two weeks off, the acclimatization protocol requirement would not go into effect because the two weeks off would not exceed 14 days. However, in situations where time off exceeds 14 days, the requirement would apply.

Proposed paragraph (e)(7)(iii) would set forth an exception to acclimatization requirements of paragraphs (e)(7)(i) and (ii) if the employer can demonstrate that the employee consistently worked under the same or similar conditions as the employer's working conditions within the previous 14 days. Same or similar conditions means that new employees must have been doing work tasks that are similar or higher in level of exertion to the tasks that are required in the new job and that they conducted these tasks in similar or hotter heat conditions than the new job (e.g., at or above the heat index for current conditions in the new job). Employers should not assume that employees who recently came from climates that are perceived to be similar or hotter (e.g., Mexico) were actually exposed to similar or hotter conditions because climate can vary dramatically based on factors such as elevation levels and humidity. Therefore, employers could check weather records to determine heat indices for the location that the employee worked at during the previous two weeks to determine if the employee was actually exposed to conditions at least as hot as in the new position.

In determining if tasks the employee conducted in the past two weeks were similar or higher in level of exertion to the tasks that are required in the new job, employers could generally consider factors such as weight carried and intensity of activity (e.g., walking versus climbing). For example, picking tomatoes and picking watermelons would generally not be considered similar tasks because of the heavier weight of the watermelons. However, picking tomatoes and picking cucumbers could generally be considered similar tasks if other job conditions are similar. Installing telephone wires on poles and laying out communication wires in a trench dug using

machinery would generally not be considered similar to laying out communication wires in a trench dug manually because of the greater work intensity involved with digging a trench manually. Laying communication wire in a pre-dug trench and conducting inspections on the ground might be considered similar tasks if both tasks primarily involve walking. Landscaping work involving weeding and laying out mulch versus hand digging trenches for drainage systems would generally not be considered similar tasks because of the greater work involved in digging trenches. However, hand digging trenches for drainage and hand digging holes to install trees and shrubs could generally be considered similar tasks if those are the primary tasked performed throughout the workday.

The employee must have engaged in similar work activities in the similar heat conditions consistently over the preceding 14 days. OSHA intends "consistently" to mean the employee engaged in the task for at least two hours per day on a majority of the preceding 14 days. This aligns with recommendations from NIOSH (NIOSH, 2016).

Examples of when this exception would not apply include when new employees' previous positions, which included similar heat conditions and exertion levels, ended longer than 14 days ago, when new employees' previous positions ended within the last 14 days and involved similar work tasks but in cooler conditions, or when new employees' previous positions ended within the last 14 days and involved hotter conditions but less exertion. The exemption would also not apply if new employees' previous positions ended less than 14 days ago but they were not performing similar work tasks in similar heat conditions for at least two hours per day on a majority of the preceding 14 days.

To demonstrate that a new employee consistently worked under the same or similar conditions as the employer's working conditions within the prior 14 days, the employer could obtain information directly from the new employee to confirm the

requirements of proposed paragraph (e)(7) are met considering the explanation of same or similar working conditions provided above. The employer could ask questions verbally or in writing about the prior work (i.e., timing, location, duration, type of work). If an employer asked new employees "in the past 14 days, did you consistently work under the same or similar conditions as the employer" but did not ask for any supporting details, the requirement would not be satisfied.

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Data or examples of successful implementation of an acclimatization program;
- Whether the term "same or similar conditions" is sufficiently clear so that employers know when the exception to the acclimatization requirement would apply for new employees, and if not, how should OSHA clarify the requirement;
- Whether a minimum amount of heat exposure to achieve acclimatization should be specified under Option B, the gradual acclimatization option;
- Whether the requirement to demonstrate that an employee consistently worked under the same or similar conditions as the employer's working conditions within the prior 14 days is sufficiently clear, and if not, how should OSHA clarify the requirement;
- Whether the standard should require acclimatization protocols during local heat waves, and if so, how OSHA should define heat waves;
- Whether the standard should require annual acclimatization of all employees at the beginning of each heat season (e.g., the first hot week of the year) and approaches for doing so;
- Examples that OSHA should consider of acclimatization protocols for industries or occupations where it may not be appropriate for an employee to conduct heat-

exposed work tasks during the first week on the job (e.g., what activities would be appropriate for these workers to achieve acclimatization);

- Data or examples that OSHA should consider in determining if acclimatization should be required in certain situations for existing employees and examples of successful acclimatization programs for such employees;
- Which option (i.e., following requirements of the high heat trigger or gradual increase in exposure to work in heat) presented in the proposal would employers implement and whether the standard should include other options;
- Whether the standard should include any additional acclimatization requirements for employees returning after less than 14 days away from work after acute illnesses that may put them at increased risk of heat-related illness (i.e., illnesses involving fever or gastrointestinal infections), and if so, suggestions and evidence for the additional requirements; and
- Considering that employees starting or returning when the heat index is above 90°F would not receive unique acclimatization benefits if the employer chose Option A, whether the standard should specify additional requirements for these scenarios, such as breaks that are more frequent or of longer duration.

OSHA has concerns that the proposed exception in paragraph (e)(7)(iii) could create incentives for employees to lie and/or employers to pressure employees to lie about their acclimatization status. For example, an employer could pressure an employee to report that they consistently worked under the same or similar conditions within the prior 14 days, so that the employer does not need to comply with paragraph (e)(7) during the employee's first week on the job. These incentives could put new and returning employees at increased risk because they are not receiving appropriate protection based on their acclimatization status. OSHA seeks comments and evidence on the likelihood of this happening and what OSHA could do to address these potential troubling incentives.

VIII. Rest breaks if needed.

Proposed paragraph (e)(8) would require employers to allow and encourage employees to take paid rest breaks in break areas that would be required under paragraphs (e)(3) or (4) if needed to prevent overheating. As discussed in Section V.C., Risk Reduction, rest breaks have been shown to be an effective intervention for preventing HRI by allowing employees to reduce their work rate and body temperature. Rest breaks allow employees time to hydrate and cool down in areas that are shaded, air-conditioned, or cooled with other measures. Therefore, OSHA preliminary finds that allowing employees to take rest breaks when they are needed to prevent overheating is an important control for preventing or reducing HRIs in the workplace.

Providing employees the opportunity to take unscheduled rest breaks to prevent overheating helps to account for protecting employees who vary in susceptibility to HRI and address scenarios where employees might experience increased heat strain. For example, unscheduled rest breaks may help to protect employees who are more susceptible to HRI for reasons such as chronic health conditions, recent recovery from illness, pregnancy, prior heat-related illness, or use of certain medications (see Section IV.O., Factors that Affect Risk for Heat-Related Health Effects). Unscheduled rest breaks may also help reduce heat strain in employees who are assigned new job tasks that are more strenuous than the tasks they were performing. Additionally, rest breaks would allow employees an opportunity to remove any PPE that may be contributing to heat strain.

Under proposed paragraph (e)(8), employees would be allowed to decide on the timing and frequency of unscheduled rest breaks to prevent overheating. However, unscheduled rest breaks must be heat-related (i.e., only if needed to prevent overheating). In addition, if the work process is such that allowing employees to leave their work station at their election would present a hazard to the employee or others, or if it would

result in harm to the employer's equipment or product, the employer could require the employee to notify a supervisor and wait to be relieved, provided a supervisor is immediately available and relieves the employee as quickly as possible.

An example of a scenario where an employee may decide they need a rest break is if the employee experiences certain symptoms that suggests the employee is suffering from excessive heat strain but does not have an HRI that would need to be addressed under proposed paragraph (g)(2) (e.g., excessive thirst, excessive sweating, or a general feeling of unwellness that the employee attributes to heat exposure). However, rest breaks to prevent overheating do not need to be tied to onset of symptoms. For example, if an employee starts to have trouble performing a task on a hot day that they do not normally have trouble performing, that may be a sign they need a break. OSHA expects that most unscheduled rest breaks to prevent overheating would typically last less than 15 minutes. In some cases, a rest break that extends beyond 15 minutes or frequent unscheduled rest breaks may be a sign that the employee may be experiencing an HRI.

As noted, proposed paragraph (e)(8) requires employers to both encourage and allow employees to take a paid rest break if needed. Employers can encourage employees to take rest breaks by periodically reminding them of that option. Although employers must allow employees to take breaks if the employee determines one is needed, nothing precludes an employer from asking or directing an employee to take an unscheduled paid rest break if the employer notices signs of excessive heat strain in an employee.

Slowing the pace of work would not be considered a rest break, and as specified in proposed paragraph (e)(8), rest breaks if needed must be provided in break areas required under paragraph (e)(3) or (4) (see *Explanation of Proposed Requirements* for paragraphs (e)(3), *Break area(s) at outdoor work sites* and (e)(4), *Break area(s) at indoor work sites* for additional discussion of break areas and *Explanation of Proposed*

Requirements for paragraph (f)(2), *Rest breaks*, for additional discussion related to rest breaks.)

Proposed paragraph (e)(8) would require that employees be paid during the time they take rest breaks needed to prevent overheating. OSHA preliminary finds it is important that these breaks be paid so that employees are not discouraged from taking them. The reason for requiring these breaks be paid is further explained in the *Explanation of Proposed Requirements* for paragraph (j), *Requirements implemented at no cost to employees*, including the importance of the requirement and how employers can ensure that employees are compensated to ensure they are not financially penalized for taking breaks that would be allowed or required under the proposed standard.

Evidence indicates that employees are often reluctant to take breaks and thus, are not likely to abuse the right to take rest breaks if needed to prevent overheating; to the contrary, the evidence shows that employees are more likely to continue working when they should take a rest break to prevent overheating. A review of the evidence showing that many employees are reluctant to take rest breaks is included in the *Explanation of Proposed Requirements* for paragraph (f)(2) *Rest breaks*.

A. Requests for Comments.

OSHA seeks comments and information on the proposed requirement to provide employees with rest breaks if needed to prevent overheating, including:

- If there are specific signs or symptoms that indicate employees need a rest break to prevent overheating;
- If employers currently offer rest breaks if needed to prevent overheating, and if so, whether employees take rest breaks when needed to prevent overheating;
- The typical duration of needed rest breaks taken to prevent overheating; and
- Any challenges to providing rest breaks if needed to prevent overheating.

In addition, OSHA encourages stakeholders to provide information and comments on the questions regarding compensation of employees during rest breaks in the *Explanation of Proposed Requirements* for paragraph (j), *Requirements implemented at no cost to employees*.

IX. Effective communication.

Paragraph (e)(9) of the proposed standard establishes requirements for effective communication at the initial heat trigger. Early detection and treatment of heat-related illness is critical to preventing the development of potentially fatal heat-related conditions, such as heat stroke (see Section V., Health Effects). Effective two-way communication provides a mechanism for education and notification of heat-related hazards so that appropriate precautions can be taken. It also provides a way for employees to communicate with the employer about signs and symptoms of heat-related illness, as well as appropriate response measures (e.g., first aid, emergency response).

The NACOSH Heat Injury and Illness Prevention Work Group recommended that elements of a proposed standard for prevention of HRIs address communication needs to meet the objective of monitoring the work site to accurately assess conditions and apply controls based on those conditions. The Work Group recommended addressing communications needs for tracking to facilitate monitoring and check-ins so that employees can report back to employers (NACOSH Working Group on Heat, 2023).

OSHA preliminarily finds that two-way, regular communication is a critical element of HRI prevention. Paragraph (e)(9) requires the employer maintain effective, two-way communication with employees and regularly communicate with employees. The means of communication must be effective. In some cases, voice (or hand signals) may be effective, but if that is not effective at a particular workplace (e.g., if employees are not close together and/or not near a supervisor), then electronic means may be needed to maintain effective communication (e.g., handheld transceiver, phone, or radio). If the

employer is communicating with employees by electronic means, the employer must respond in a timely manner for communication to be effective (e.g., providing a phone number for employees to call would not be effective if no one answers or responds in a timely manner).

The means of communication must also be "two-way" (i.e., a way for the employer to communicate with employees, and for employees to communicate with the employer). This is important because this provides a means for employees to reach the employer when someone is exhibiting the signs and symptoms of heat-related illness.

Paragraph (e)(9) also requires that employers regularly communicate with employees. The employer could comply with this requirement by regularly reaching out to employees, or setting up a system by which employees are required to make contact, or check in, with the employer. However, it is the employer's responsibility to ensure that regular communication is maintained with employees (e.g., every few hours). If a system is chosen whereby the employer requires employees to initiate communication with the employer, and if the employer does not hear from the employee in a reasonable amount of time, the employer must reach out to the employee to ensure that they are not experiencing heat-related illness symptoms. Employers must ensure that when it is necessary for an employee to leave a message (e.g., text) with the employer, the employer will respond, if necessary, in a reasonable amount of time.

This proposed requirement also applies for employees who work alone on the work site. This means that the communication system chosen by the employer must allow for communication between these employees and the employer, although the means may be different than for employees who work on a work site with multiple employees (e.g., by electronic means).

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- How employers currently communicate with employees working alone, including any challenges for effectively communicating with employees working alone and any situations where communication with employees working alone may not be feasible; and
- Whether OSHA should specify a specific time interval at which employers must communicate with employees and, if so, what the interval should be, and the basis for such a requirement.

X. Personal protective equipment (PPE).

Paragraph (e)(10) of the proposed standard would require employers to maintain the cooling properties of cooling PPE if provided to employees. The proposed standard does not require employers to provide employees with cooling PPE. However, if employers do provide cooling PPE, they must ensure the PPE's cooling properties are maintained at all times during use. It is critical that employers who provide cooling PPE maintain the equipment's cooling properties; when these properties are not maintained, the defective equipment can heighten the risk of heat injury or illness with continued use. Reports from employees indicate that the use of cooling PPE, such as cooling vests, is burdensome and increases heat retention once the cooling properties are lost or ice packs have melted (Chicas et al., 2021).

A. Requests for Comments.

OSHA requests comments and evidence as to whether there are any scenarios in which wearing cooling PPE is warranted and feasible and OSHA should require its use.

F. Paragraph (f) Requirements at or above the high heat trigger.

I. Timing.

Paragraph (f) of the proposed standard would establish requirements when employees are exposed to heat at or above the high heat trigger. As discussed in Section V.B., Basis for Initial and High Heat Triggers, OSHA has preliminarily determined that

the experimental and observational evidence support that heat index triggers of 80°F and 90°F are highly sensitive and therefore highly protective of employees. Exposures at or above the high heat trigger, a heat index of 90°F, or a corresponding wet bulb globe temperature equal to the NIOSH Recommended Exposure Limit, would require the employer to provide the protections outlined in paragraphs (f)(2) through (5). These protections would be in addition to the measures required by paragraph (e) *Requirements at or above the initial heat trigger*, which remain in effect after the high heat trigger is met.

The employer would only be required to provide the protections specified in paragraph (f) during the time period when employees are exposed to heat at or above the high heat trigger. In many cases, employees may only be exposed at or above the high heat trigger for part of their work shift. For example, employees may begin work at 9 a.m. and finish work at 5 p.m. If their exposure is below the high heat trigger from 9 a.m. until 2 p.m., and at or above the high heat trigger from 2 p.m. to 5 p.m., the employer would only be required to provide the protections specified in this paragraph from 2 p.m. to 5 p.m. Protective measures outlined in paragraph (e) *Requirements at or above the initial heat trigger,* would be required at any time when employees are exposed to heat at or above the initial heat trigger.

II. Rest breaks.

Proposed paragraph (f)(2) specifies the minimum frequency and duration for rest breaks that would be required (i.e., 15 minutes every two hours) when the high heat trigger is met or exceeded and provides clarification on requirements for those rest breaks.

A. Background on the provision.

As discussed in Section V.C., Risk Reduction, rest breaks have been shown to be an effective intervention for preventing HRI by allowing employees to reduce their work

rate and body temperature. Rest breaks also allow employees time to hydrate and cool down in areas that are shaded, air-conditioned, or cooled with other measures. OSHA preliminarily finds there are at least two reasons that warrant the inclusion of rest breaks at a minimum frequency and duration when the high heat trigger is met or exceeded. The first is that heat strain is greater in employees exposed to higher levels of heat. (See Section IV., Health Effects).

The second is that the available evidence shows many employees are not taking adequate or enough rest breaks. This evidence shows that while workers paid on a piece-rate basis (e.g., compensated based on factors such as quantity of produce picked, jobs completed, or products produced) may be especially reluctant to take breaks because of financial concerns (Lam et al., 2013; Mizelle et al., 2022; Iglesias-Rios et al., 2023; Spector et al., 2015; Wadsworth et al., 2019), a significant portion of employees paid on an hourly basis are also not taking adequate breaks for other reasons such as pressure from co-workers or supervisors, high work demands, or attitudes related to work ethics (Arnold et al., 2020; Wadsworth et al., 2019). For example, Langer et al. (2021) surveyed 507 Latinx California farmworkers (77% paid hourly) during the summers of 2014 and 2015, when California regulations to protect employees from heat required employers to provide rest breaks if needed but did not require rest breaks at a minimum frequency and duration; 39% of surveyed employees reported taking fewer than 2 rest breaks (not including lunch) per day. Additionally, in a study of 165 legally employed child Latinx farm employees (64% hourly workers) ranging in age from 10–17 years in North Carolina, 88% reported taking breaks in shade, but based on some interviews, the breaks appeared to be of short duration (e.g., "for some five minutes;" "you can take a break whenever you want. . . not for a long time. . . if you wanna get a drink of water only for a couple of minutes, three or five") (Arnold et al., 2020). The children who were interviewed by Arnold et al. (2020) reported pressure to keep up with the pace of work

and being discouraged to take breaks by co-workers or supervisors. In interviews of 405 migrant farmworkers in Georgia, 20% reported taking breaks in the shade (Fleischer et al., 2013).

In a study of 101 farmworkers (61% paid hourly) in the Florida/Georgia region, Luque et al. (2020) reported that only 23% took breaks in the shade. The need for breaks was supported by observations that while some employees carried water bottles, most were only seen drinking during rest breaks. In another study, focus group discussions with piece-rate farm employees revealed that many expressed concerns about possible losses in earnings and that they might be replaced by another employee if they took breaks. Many such employees brought their own water to work to reduce the time they are not picking produce (Wadsworth et al., 2019). In that same study by Wadsworth et al. (2019), piece rate farmworkers also described "their desire to be seen as a good worker, with great fortitude." Good workers were described by the farmworkers as those who "work fast and do not slow things down and jeopardize success for the group. They continue working in spite of the conditions or how they feel." (Wadsworth et al., 2019, p. 224). A case study highlighted in the NIOSH criteria document discusses a migrant farmworker who died from HRI after he continued to work despite a supervisor instructing him to take a break because he was working slowly (NIOSH 2016, pp. 46-47). On the day of his death, the heat index ranged from 86 to 112^{o} F.

Evidence supporting the need for required rest breaks is not limited to farmworkers. For example, a NIOSH health hazard evaluation (HHE) indicated that truck drivers for an airline catering facility often skipped breaks they were allowed to take between deliveries in an air-conditioned room at the catering facility to keep up with job demands (NIOSH, 2016, p. 44). Such attitudes appear common in employees of all sectors. Phan and Beck (2023) surveyed 107 office workers, and 25-33% of those employees reported they skipped breaks because of a high workload, not wanting to lose

momentum, or to reduce the amount of work to be completed in the future. A number of informal surveys reported similar findings for office and remote workers. In those surveys, many employees (approximately 40%) skip some breaks, particularly lunch breaks (Tork, June 14, 2021; Joblist, July 5, 2022). Common reasons for skipping lunch breaks included work demands and feelings of guilt or being judged for taking a break (Tork, June 14, 2021; Joblist, July 5, 2022). One survey also reported that a major reason why many employees do not take paid time off is because of concerns for coworkers (Joblist, July 5, 2022). Although these informal surveys cover employees who would likely not be covered by the scope of this proposed standard, these informal surveys echo the findings of the studies in the preceding paragraphs and show that employees generally do not take rest breaks or other paid time off.

Studies of presenteeism (i.e., working while ill or injured) suggest that employees may be more likely to ignore signs of excessive heat strain than they are to take breaks needed to prevent overheating. Hemp (October 2004, pp. 3-4) stated "[u]nderlying the research of presenteeism is the assumption that employees do not take their jobs lightly, that most of them need and want to continue working if they can." Although financial reasons such as lack of paid leave are often drivers of presenteeism, non-financial considerations also play a major role. One study analyzed presenteeism in many of the industries covered by the proposed standard including in the categories of agriculture, utilities, manufacturing, transportation and storage, and construction (Marklund et al., 2021). Non-financially related reasons for presenteeism reported by Marklund et al. (2021) were not wanting to burden coworkers, perception that no one else can do the work, enjoyment of work, not wanting to be perceived as lazy or unproductive, and pride. Similar reasons were reported in other studies including wanting to spare co-workers from additional work, pressure from coworkers, strong teamwork and good relationships

with coworkers, examples set by management, institutional loyalty, or a perception that taking time off is underperformance (Garrow, February 2016; Lohaus et al., 2022).

The proposed requirement to include mandatory rest breaks is consistent with recommendations by authoritative sources. For example, NIOSH recommends mandatory rest breaks (NIOSH, 2016, p. 45; NIOSH, 2017b, p.1). Additionally, ACGIH (2023) lists "appropriate breaks with shade" as an essential element of a heat stress management program. The NACOSH Working Group on Heat also recommended that scheduled, mandatory rest breaks be provided without retaliation (NACOSH Working Group on Heat, 2023, pp. 6- 7).

OSHA examined a number of studies to determine an appropriate frequency and duration of rest breaks. First, a series of laboratory studies by Notley et al. (2021; 2022a, b) provide insight on the appropriate frequency of rest breaks. In those studies, unacclimatized participants wearing a single clothing layer exercised at a moderate intensity level until stay time was reached (i.e., core temperatures reached 38°C (100.4°F) or increased by at least 1°C) at various ambient temperatures and at a relative humidity of 35% (Notley et al., 2021; 2022a, b)[1]. In a study of younger (18–30 years old) and older men (50–70 years old), data from all participants were pooled to calculate initial stay times of 111 minutes at ambient conditions of 34.1°C (93.4°F) (heat index = 93.9°F) and 44 minutes at ambient conditions of 41.4°C (106.5°F) (heat index = 119.8°F) (Notley et al., 2022b). In a study of unacclimatized younger men (mean age 22 years), older men (mean age 58 years), and older men with diabetes (mean age 60 years) or hypertension (mean age 61 years), median stay times were 128 minutes at 36.6°C (97.9°F) (heat index = 101.5°F) and 68 minutes at 41.1°C (106.5°F) (heat index = 118.5°F) (Notley et al., 2021). In a third study, unacclimatized men and women were able to work for a median time of 117 minutes at 36.6°C (97.9°F) (heat index = 101.5°F) and 63 minutes at 41.4°C (106.5°F) (heat index = 119.8°F) (Notley et al., 2022a). Overall, the results of these

studies support work times ranging from 111 minutes to 128 minutes at heat indices of 93.9°F to 101.5°F and 44 to 68 minutes at heat indices of 118.5°F to 119.8°F.

Two laboratory studies support a preliminary conclusion that rest breaks contribute to the protection of workers from the effects of heat (Uchiyama et al., 2022; Smallcombe et al., 2022). These studies were conducted over periods that could represent all or part of a workday, with light exertion exercise conducted under hot conditions (e.g., 37°C (98.6°F) and 40% relative humidity (heat index = 106°F)) in Uchiyama et al. (2022), and moderate to heavy exertion exercise conducted under four conditions: 15°C (59°F) and 50% relative humidity (referent group, heat index not relevant), 35°C (95°F) 50% relative humidity (heat index = 105°F); 40°C (104°F) and 50% relative humidity (heat index = 131°F); and 40°C (104°F), and 70% relative humidity (heat index=161°F) in Smallcombe et al. (2022). In both studies, breaks were provided in air-conditioned or cooler areas. The studies show little evidence of excessive heat strain in participants as mean core temperatures remained within 1°C of 37.5°C (99.5°C) (ACGIH, 2023, p. 244). Uchiyama et al. (2022) evaluated two work/rest protocols, including one in which participants exercised for 1 hour, rested for 30 minutes, exercised for 1 hour, rested for 15 minutes, and then exercised for another hour; increases in mean core temperatures were less than 1°C above mean baseline temperature (37.2°C) in five of the six time points reported and slightly exceeded a 1°C increase at 180 minutes, the final time point of measurement (38.29°C). OSHA finds these work/rest cycles to be similar to a late morning period of work, followed by a 30-minute lunch and then an early afternoon work/rest period, although acknowledges that the duration between rest periods is longer in the proposed rule than in this study. Also, in the Uchiyama et al. (2022) study, a lack of heat strain was also observed in a protocol consisting of 1 hour of work and 15 minutes rest, followed by three half hour work periods separated by 10-minute rest periods and, and a final half hour work period.

The Smallcombe et al. (2022) study most closely reflected a typical workday because it was conducted over a 7-hour period with cycles of 50-minute work/10-minute rest and a 1-hour lunch. Participants were tested under one referent conditions and three hot temperature conditions and average rectal temperature remained at or below 38°C (100.4°F) in all groups during each exercise period at heat indices ranging from 105°F to 161°F (table S2).

Overall, OSHA preliminarily finds that these studies show that 15-minute rest breaks would offer more protection for employees than shorter duration rest breaks, because the frequency of rest breaks in these studies by Uchiyama et al. (2022) and Smallcombe et al. (2022) was greater than what OSHA is proposing and rest breaks were provided in air-conditioned or cooler areas. OSHA expects some employees will not have access to air-conditioned areas during break periods. OSHA acknowledges uncertainties in determining a precise rest break frequency and duration, but preliminarily concludes that a minimum of a 15-minute rest break every two hours would be highly protective in many circumstances at or above the high heat trigger, while offering employers administrative convenience. For example, other approaches such as adjusting rest break frequency and duration based on weather conditions, work intensity, or protective clothing are likely to be difficult for many employers to implement. A 15-minute break every two hours is administratively convenient to implement because, as explained below, a standard meal break could qualify as a rest break, and therefore, assuming an 8-hour workday with a meal break in the middle of the day, paragraph (f)(2) would only require two other breaks, one break in the morning and a second break in the afternoon, assuming the high heat trigger is met or exceeded the entire day.

The frequency and duration of these proposed rest breaks are within the ranges of frequencies and durations required by four U.S. States that have finalized regulations protecting against HRI by requiring rest breaks under high heat conditions. First, the

California regulation for outdoor employees requires a minimum ten-minute rest period every two hours for agricultural employees, when temperatures reach or exceed 95°F (Cal. Code Regs. tit. 8, section 3395 (2024)). Second and similarly, the Colorado regulation for agricultural employees requires a minimum 10-minute rest period every two hours under increased risk conditions that include a temperature at or above 95°F (7 Colo. Code Regs. section 1103-15:3 (2023)). Third, in Oregon rules applying to agriculture as well as indoor and outdoor workplaces, employers can select from three different options for work-rest periods at high heat, including: (1) an employer-designed program with a minimum of a 10-minute break every two hours at a heat index of 90°F or greater and a 15-minute break every hour at a heat index of 100°F or greater, with possible increased frequency and duration of breaks based on PPE use, clothing, relative humidity, and work intensity; (2) development of work/rest schedules based on the approach recommended by NIOSH (see NIOSH, 2016), or (3) a simplified rest break schedule that calls for a 10-minute break every two hours, with durations and frequencies of rest breaks increasing with increases in heat index (Or. Admin. R. 437-002-0156 (2024); Or. Admin. R. 437-004-1131 (2024)). Fourth and finally, for outdoor workplaces, Washington requires a minimum 10-minute rest period every two hours at an air temperature at or above 90°F and a minimum 15-minute rest period every hour at an air temperature at or above 100°F (Wash. Admin. Code 296-307-09747 (2023)).

A NIOSH guidance document recommends work/rest cycles for employees wearing “normal clothing” that considers temperature adjusted for humidity levels and cloud cover and work intensity; in that guidance, when the need for rest cycles is triggered, work/rest cycles range from 45 minutes work/15 minutes rest to 15 minutes work/45 minutes rest, with extreme cautioned urged under some conditions (NIOSH, 2017b).

OSHA acknowledges the requirements of some States and recommendations by NIOSH to increase frequency and duration of rest breaks as heat conditions increase, but OSHA has preliminarily decided on a more simplified approach, in part because of implementation concerns raised by stakeholders, such as difficulty in implementing a more complex approach (e.g., longer and more frequent rest breaks with increasing temperature), and interference with certain types of work tasks (e.g., continuous production work and tasks such as pouring concrete that could be disrupted by more frequent breaks). In addition, the requirement to continue providing paid breaks if needed above the high heat trigger, coupled with the requirement to encourage employees to take these breaks, will help ensure that any employee that needs an additional break can take one. However, OSHA acknowledges that, for the reasons discussed above, this encouragement may become more vital as the temperature increases to ensure that employees don't forego the breaks they are entitled to. OSHA welcomes comment and data on the appropriateness of this approach.

B. Complying with rest break provisions.

The required break periods under paragraph (f)(2) are a minimum. Nothing in the proposed standard would preclude employers from providing longer or more frequent breaks. Additionally, employers would need to comply with paragraph (e)(8) (i.e., providing rest breaks if needed to prevent overheating), which may include situations where employees need more frequent or longer break periods. Paragraph (f)(2) requires employers to ensure that employees have at least one break that lasts a minimum of 15 minutes every two hours when the high heat trigger is met or exceeded. The requirement is in addition to employers' obligation under paragraph (e)(8) to allow and encourage rest breaks if needed to prevent overheating, which continues after the high heat trigger is met. However, if an employee takes a rest break under paragraph (e)(8) that lasts at least 15 consecutive minutes, that would impact when the employer would next need to

provide a break under paragraph (f)(2). For example, if the high heat trigger is exceeded for an entire 8-hour work day, and the employee takes a 15-minute break after their first hour of work because they need one to prevent overheating, the employer would not be required to provide another 15-minute break under paragraph (f)(2) for the next two hours. However, the employer's on-going obligation under paragraph (e)(8) would remain. Employers would also need to comply with paragraph (g)(2) (i.e., relieving an employee from duty when they are experiencing signs and symptoms of heat-related illness).

Under proposed paragraph (f)(2), when the high heat trigger is met or exceeded, employers would be required to provide a minimum 15-minute paid rest break at least every two hours in the break area that would be required under paragraph (e)(3) or (4). These rest breaks would be mandatory, and the employer would need to ensure that rest breaks are taken as required.

Proposed paragraphs (f)(2) and (e)(8) would require that employees be paid during rest breaks. As discussed further in the *Explanation of Proposed Requirements* for paragraph (j), *Requirements implemented at no cost to employees*, OSHA finds it important that employees be paid during the time they are taking breaks that are mandatory or needed to prevent overheating so that employees are not financially penalized and thus discouraged from taking advantage of those protections. See *Explanation of Proposed Requirements* for paragraph (j) for *Requirements implemented at no cost to employees* for a discussion of approaches employers can take to ensure that both hourly employees and piece rate employees are compensated for time on rest breaks.

Rest breaks are not the same as slowing down or pacing. In addition, performing a sedentary work activity, even if done in an area that meets the requirements of a break area under proposed paragraphs (e)(3) or (4), would not be considered a rest break under

the proposed standard. This ensures that employees can rest (thus modulating increases in heat strain) and hydrate during that rest break.

OSHA recognizes that providing a rest break every two hours might be challenging for some employers. However, employers could consider approaches such as staggering employee break times, within the required two-hour period, to ensure that some employees are always available to continue working. In other cases, employers who have concerns about employee safety, such as having to climb up and down from high locations to take a break, might be able to provide portable shade structures, if safe to use under the conditions (e.g., elevation, wind conditions). In addition, employers could consider scheduling work tasks during cooler parts of the day to avoid required rest breaks.

Proposed paragraphs (f)(2)(i) indicates that a meal break that is not required to be paid under law may count as a rest break. Whether a meal break must be paid is governed by other laws, including State laws. Under the Federal Fair Labor Standards Act, bona fide meal periods (typically 30 minutes or more) generally do not need to be compensated as work time (see 29 CFR 785.19). The employee must be completely relieved from duties for the purpose of eating regular meals. Furthermore, an employee is not relieved if they are required to perform any duties, whether active or inactive, while eating.

Proposed paragraphs (f)(2)(ii) and (iii) further clarify that total time of the rest break would not include the time that employees take to put on and remove PPE or the time to walk to and from the break area. OSHA preliminarily finds it important to exclude this time from the 15-minute rest period so employees have the full 15 minutes to cool down.

C. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Stakeholders' experiences with rest breaks required under law or by the employer, including successes and challenges with such approaches;
- Whether there is additional evidence to support a 15-minute rest break every 2 hours as effective in reducing heat strain and preventing HRIs;
- Whether OSHA should consider an alternative scheme for the frequency and/or duration of rest breaks under paragraph (f)(2). If so, what factors (such as weather conditions, intensity of work tasks, or types of clothing/PPE) should it be based on and why;
- Whether varying frequency and duration of rest breaks based on factors such as the heat index would be administratively difficult for employers to implement and how any potential administrative concerns could be addressed;
- Whether employees could perform certain sedentary work activities in areas that meet the proposed requirements for break areas without hindering the effectiveness of rest breaks for preventing HRI, including examples of activities that would or would not be acceptable; and
- Whether OSHA should require removal of PPE that may impair cooling during rest breaks.

III. Observation for signs and symptoms.

Paragraph (f)(3) of the proposed standard would establish requirements for observing employees for signs and symptoms of heat-related illness when the high heat trigger is met or exceeded. As explained in Section IV., Health Effects, heat-related illnesses can progress to life-threatening conditions if not treated properly and promptly. Therefore, it is important to identify the signs and symptoms of heat-related illness early so appropriate action can be taken to prevent the condition from worsening. OSHA preliminarily finds that observation for signs and symptoms of heat-related illness in employees is a critical component of heat injury and illness prevention.

NIOSH recommends observation for signs and symptoms of heat-related illness by a fellow worker or supervisor (NIOSH, 2016). The NACOSH Heat Injury and Illness Prevention Work Group also provided recommendations related to observation for signs and symptoms of heat-related illness in its recommendations to OSHA on potential elements of heat injury and illness prevention standard. The NACOSH Work Group recommended that there be additional requirements for workers who work alone since a buddy system is not possible in those cases, including a communication system with regular check-ins (NACOSH Working Group on Heat, 2023).

Paragraph (f)(3) would require that the employer implement at least one of two methods of observing employees for signs and symptoms of heat-related illness, with a third option for employees who work alone at a work site. As defined under proposed paragraph (b), *Signs and symptoms of heat related illness* means the physiological manifestations of a heat-related illness and includes headache, nausea, weakness, dizziness, elevated body temperature, muscle cramps, and muscle pain or spasms.

The first option, under proposed paragraph (f)(3)(i), that an employer may choose is to implement a mandatory buddy system in which co-workers observe each other. Employers could satisfy this requirement by pairing employees as "buddies" to observe each other for signs and symptoms of heat-related illness. Co-workers assigned as buddies would need to be in the same work area so that it is possible for them to observe each other. Co-workers could also use visual cues or signs and/or verbal communication to communicate signs and symptoms of heat-related illness to each other.

The second option, under proposed paragraph (f)(3)(ii), that the employer may choose is for observation to be carried out by a supervisor or heat safety coordinator. If the employer chooses this option, proposed paragraph (f)(3)(ii) specifies that no more than 20 employees can be observed per supervisor or heat safety coordinator. OSHA preliminarily finds that it is important to limit the number of employees being observed to

ensure that each employee is receiving the amount of observation needed to determine if they are experiencing any signs and symptoms of heat-related illness. Supervisors or heat safety coordinators would need to be in a position to observe the employees they are responsible for observing for signs and symptoms (e.g., in close enough proximity to communicate with and see) when observing for signs/symptoms. The supervisor or heat safety coordinator could have other tasks or work responsibilities while implementing the observation role, but they must be able to be within close enough proximity to communicate with and see those they are observing and be able to check in with the employee regularly (e.g., every two hours). When the high heat trigger is met, employers would still be responsible for meeting the proposed requirements of paragraph (e)(9), *Effective Communication*. Employees need to have a means of effective communication with a supervisor (e.g., phone, radio) and employers must regularly communicate with employees at or above both the initial and high heat triggers.

Because symptoms of heat-related illness may not be outwardly visible (e.g., nausea, headache), employers should ensure employees are asked if they are experiencing any signs and symptoms. This is especially true if the employee shows changes in behavior such as working more slowly or dropping things because this could indicate that the employee is experiencing heat-related illness but not recognizing it. It is also important that employees report any signs and symptoms they are experiencing or that they observe in others in order to prevent development of potentially life-threatening forms of heat-related illness (see proposed paragraph (h)(1)(x), *Training*). Additionally, as discussed below, certain signs and symptoms indicate a heat-related emergency.

Employees who work alone at a work site do not have a co-worker, supervisor, or heat safety coordinator present who can observe them to determine if they are experiencing signs and symptoms of heat-related illness. For employees working alone at a work site, the employer would instead need to comply with proposed paragraph

(f)(3)(iii) and maintain a means of effective, two-way communication with those employees and make contact with them at least every two hours. This means that employers must not only reach out to lone employees, but also receive a communication back from the employees. Receiving communication back from the employee allows the employee to report any symptoms. If no communication is received, this may be a sign that the employee is having a problem.

Under proposed paragraph (h)(1)(iv), employers would be required to train employees on signs and symptoms of heat-related illness and which ones require immediate emergency action. Proposed paragraph (b) defines *signs and symptoms of a heat emergency* as physiological manifestations of a heat-related illness that requires emergency response and includes loss of consciousness (i.e., fainting, collapse) with excessive body temperature, which may or may not be accompanied by vertigo, nausea, headache, cerebral dysfunction, or bizarre behavior. This could also include staggering, vomiting, acting irrationally or disoriented, having convulsions, and (even after resting) having an elevated heart rate. Employer obligations when an employee is experiencing signs and symptoms of a heat-related illness or heat emergency are addressed under proposed paragraph (g).

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Stakeholders' experiences with implementing observational systems such as those that OSHA is proposing and examples of the implementation of other observational systems for signs and symptoms of heat-related illness that OSHA should consider;
- Data of the effectiveness of such observation systems;
- The frequency at which observation as described in this section should occur;

- Whether there are alternative definitions of signs and symptoms of heat-related illness that OSHA should consider;
- Whether employers should be able to select a designee to implement observation in situations where it may not be possible to have a supervisor or heat safety coordinator present;
- Possible logistical concerns regarding proposed requirements for communication at least every two hours for employees who work alone at the work site; whether there are examples of successful implementation of these types of communication systems; examples of the types of technologies or modes of communication that most effectively support this type communication; and whether there are innovative approaches for keeping employees working alone safe from HRI and allowing for prompt response in an emergency; and
- For employees who work alone at the work site, whether the employer should know the location of the employee at all times.

IV. Hazard alert.

Paragraph (f)(4) of the proposed standard would require employers to issue a hazard alert to employees prior to a work shift or when employees are exposed to heat at or above the high heat trigger.

As explained in Section IV., Health Effects, hazardous heat can lead to sudden and traumatic injuries and heat-related illnesses can quickly progress to life threatening forms if not treated properly and promptly. To protect employees, it is not sufficient to respond to HRIs after they occur. Prevention of HRIs is critical. A hazard alert will help prevent HRIs by notifying employees of heat hazards, providing information on HRI prevention, empowering employees to utilize preventative measures, and providing practical information about how to access prevention resources (e.g., drinking water, break areas to cool down) and seek help in case of emergency.

Heat alert programs have been identified as important prevention strategies (NIOSH, 2016; Khogali, 1997). NIOSH identified heat alert programs as a strategy to prevent excessive heat stress and recommended that heat alert programs be implemented under certain high heat conditions (NIOSH, 2016, p. 10). NIOSH further describes an example of an effective heat alert program, drawing in part on recommendations described by Dukes-Dobos (1981). Effective elements of a hazard alert program include similar elements to the proposed provision (f)(4), such as "Establish[ing] criteria for the declaration of a heat alert" and "Procedures to be followed during the state of [the] [h]eat [a]lert" (e.g., reminding employees to drink water) (NIOSH, 2016, pp. 80-81).

Employees may face pressure or incentives to work through hazardous heat which can increase their risk of heat-related illness; some employees also may not recognize that they are developing signs and symptoms of a heat-related illness (see Section IV., Health Effects). The hazard alert provision would require that employers provide information about prevention measures, including employees' right to take rest breaks if needed, at the employees' election, and the rest breaks required by paragraph (f)(2), which will empower employees to utilize the preventative measures available. This requirement would also enable effective response in the event of a heat emergency by requiring employers to remind employees in advance of its heat emergency procedures.

OSHA preliminarily finds that the hazard alert requirement in proposed paragraph (f)(4) is an important strategy for the prevention of HRIs. The provision includes minimum requirements for the hazard alert and provides flexibility for employers in how they implement the provision. Additionally, employers may choose to include additional information in the alert that is appropriate for their work sites.

Paragraph (f)(4) would require that prior to the work shift or upon determining the high heat trigger is met or exceeded, the employer must notify employees of specific information relevant to the prevention of heat hazards. Specifically, the employer would

be required to notify employees of the following: the importance of drinking plenty of water; employees' right to, at employees' election, take rest breaks if needed and the rest breaks required by paragraph (f)(2); how to seek help and the procedures to take in a heat emergency; and for mobile work sites, information on the location of break area(s) required by paragraph (e)(3) or (4) and drinking water required by paragraph (e)(2). Because the location of break area(s) and drinking water may change frequently for mobile work sites, it is important to make sure employees at those work sites are reminded of their location on high heat days. Mobile work sites include work sites that change as projects progress or when employees relocate to a new project (e.g., landscaping, construction).

Paragraph (f)(4) would require the employer to issue the hazard alert prior to the work shift or upon determining the high heat trigger is met or exceeded. However, issuing the alert prior to the start of the work shift would not be required unless exposures will be at or above the high heat trigger at the start of the work shift. If the start of the work shift is below the high heat trigger and the hazard alert is not issued at the start of the work shift, then the hazard alert must be issued when the high heat trigger is met and ideally before exposure occurs. For example, if a work shift runs from 8 a.m. to 5 p.m. and the high heat trigger is not met until 10 a.m., the employer must either issue the alert at the beginning of the work shift, or issue the alert when the high heat trigger is met at 10 a.m. If an employer regularly communicates with an employee via a particular means of communication and uses that form of communication to issue the alert, then the employer can presume the notification was received. If, however, the employer has reason to believe the hazard alert was not received, they would need to take additional steps to confirm.

Employers could satisfy the requirements of this provision by posting signs with the required information at locations readily accessible and visible to employees. For

example, some employers may choose to post signs at the entrance to the work site. Signs are not an option for all employers as they may not be sufficient to ensure employees receive the hazard alert (e.g., employers with mobile employees or employees who work alone on a work site). Additionally, signs may not be an option for employers who choose not to provide the hazard alert at the start of the work shift. For example, posting a sign at the entrance to the work site would not be sufficient to ensure employees are notified after all employees have already entered the work site. Employers may also satisfy the hazard alert notification requirement by issuing the alert electronically (e.g., via email, text message) or through verbal means (e.g., an in-person meeting, radio or voicemail). Employers may be able to use the system they have in place to meet the requirements of paragraph (e)(9) for effective, two-way communication with employees to issue the hazard alert.

For any method the employer chooses to issue the hazard alert notification, the hazard alert must be sufficient to ensure all employees are notified of the information in paragraphs (f)(2)(i) through (iv). To ensure this, the hazard alert must be issued in languages and at a literacy level understood by employees.

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether any additional information should be required in the hazard alert;
- The frequency of the hazard alert, particularly in locations that frequently exceed the high heat trigger; and
- Any alternatives to a hazard alert requirement that OSHA should consider.

V. Excessively high heat areas.

Paragraph (f)(5) of the proposed standard would require that employers place warning signs at indoor work areas with ambient temperatures that regularly exceed 120°F. The warning signs must be legible, visible, and understandable to employees

entering the work area. Specifying the requirement for warning signs ensures that all employees and contractors at the work site are aware of areas with excessively high heat. Warning signs signal a hazardous situation that, if not avoided, could result in death or serious injury and, if employees need to enter the areas, serve as a reminder to take appropriate precautions.

The warning signs must be legible, visible, and understandable to employees entering the work areas. The sign must be in a location that employees can clearly see before they enter the excessively high heat area. To maintain visibility of the warning signs, employers must ensure that there is adequate lighting in the area to read the signs and that the signs are not blocked by items that would prevent employees from seeing them. The signs would have to be legible (e.g., writing or print that can be read easily). The proposed standard does not specify contents of the sign, but signs could include a signal word such as “Danger”, the hazard (e.g., “High Heat Area”), possible health effects (e.g., May Cause Heat-Related Illness or Death), information pertaining to who is permitted to access the area (e.g., Authorized Personnel Only), and what precautions entrants would have to take to safely enter the area. Employees must be able to understand the signs. Therefore, the signs must be printed in a language or languages that all potentially exposed employees understand. If it is not practical to provide signs in a language or languages spoken by all employees, employers still must ensure all employees understand what the signs mean. Employers could do this by training on what the warning signs mean and providing those employees with information regarding the extent of the hazardous area as indicated on the signs.

Employers would have to place warning signs at indoor work areas with ambient temperatures that regularly exceed 120°F. The term "regularly" means a pattern or frequency of occurrence rather than isolated incidents. This would mean that the indoor work areas experience temperatures exceeding 120°F on a frequent or recurring basis,

such as daily during certain seasons or under specific operational conditions. The process of identifying heat hazards pursuant to proposed paragraph (d) may help employers identify excessively high heat areas. Under proposed paragraph (d)(3), employers would be required to identify each work area(s) where employees are reasonably expected to be exposed to heat at or above the initial heat trigger and develop a monitoring plan. If, while monitoring, an employer determines temperatures in an indoor work area regularly exceed the 120°F threshold, then the employer would need to ensure that warning signs are placed at that work area to alert employees to the potential hazards associated with such extreme temperatures.

If an employer's work site contains an excessively high heat area(s), the employer must train employees in the procedures to follow when working in these areas (see proposed provision (h)(1)(xvi)).

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether OSHA should further specify the required location of warning signs;
- Whether OSHA should specify the wording/contents of the warning signs; and
- Whether OSHA should consider defining "excessively high heat area" as something other than a work area in which ambient temperatures regularly exceed 120°F; and evidence available to support a different temperature threshold or other defining criteria.

G. Paragraph (g) Heat illness and emergency response and planning.

Paragraph (g) of the proposed standard would establish requirements for heat illness and emergency response and planning. It would require that employers develop and implement a heat emergency response plan as part of their HIIPP, as well as specify what an employer's responsibilities would be if an employee experiences signs and symptoms of heat-related illness or a heat emergency. Effective planning and emergency

response measures can minimize the severity of heat-related illnesses when they occur and allow for more efficient access to medical care when needed.

Proposed paragraph (g)(1) specifies that the employer would be required to develop and implement a heat emergency response plan as part of their HIIPP and specifies the elements that would be required in an employer's emergency response plan. Because the emergency response plan is part of the HIIPP, some of the requirements in paragraph (c) are relevant to the emergency response plan. For example, the employer would need to seek the input and involvement of non-managerial employees and their representatives, if any, in the development and implementation of the emergency response plan (see proposed paragraph (c)(6)). See *Explanation of Proposed Requirements* for paragraph (c), for a detailed explanation of the requirements that apply to the HIIPP. Only one plan would be required for each employer (i.e., for the whole company). However, if the employer has multiple work sites that are distinct from each other, the plan would be tailored to each work site or type of work site. For instance, if an employer has employees engaged in work activities outdoors on a farm, as well as employees loading and unloading product from vehicles at various locations, the employer could have one emergency response plan with the specifications for each of these types of work sites represented. Employers may also choose to include other elements in the plan to account for any work activities unique to their workplace.

Proposed paragraph (g)(1)(i) would require employers to include a list of emergency phone numbers (e.g., 911, emergency services) in their emergency response plan. Indicating the most appropriate phone number(s) to contact in the case of an emergency helps ensure medical support and assistance are provided timely and efficiently during a heat emergency. Examples of other phone numbers for assistance aside from 911 that employers might include in the plan are those for on-site clinicians or

nurses to be contacted if an employee is experiencing signs and symptoms of a heat-related illness.

Proposed paragraph (g)(1)(ii) would require employers to include a description of how employees can contact a supervisor and emergency medical services in their emergency response plan. Because time is of the essence in emergency situations, it is important that employees know beforehand how to contact a supervisor and emergency medical services in the event of a heat emergency. For example, if employees do not have phone service or access to a phone to call for medical help, but they do have access to other means of communication such as radios, walkie-talkies, personal locator beacons, and audio signals, the employer's plan would describe how to use these other means of communication to contact a supervisor and emergency medical services.

Proposed paragraph (g)(1)(iii) would require the emergency response plan to include the individual(s) designated to ensure that heat emergency procedures are invoked when appropriate. Clearly assigning this responsibility to an individual(s) can reduce confusion and allow for swift action in the event of a heat emergency. Employers with multiple work sites or dispersed work areas may not be able to ensure heat emergency procedures are invoked without designating different individuals for each work site/area. For example, an employer with work activities inside two factories in different geographic locations would need to designate an individual(s) to ensure heat emergency procedures are invoked at each factory location.

Proposed paragraph (g)(1)(iv) would require the emergency response plan to have a description of how to transport employees to a place where they can be reached by an emergency medical provider. Planning for where employees can access emergency medical services can ensure aid is provided efficiently. This is especially important for employers with employees engaging in work activities in remote locations, where medical services cannot reach them. For example, an employee working in an area of a

farm not easily accessible by vehicle or an employee in a difficult to reach location inside a building being constructed.

Proposed paragraph (g)(1)(v) would require the emergency response plan to include clear and precise directions to the work site, including the address of the work site, which can be provided to emergency dispatchers. For certain work sites that are remote/hard to reach or do not have an address, GPS coordinates may be necessary to share with emergency responders, or a description of how to get to their location from the main road, entrance, building, etc. If an employee's work site changes frequently, the emergency response plan would need to include a clear strategy to account for their changing locations and ensure directions to the work site are readily accessible when needed to provide to emergency dispatchers.

Proposed paragraph (g)(1)(vi) would require the emergency response plan to include procedures for responding to an employee experiencing signs and symptoms of heat-related illness, including heat emergency procedures for responding to an employee with suspected heat stroke. Prior development of emergency response procedures can ensure assistance and medical attention are provided efficiently and quickly. In developing the procedures, OSHA expects that employers would look to resources such as OSHA guidance (e.g., *www.osha.gov/heat-exposure/illness-first-aid*) and NIOSH recommendations (NIOSH, 2016) for more information.

The proposed standard does not require employers to develop a plan for each work site. However, the employer's emergency response plan(s) must contain all the information required by paragraphs (g)(1)(i) through (vi), some of which will vary based on work site. The employer may be able to incorporate the information needed for different work sites into the same emergency response plan. For instance, if an employer has employees engaged in work activities outdoors on a farm, as well as employees loading and unloading product from vehicles at various locations, the employer could

have one emergency response plan with the specifications for each of these types of work sites represented. Employers may also choose to include elements beyond those required by paragraphs (g)(1)(i) through (vi) in their plan to account for any work activities unique to their workplace.

Proposed paragraph (g)(2) specifies the actions employers would be required to perform if an employee is experiencing signs and symptoms of heat-related illness. Under proposed paragraph (b) *signs and symptoms of heat-related illness* means the physiological manifestations of a heat-related illness and includes headache, nausea, weakness, dizziness, elevated body temperature, muscle cramps, and muscle pain or spasms.

Proposed paragraph (g)(2)(i) would require employers to relieve from duty employees who are experiencing signs and symptoms of heat-related illness. Relieving the employee from duty would allow the employer to address the heat-related illness according to the procedures outlined in proposed paragraphs (g)(2)(ii) through (v). This relief from duty, including the time it takes to address the heat-related illness according to the procedures outlined in proposed paragraphs (g)(2)(ii) through (v), must be with pay and must continue at least until symptoms have subsided.

Proposed paragraph (g)(2)(ii) would require that employers monitor employees who are experiencing signs and symptoms of heat-related illness, and proposed paragraph (g)(2)(iii) would require employers to ensure that employees who are experiencing signs and symptoms of heat-related illness are not left alone. Continuous monitoring of employees who are experiencing signs and symptoms of a heat-related illness is important to ensure that if the employee's condition progresses to a heat emergency, someone is there to observe it and quickly respond.

Proposed paragraph (g)(2)(iv) would require employers to offer employees who are experiencing signs and symptoms of heat-related illness on-site first aid or medical

services before ending any monitoring. This requirement is intended to be consistent with existing first aid standards (e.g. 29 CFR 1910.151, 1915.87, 1926.23 and 1926.50), which require accessibility of medical services and first aid to varying degrees depending on the industry or whether the workplace is near an infirmary, clinic or hospital. Proposed paragraph (g)(2)(iv) would not add new requirements for staff to be fully trained in first aid. Employers would offer the first aid or medical resources they have available to employees on site to the extent already required by first aid standards and follow the procedures developed in paragraph (g)(1)(vi) as applicable.

Proposed paragraph (g)(2)(v) would require employers to provide employees who are experiencing signs and symptoms of heat-related illness with means to reduce their body temperature. Examples of means to reduce body temperature are instructing those employees to remove all PPE and heavy outer clothing (e.g., heavy/impermeable protective clothing) and moving them to a cooled or shaded area (e.g., the break areas required under paragraphs (e)(3) and (4)) where they can sit and drink cool water. If the employer has cooling PPE (e.g., cooling bandanas or neck wraps, and vests and cooling systems such as hybrid personal cooling systems (HPCS), and fans) available on site, those could also be used to cool employees as well. (For information related to the requirement to reduce an employee's body temperature in the case of a heat emergency, see discussion below.)

Proposed paragraph (g)(3) specifies the actions employers would have to perform if an employee is experiencing signs and symptoms of a heat emergency. Proposed paragraph (b) defines *signs and symptoms of a heat emergency* as the physiological manifestations of a heat-related illness that requires emergency response and includes loss of consciousness (i.e., fainting, collapse) with excessive body temperature, which may or may not be accompanied by vertigo, nausea, headache, cerebral dysfunction, or

bizarre behavior. This could also include staggering, vomiting, acting irrationally or disoriented, having convulsions, and (even after resting) having an elevated heart rate.

Proposed paragraph (g)(3)(i) would require employers to take immediate actions to reduce the employee's body temperature before emergency medical services arrive. Rapid cooling of body temperature during a heat emergency is essential because the potential for organ damage and risk of death increase in a short period of time, often before medical personnel can respond, transport, and treat the affected individual (Belval et al., 2018). Immersion in ice water or cold water has been reported to have the fastest cooling rates (McDermott et al., 2009b; Casa et al., 2007). However, OSHA realizes that immersing an employee in a tub of ice/cold water is not an option that will be available at most work sites. Other, more practical methods of reducing employee body temperature using materials that employers are likely to have, or are similar to materials that an employer is likely to have, on site have been reported to be highly effective in preventing death from exertional heat stroke. DeGroot et al. (2023) reported survival of 362 of 363 military personnel who were suffering from exertional heat stroke and were treated with strategically placed "ice sheets" (i.e., bed sheets soaked in ice water). McDermott et al. (2009a) reported 100% survival in nine marathon runners who were suffering from exertional heat stroke and treated by dousing with cold water and rubbing of ice bags over major muscle groups. Another possible approach is the tarp-assisted cooling oscillation (TACO) method that involves wrapping the affected individual in a tarp with ice (Luhring et al., 2016).

Proposed paragraph (g)(3)(ii) would require employers to contact emergency medical services immediately for employees experiencing signs and symptoms of a heat emergency, and proposed paragraph (g)(3)(iii) would require employers to also perform the activities described in paragraphs (g)(2)(i) through (iv) to aid an employee during a heat emergency until emergency medical services arrives. Some heat-related illnesses can

quickly progress and become fatal (see Section IV., Health Effects). The severity and survival of heat stroke is highly dependent on how quickly effective cooling and emergency medical services are provided (Vicario et al., 1986; Demartini et al., 2015; Belval et al., 2018).

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether OSHA should require a minimum duration of time an employee who has experienced signs and symptoms of heat-related illness must be relieved from duty, and what an appropriate duration of time would be before returning employees to work;
- Whether OSHA should add or remove any signs or symptoms in the definitions of *signs and symptoms of heat-related illness* and *signs and symptoms of a heat emergency* in proposed paragraph (b). If so, provide clear and specific evidence for inclusion or exclusion;
- Whether paragraph (g)(3)(i) should require specific actions that the employer must take to reduce an employee's body temperature before emergency medical services arrive, rather than merely requiring unspecified "immediate actions". If so, describe those specific actions; and
- Whether paragraph (g)(3)(i) should prohibit certain actions to reduce an employee's body temperature before emergency medical services arrive. If so, indicate if there is evidence or observations that certain actions are not helpful or are counterproductive.

H. Paragraph (h) Training.

Paragraph (h) of the proposed standard establishes requirements for training on HRI prevention. It addresses the topics to be addressed in training, the types of employees who are to be trained, the frequency of training, triggers for supplemental

training, and how training is to be conducted. OSHA regularly includes training requirements in its standards to ensure employees understand the hazards addressed by the standard, the protections they are entitled to under the standard, and the measures to take to protect themselves. Here, OSHA believes that it is essential that employees are trained on heat-related hazards and how to identify signs and symptoms of HRIs as well as on the requirements of the proposed standard and the employer's heat-related policies and procedures. This training ensures that employees understand heat hazards and the workplace specific control measures that would be implemented to address the hazard. The effectiveness of the proposed standard would be undermined if employees did not have sufficient knowledge and understanding to identify heat hazards and their health effects or sufficient knowledge and understanding of their employer's policies and procedures for addressing those hazards.

Surveys and interviews with diverse working populations highlight the need for additional education and training on HRIs and prevention strategies amongst employees (Luque et al., 2020; Smith et al., 2021; Fleischer at al., 2013; Stoecklin-Marois et al., 2013; Langer et al., 2021; Jacklitsch et al., 2018). The NACOSH Heat Injury and Illness Prevention Work Group recommended that both workers and supervisors are trained in heat illness and injury prevention strategies. Additionally, the Work Group recommended that the training program includes the following elements: identification of hazards; mitigation of hazards through prevention; reporting of signs and symptoms; and emergency response. OSHA preliminarily finds that effective training is an essential element of any heat injury and illness prevention program and that the requirements in proposed paragraph (h) are necessary and appropriate to ensure the effectiveness of the standard as a whole.

Proposed paragraph (h)(1) establishes the initial training requirements for all exposed employees. It would require employers to ensure that each employee receives,

and understands, training on the topics outlined in proposed paragraphs (h)(1)(i) through (xvi) prior to the employee performing any work at or above the initial heat trigger. Requiring that initial training occur before employees perform any work at or above the initial heat trigger ensures that the employees have all the knowledge necessary to protect themselves prior to their exposure to the hazard.

This provision, like paragraphs (h)(2) through (h)(4), would require employers to ensure that employees, including supervisors and heat safety coordinators, understand the training topics. While OSHA does not mandate testing or specific modes of ascertaining employee understanding of the training materials, OSHA expects that all required training will include some measure of comprehension. Different ways that employers could ensure comprehension of the training materials include a knowledge check (e.g., written or oral assessment) or discussions after the training. Post training assessments may be particularly useful for ensuring employee participation and comprehension when employers offer online training. Proposed paragraph (h)(5), discussed below, includes additional requirements for presentation of the training.

Proposed paragraph (h)(1)(i) would require employers to provide training on heat stress hazards. Heat stress is the total heat load on the body. There are three major types of hazards which contribute to heat stress: (1) environmental factors such as high humidity, high temperature, solar radiation, lack of air movement, and process heat (i.e., radiant heat produced by machinery or equipment, such as ovens and furnaces), (2) use of personal protective equipment or clothing that can inhibit the body's ability to cool itself, and (3) the body's metabolic heat (i.e., heat produced by the body during work involving physical activity and exertion). Employers should make employees aware of all the sources of heat at the workplace that contribute to heat stress.

Proposed paragraph (h)(1)(ii) would require employers to provide training on heat-related injuries and illnesses. See Section IV., Health Effects, for a discussion of

HRIs. Examples of heat-related illnesses include heat stroke, heat exhaustion, heat cramps, heat syncope, and rhabdomyolysis. Heat-related injuries that could result from heat illness include slips, trips, falls, and other injuries that could result from the mishandling of equipment due to the effects of heat stress.

Proposed paragraph (h)(1)(iii) would require employers to provide training on risk factors for heat-related injury or illness, including the contributions of physical exertion, clothing, personal protective equipment, a lack of acclimatization, and personal risk factors (e.g., age, health, alcohol consumption, and use of certain medications). As noted above, physical exertion, clothing, and personal protective equipment all increase an employee's heat load. More information on acclimatization and how it affects risk is included in Section V.C., Risk Reduction, and more information about personal risk factors is included in Section IV.O., Factors that Affect Risk for Heat-Related Health Effects.

Proposed paragraph (h)(1)(iv) would require employers to provide training on signs and symptoms of heat-related illness and which ones require immediate emergency action. As defined in proposed paragraph (b), *signs and symptoms of heat-related illness* means the physiological manifestations of a heat-related illness and includes headache, nausea, weakness, dizziness, elevated body temperature, muscle cramps, and muscle pain or spasms. Also defined in proposed paragraph (b), *signs and symptoms of a heat emergency* means the physiological manifestations of a heat-related illness that requires emergency response and includes loss of consciousness (i.e., fainting, collapse) with excessive body temperature, which may or may not be accompanied by vertigo, nausea, headache, cerebral dysfunction, or bizarre behavior. This could also include staggering, vomiting, acting irrationally or disoriented, having convulsions, and (even after resting) having an elevated heart rate. Employers must train employees on how to identify these signs and symptoms of heat-related illness in themselves and their coworkers and when

to employ the employer's emergency response procedures, as required under proposed paragraph (g). That provision specifies the actions that an employer must take both when an employee experiences signs and symptoms of a heat-related illness and when an employee experiences signs and symptoms of a heat emergency. For further discussion see the *Explanation of Proposed Requirements* for Paragraph (g).

Proposed paragraphs (h)(1)(v) through (vii) would require employers to train employees on the importance of removing PPE that may impair cooling during rest breaks, taking rest breaks to prevent heat-related illness or injury, and that rest breaks are paid, and drinking water to prevent heat-related illness or injury. Removing PPE when possible, allows employees to cool down faster during rest breaks. As discussed in Section V.C., Risk Reduction, drinking adequate amounts of water and taking rest breaks are important for reducing heat strain that could lead to HRI. Training on these topics could give the employer an opportunity to address common misperceptions regarding heat, such as that drinking cold water in the heat is harmful. In addition, proposed paragraph (h)(1)(viii) and (ix) would require that employers train employees on where break areas and employer provided water are located. This would ensure employees are aware of the locations of break areas and water and encourage their effective utilization.

Proposed paragraph (h)(1)(x) would require employers to train employees on the importance of reporting signs and symptoms of heat-related illnesses that they experience personally or those they observe in co-workers. Training employees to be observant of and to report early any signs and symptoms of heat-related illnesses they see at the workplace is a key factor to identifying and addressing potential heat-related incidents before they result in a serious illness or injury. In addition, employers should ensure that employees are familiar with the employer's own procedures for reporting signs and symptoms of a heat emergency or heat-related illness pursuant to its heat emergency response plan as required in proposed paragraph (g).

Proposed paragraph (h)(1)(xi) would require employers to train employees on all the policies and procedures applicable to the employee's duties, as indicated in the work site's HIIPP. Employees play an important role in effective implementation of the employer's work site-specific policies and procedures to prevent heat-related illnesses and injury, and training on these policies and procedures is necessary to ensure that they are implemented effectively. OSHA recognizes that employees perform various duties and therefore likely need different types of training, and the proposed requirement allows employers flexibility to account for these differences in their training programs. Thus, certain components of the training may need to be tailored to an employee's assigned duties. For example, while all employees would require training on recognizing signs and symptoms of heat-related illness, employees observing a co-worker as part of buddy system under proposed paragraph (f)(3)(i) may require additional training on how to report signs and symptoms according to the policies and procedures established and implemented by the employer. In another example, the individual designated by the employer to ensure that emergency procedures are invoked when appropriate under proposed paragraph (g)(1)(iii) might require more detailed training on the employer's heat emergency response procedures. Another example could be training employees who wear vapor-impermeable clothing on the policies and procedures the employer has implemented to protect them under proposed paragraph (c)(3).

Proposed paragraph (h)(1)(xii) would require employers to train employees on the identity of the heat safety coordinator. Under proposed paragraph (c)(5), the heat safety coordinator would be designated to implement and monitor the HIIPP and would be given authority to ensure compliance with the HIIPP. Therefore, employees could contact the heat safety coordinator to ask questions about the HIIPP, to provide feedback on the policies and procedures, or report possible deficiencies with implementation of the HIIPP. Employers should encourage employees to contact the heat safety coordinator for

these reasons. To ensure that employees are able to contact the heat safety coordinator, employers could provide the name of the individual and other information needed to contact them as part of the training required under this paragraph.

Proposed paragraph (h)(1)(xiii) would require employers to train employees on the requirements of this standard. While proposed paragraph (h)(1)(xi) would require training on all policies and procedures applicable to an employee's duties as noted in the employer's HIIPP, training under (h)(1)(xiii) would ensure that employees are familiar with all requirements of this proposed standard. For example, employees would have to be informed of the requirements related to employee participation, including in the development, implementation, review and update of the HIIPP under proposed paragraph (c), and identifying work areas with reasonable expectations of exposures at or above the initial heat trigger, and in developing and updating the monitoring plan under proposed paragraph (d). Employees would also need to be informed that requirements of the proposed standard would be implemented at no cost to employees under proposed paragraph (j). The proposed provision would also ensure that employees are made familiar with the employer's heat-related policies and procedures.

Proposed paragraph (h)(1)(xiv) would require employers to train employees on how to access the work site's HIIPP. If relevant this would include training on how to access both digital or physical copies.

Proposed paragraph (h)(1)(xv) would require employers to train employees on their right to protections under this standard (e.g., rest breaks, water), and that employers are prohibited from discharging or in any manner discriminating against any employee for exercising those rights. Employees' right to be free from retaliation for availing themselves of the protections of the standard or for raising safety concerns comes from section 11(c) of the OSH Act, 29 U.S.C. 660(c), and requiring employers to train on these protections is consistent with the purpose of that provision. Proposed paragraph

(h)(1)(xv) is also consistent with section 8(c)(1) of the Act, 29 U.S.C. 657(c)(1), which directs the Secretary to issue regulations requiring employers to keep their employees informed of their protections under the Act and any applicable standards, through posting of notices or "other appropriate means." This training ensures that employees know that they have a right to the protections required by the standard. Having employers acknowledge and train their employees about their rights under this standard provides assurance that employees are aware of the protections afforded them and encourages them to exercise their rights without fear of reprisal. They may otherwise fear retaliation for utilizing the protections afforded them under the standard or for speaking up about workplace heat hazard concerns. This fear would undermine the effectiveness of the standard because employee participation plays a central role in effectuating the standard's purpose.

Proposed paragraph (h)(1)(xvi) would require that if the employer is required under paragraph (f)(5) to place warning signs for excessively high heat areas, they would be required to train employees on procedures to follow when working in these areas. These procedures could include, but are not limited to, any PPE that might be required when working in those areas, if relevant, and reminders to remove PPE when taking rest breaks in break areas and should reinforce employees' access to rest breaks in break areas, required under paragraph (f)(2), and drinking water, required under paragraph (e)(2), as appropriate.

Proposed paragraph (h)(2) would require the employer to ensure that each supervisor responsible for supervising employees performing any work at or above the initial heat trigger and each heat safety coordinator receives training on, and understands, both the topics outlined in paragraph (h)(1) and the topics outlined in paragraphs (h)(2)(i) and (ii). Proposed paragraph (h)(2)(i) would require the employer to train supervisors and heat safety coordinators on the policies and procedures developed to comply with the

applicable requirements of this standard, including the policies and procedures for monitoring heat conditions developed to comply with paragraphs (d)(1) and (d)(3)(ii). Proposed paragraph (h)(2)(ii) would require the employer to train supervisors and heat safety coordinators on procedures they would have to follow if an employee exhibits signs and symptoms of heat related illness, which an employer is required to develop for its HIIPP pursuant to proposed paragraph (g)(1)(vi). This would ensure effective and rapid treatment and care for employees experiencing signs and symptoms of heat-related illness. OSHA included these proposed provisions to ensure that supervisors and heat safety coordinators receive additional training needed to perform their duties as specified in the proposed standard.

Proposed paragraph (h)(3) would require the employer to ensure that each employee receives annual refresher training on, and understands, the subjects addressed in paragraph (h)(1) of the proposed standard. This paragraph would also require that each supervisor and heat safety coordinator additionally receive annual refresher training on, and understands, the topics addressed in paragraph (h)(2). OSHA preliminarily finds that annual training is needed to refresh and reinforce an employee's recollection and knowledge about the topics addressed in this paragraph. This proposed provision also indicates that for employees who perform work outdoors, the employer must conduct the annual refresher training before or at the start of the heat season. This can vary depending on the weather conditions in the geographic region where the employer is located. Accordingly, OSHA intends this requirement to be flexible and to allow employers leeway to determine the start of the heat season, so long as those determinations are reasonable. For example, in northern States such as Michigan, employers might find it best to do annual training before the time when temperatures commonly reach the initial heat trigger or above. In those cases, temperatures are likely to be below the initial heat trigger for a substantial portion of the year and employees are likely to need reminders of

all policies and procedures related to heat, both for the initial and high heat triggers. Employers can determine when heat season is for them based on normal weather patterns and would be required to conduct training prior to or at the start of the heat season. In most instances, OSHA expects that employers would do this no sooner than 30 days before the start of their heat season, so that employees can recall training materials easily, rather than for example, 6-months before the start of heat season. For new employees at outdoor work sites, this may result in some employees receiving the annual refresher training less than a year after the initial training.

Proposed paragraph (h)(4) specifies when supplemental training would be required. Proposed paragraph (h)(4)(i) would require the employer to ensure that employees promptly receive and understand additional training whenever changes occur that affect the employee's exposure to heat at work (e.g., new job tasks, relocation to a different facility or area of a facility). For example, if an employee is assigned to a new task or workstation that exposes them to high process heat or to outdoor work where the employee is exposed to hazardous heat, and such employee was not previously trained on the necessary topics required under this paragraph, then the employer would have to provide that employee with the requisite training. Similarly, if an employee is assigned to a new work area to which different heat-related policies and procedures apply, they would need to be trained on these area-specific policies and procedures. Additional examples could include when an employer's work site experiences heat waves, when new heat sources are added to the workplace, or when employees are assigned to a new task where they need to wear vapor-impermeable PPE (i.e., non-breathable). In these instances, the training required under this provision would have to comport with the requirements of the rest of this paragraph.

Proposed paragraph (h)(4)(ii) would require that each employee promptly receives, and understands, additional training whenever changes occur in policies and

procedures addressed in paragraph (h)(1)(xi) of this proposed standard. Proposed paragraph (c) would require employers to monitor their HIIPP to ensure ongoing effectiveness. When doing so, the employer may find that the policies and procedures are inadequate to protect employees from heat hazards. If so, the employer would have to update those policies and procedures. When this happens, employers would be required to train all employees on the new or altered policies and procedures so that the employees are aware of the new policies and procedures and how to follow them to reduce their risk of developing heat-related illnesses and injuries.

Proposed paragraph (h)(4)(iii) would require that each employee promptly receives, and understands, additional training whenever there is an indication that an employee(s) has not retained the necessary understanding. Examples of this would include employees who appear to have forgotten signs and symptoms of heat-related illnesses or how to respond when an employee is experiencing those signs and symptoms. It is essential that employees remain familiar with training they have received so they continue to have the knowledge and skills needed to protect themselves and possibly co-workers from heat hazards. Supplemental training under paragraph (h)(4)(iii) must be provided to those employees who have demonstrated a lack of understanding or failure to follow the employer's heat policies and procedures or comply with the requirements of this proposed standard.

Proposed paragraph (h)(4)(iv) would require that each employee promptly receives, and understands, additional training whenever a heat-related injury or illness occurs at the work site that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness. Occurrences of these types of heat-related injuries and illnesses could indicate that one or more employees are not following policies and procedures for preventing or responding to heat-related illnesses and injuries. After a heat-related illness or injury in the workplace occurs that meets the requirements

of proposed paragraph (h)(4)(iv), OSHA expects that each employee would receive supplemental training. This training could be a "lessons learned" or "alert" type training.

Both initial and supplemental training are important components of an effective heat injury and illness prevention program. Initial training provides employees with the knowledge and skills they need to protect themselves against heat hazards, and also emphasizes the importance of following workplace policies and procedures in the HIIPP. Supplemental training ensures employees continue to have the knowledge and skills they need to protect themselves from heat hazards. It provides an opportunity to present new information that was not available during the initial training or that becomes relevant when an employee's duties change. Additionally, supplemental training is necessary when an employee demonstrates that they have not retained information from the initial training (e.g., by failing to follow appropriate policies and procedures). Supplemental training does not necessarily need to include all information covered in the initial training, as only some policies or procedures may need to be reviewed, and employees will receive a full refresher training annually.

Proposed paragraph (h)(5) would require that all training provided under paragraphs (h)(1) through (4) is provided in a language and at a literacy level each employee, supervisor, and heat safety coordinator understands. In addition, the provision would require that the employer provide employees with an opportunity for questions and answers about the training materials. For the training to be effective, the employer must ensure that it is provided in a manner that the employee is able to understand. Employees have varying educational levels, literacy, and language skills, and the training must be presented in a language, or languages, and at a level of understanding that accounts for these differences. This may mean, for example, providing materials, instruction, or assistance in Spanish rather than English if the employees being trained are Spanish-speaking and do not understand English. The employer is not required to provide training

in the employee's preferred language if the employee understands both languages; as long as the employee is able to understand the material in the language used, the intent of the proposed standard would be met. As explained above with respect to paragraph (h)(1), OSHA does not mandate testing or specific modes of ascertaining employee understanding of the training materials, but expects that all required training will include some measure of comprehension.

The proposed provision does not specify the manner in which training would be delivered. Employers may conduct training in various ways, such as in-person (e.g., classroom instruction or informal discussions during safety meetings/toolbox talks), virtually (e.g., videoconference, recorded video, online training), using written materials, or any combination of those methods. However, this paragraph would require the employer to provide an opportunity for employees to ask questions regardless of the medium of training. It is critical that trainees have the opportunity to ask questions and receive answers if they do not fully understand the material that is presented to them. If it is not possible to have someone present or available during the training, employers could provide the contact information of the individual that employees can contact to answer their questions (e.g., an e-mail or telephone contact). OSHA expects employers to make an effort to respond to questions promptly.

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether the agency should require other training topics in the standard;
- Whether the inclusion of separate training requirements for supervisors and heat safety coordinators is appropriate, or whether the duty-specific training requirements in proposed paragraph (h)(1) are sufficient;
- Whether the agency has identified appropriate triggers for supplemental training;

- Whether the agency should require annual refresher training or whether the more performance-based supplemental training requirements are sufficient; and
- Whether the agency should specify certain criteria that define the start of heat season.

I. Paragraph (i) Recordkeeping.

Paragraph (i) of the proposed standard would require certain employers to create written or electronic records of on-site temperature measurements and establishes the duration of time that employers must retain those records. Specifically, it applies to employers that have indoor work areas where there is a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger, and that are therefore required to conduct on-site temperature measurements under paragraph (d)(3)(ii). These employers must have and maintain written or electronic records of these measurements. Under paragraph (i), employers must retain these records for a minimum of six months.

Maintaining these records, whether written or electronic, serves several purposes. It will assist OSHA in determining conditions at the work site, which will facilitate OSHA's ability to verify employers' compliance with the standard's provisions. Additionally, these records may facilitate employers identifying trends in indoor temperatures and their effect on employee health and safety. In the event of a heat-related injury or illness, these records can help employers assess the conditions at the time of the injury or illness in order to prevent such an event from recurring.

Paragraph (i) applies to indoor work areas only. This is because employers cannot accurately rely on weather forecasting to predict and monitor temperatures in these areas like they can for outdoor work areas. It is therefore not possible for OSHA or the employer to recreate historic temperature records for indoor work areas in the absence of on-site temperature measurement records. OSHA has preliminarily determined that six

months is an appropriate timeframe for records retention because this is the maximum time permitted for an OSHA investigation (see 29 U.S.C. 658(c)). There are several commercially available heat monitoring devices that are capable of maintaining electronic logs of recorded measurements for six months (ERG, 2024b). Therefore, employers can comply with the recordkeeping requirement by using monitoring devices with sufficient storage capability. Alternatively, employers could comply by creating and maintaining written records based on monitoring devices that do not have digital recording capabilities.

A. Requests for Comments.

OSHA requests comments and evidence regarding the following:

- Whether six months is an appropriate and feasible duration of time to maintain records of monitoring data;
- Whether permitting employers to maintain records on devices that store data locally is appropriate; and
- Whether the standard should require retention of any other records, and if so, for what duration.

J. Paragraph (j) Requirements implemented at no cost to employees.

Proposed paragraph (j) provides that implementation of all requirements of the standard must be at no cost to employees, including paying employees their normal rate of pay when compliance requires employee time. This provision is included to make it clear that the employer is responsible for all costs associated with implementing the standard, including not only direct monetary expenses to the employee, but also reasonable time to perform required tasks and training.

This proposed requirement is consistent with the OSH Act, which requires employers to ensure a safe and healthful workplace. The OSH Act reflects Congress's determination that the costs of compliance with the Act and OSHA standards are part of

the cost of doing business and OSHA may foreclose employers from shifting those costs to employees (see *Am. Textile Mfrs. Inst., Inc. v. Donovan*, 452 U.S. 490, 514 (1981); *Phelps Dodge Corp. v. OSHRC*, 725 F.2d 1237, 1239-40 (9th Cir. 1984); see also *Sec'y of Labor v. Beverly Healthcare-Hillview*, 541 F.3d 193, 198-201 (3d Cir. 2008)). The proposed requirement is also consistent with OSHA's longstanding practice in prior rulemakings. See, e.g., Employer Payment for Personal Protective Equipment; 72 FR 64342, 64344 (Nov. 15, 2007); Occupational Exposure to Bloodborne Pathogens, 56 FR 64004, 64125 (Dec. 1991). The intent of proposed paragraph (j) is that the standard be implemented at no cost to employees because employer payment for items, such as access to water and shade, is necessary to ensure employees are provided safe working conditions and are protected from the hazard of heat stress. Employees are more likely to take advantage of various workplace protections if such protections are provided at no cost to them. Moreover, as explained in Section VIII., Distributional Analysis, workers from underserved populations are disproportionately exposed to occupational heat hazards. For all workers, but particularly more vulnerable workers, protection from occupational hazards must not depend on workers' ability to pay for those protections. In indicating that the implementation of all requirements of this standard must be at no cost to the employee, OSHA considers costs to include not only direct monetary expenses to the employee, but also the time and other expenses necessary to perform required tasks.

The following discussion highlights specific proposed requirements in paragraphs (c) *Heat injury and illness prevention plan,* (d) *Identifying heat hazards,* (e) *Requirements at or above the initial heat trigger*, (f) *Requirements at or above the high heat trigger,* (g) *Heat illness and emergency response and planning*, and (h) *Training*. This discussion is illustrative of the requirement that employees are not to bear the costs of implementing the standard. However, the requirement in proposed paragraph (j)

applies to all provisions of the proposed standard, including employee time spent to implement or comply with those provisions.

Proposed paragraphs (c)(6) and (7) would require employers to seek the input and involvement of non-managerial employees and their representatives, if any, in the development and implementation of the heat injury and illness prevention plan (HIIPP) and during any reviews or updates of the HIIPP. Similarly, proposed paragraph (d)(3)(iv) would require the employer to seek the input and involvement of non-managerial employees and their representatives, if any, when evaluating the work site to identify work areas with a reasonable expectation of exposures at or above the initial heat trigger and in developing and updating monitoring plans. Under these paragraphs, the employer would be required to cover the expenses of non-managerial employees such as any travel costs that may be necessary, and to pay employees their normal rate of pay for the time necessary to engage in the development, implementation, and the required reviews and updates of the employer's HIIPP and monitoring plan.

Proposed paragraph (e)(2) would require the employer to provide access to potable water for drinking that is placed in locations readily accessible to the employee, suitably cool, and of sufficient quantity to provide access to 1 quart of drinking water per employee per hour. To ensure this is provided at no cost to employees, the employer would not only need to pay for the water, its container, and the means to utilize the water (cups, bottles, etc.) but would be required to pay employees their normal rate of pay for time necessary to consume water and any time that may be necessary to travel to and from the location where water is provided. For example, if an employee works in an area where water cannot be made available due to safety considerations (e.g., certain areas in foundries) or because of the presence of toxic materials, and must walk to a water fountain in a break room to obtain water, the employer would be required to pay the

employee for the time required to walk to the water fountain, consume water, and return to the work area.

Proposed paragraph (e)(7) would require employers to implement an acclimatization protocol for new and returning employees when they would be exposed to heat at or above the initial heat trigger except when the employer can demonstrate the employee consistently worked under the same or similar conditions as the employer's working conditions within the prior 14 days. An acclimatization protocol sets forth the process whereby employees gradually adapt to work in the heat. Proposed paragraph (e)(7)(i) specifies the acclimatization protocol for new employees exposed to heat at or above the initial heat trigger during their first week on the job. The employer would have a choice to either: (A) implement an acclimatization plan that, at minimum, would include the measures in proposed paragraph (f) (i.e., rest breaks, observation for signs and symptoms of heat-related illness, a hazard alert, and warning signs at excessively high heat areas); or (B) provide for gradual acclimatization to heat in which employee exposure to heat is restricted to no more than 20% of a normal work shift exposure duration on the first day of work, 40% on the second day of work, 60% of the third day of work, and 80% on the fourth day of work. Proposed paragraph (e)(7)(ii) specifies the acclimatization protocol for returning employees (i.e., employees who have been away (e.g., on vacation or sick leave) for more than 14 days) exposed to heat at or above the initial heat trigger during their first week back on the job. The employer would have a choice to either: (A) implement an acclimatization plan that, at minimum, would incorporate the measures in proposed paragraph (f) whenever the heat index is at or above the initial heat trigger during the employee's first week upon returning to work; or (B) provide for gradual acclimatization to heat in which employee exposure to heat is restricted to no more than 50% of a normal work shift exposure during the first day of work, 60% on the second day of work, and 80% on the third day of work.

An employer who chooses to provide a plan for gradual acclimatization to heat in which employee exposure to heat is restricted would be required to compensate the employee for the hours they would typically be expected to work, i.e., the employee's normal full shift, after acclimatization. For example, if a new employee would be expected to work 8 hours on a normal shift after acclimatization and the new employee would be restricted to 50% exposure during the normal work shift or 4 hours on the first day, the employer would be required to compensate the employee at their normal rate of pay for the full 8 hours even if the employee worked for only 4 hours.

OSHA anticipates that many employers would provide employees with other work (e.g., work activities performed in indoor work areas or vehicles where air-conditioning consistently keeps the ambient temperature below 80°F, sedentary work activities at indoor work sites) during the acclimatization period when they are restricted from duties that involve exposure to heat at or above the initial heat trigger. Employees would still be able to work a full 8-hour shift as long as their duration of exposure to heat at or above the initial heat trigger is limited to the specified duration.

Proposed paragraphs (e)(8) and (f)(2) would require that employees be paid during the rest breaks required by those provisions. OSHA finds it important that employees be paid during the breaks to which they are entitled under the standard so that employees are not financially penalized and thus discouraged from taking advantage of those protections. For employees compensated on an hourly basis, this means employees would need to receive the same hourly rate of pay during rest breaks required by paragraphs (e)(8) and (f)(2) as they would receive while working.

Some employees are paid on a piece-rate basis, meaning they are compensated based on factors such as jobs completed, quantity of produce picked, or products produced. Examples of employees compensated on a piece-rate basis include agricultural employees paid by the pound of produce picked, mechanics paid for each type of job

completed (e.g., oil change or tune-up), warehouse employees paid by the number and size of orders filled, manufacturing employees paid by the number of products manufactured, or construction employees paid by the size and type of job completed. Employees paid on a piece-rate basis may be especially reluctant to take breaks. In a study by Wadsworth et al., 2019, focus group discussions with piece-rate farm employees revealed that many expressed concerns about possible losses in earnings and that they might be replaced by another employee if they took breaks, and many such employees brought their own water to work to reduce the time they are not picking produce.

To ensure piece rate employees are not discouraged from taking rest breaks, the proposed standard would require employers to compensate them at their normal rate of pay for time necessary for rest breaks. In the context of piece rate employees and for purposes of this proposed standard, OSHA intends the phrase "normal rate of pay" to mean the rate that results from the following approach, which has also been adopted by the State of California (Cal. Lab. Code section 226.2 (eff. Jan 1, 2021)): employers would determine the normal rate of pay for piece-rate employees by dividing the total weekly pay by the total hours worked during the work week, not including heat-related rest breaks. That value would be multiplied by the total time of heat-related rest breaks to determine how much employees need to be paid for those breaks. For example, if a piece-rate employee works a 5-day work week, 8 am to 4:30 pm with a 30-minute unpaid lunch break from 12-12:30 each day, and earns $600 in piece rate pay for the week, and under proposed paragraph (f)(2) the employer would be obligated to provide two 15-minute heat-related rest breaks per day (i.e., the employee is exposed at or above the high heat trigger from 8 am to 4:30 pm each day), that employee would receive a normal rate of pay of $16/hour for heat-related rest breaks based on the following formula:

Formula for Heat-Related Rest Break Compensation of Piece-rate Employees
Total heat-related rest break time/week = 0.5 hours/day x 5 days/week = 2.5 hours/week
Hours worked, excluding non-meal heat-related breaks = 40 hours – 2.5 hours = 37.5 hours
Heat-related rest break compensation per hour = $600 ÷ 37.5 hours = $16/hour

For an employee who also took rest breaks needed to prevent overheating under proposed paragraph (e)(8), the time of those rest break(s) would be added to the total heat-related rest break time per week to calculate the employee's normal rate of pay. OSHA has preliminarily determined that this approach accurately represents the normal rate of pay for piece-rate workers and thereby ensures that these workers would not lose pay when taking advantage of the standard's protection.

Proposed paragraph (g)(2)(i) would require that an employee experiencing signs and symptoms of heat-related illness must be relieved from duty. The proposed standard would require the employer to pay employees their normal pay while they are relieved from duty until the signs and symptoms subside.

Proposed paragraph (h) would establish requirements for training on heat hazards and associated protective measures. All training provided by the employer to meet the requirements of the standard would be required to be provided at no cost to the employee. The employer would be required to pay employees for time spent in training, including any time needed to travel to and from training.

A. Requests for Comments.

OSHA requests comments and information on the following:

- Whether OSHA should consider an alternative approach to calculating normal rate of pay for piece-rate employees, and what those alternative approaches are;
- Whether OSHA should make the calculation for piece rate workers' normal rate of pay explicit in paragraph (j); and

- Whether proposed paragraph (j) mandating that requirements be implemented at no cost to employees is adequate, or whether there are other potential costs to employees that OSHA should take into consideration.

K. Paragraph (k) Dates.

Paragraph (k) of the proposed standard would establish the effective date for the final standard and the date for compliance with the requirements specified in the standard. In paragraph (k)(1), OSHA proposes an effective date 60 days after the date of publication of the final standard in the *Federal Register*. This period is intended to allow affected employers the opportunity to familiarize themselves with the standard.

Paragraph (k)(2) of the proposed standard would require employers to comply with all requirements of the standard 90 days after the effective date (150 days after the date of publication of the final standard in the *Federal Register*). The proposed compliance date is intended to allow adequate time for employers to undertake the necessary planning and preparation steps to comply with the standard. OSHA has preliminarily concluded that 90 days is sufficient time for employers to develop a heat injury and illness prevention plan (HIIPP), identify heat hazards in their workplace(s), implement the protective measures required under the standard, and provide required training to employees.

A. Requests for Comments.

OSHA solicits comment on the adequacy of the proposed effective and compliance dates. OSHA aims to ensure that protective measures are implemented as quickly as possible, while also ensuring that employers have sufficient time to implement these measures. In addition, the agency is interested in whether there are any circumstances that would warrant an alternative timeframe for compliance, including a shorter timeframe, and seeks comment on approaches that would phase in requirements of the standard.

L. Paragraph (l) Severability.

The severability provision, paragraph (l) of the proposed standard, serves two purposes. First, it expresses OSHA's intent that the general presumption of severability should be applied to this standard; i.e., if any section or provision of the proposed standard is held invalid or unenforceable or is stayed or enjoined by any court of competent jurisdiction, the remaining sections or provisions should remain effective and operative. Second, the severability provision also serves to express OSHA's judgment, based on its technical expertise, that each individual section and provision of the proposed standard remains workable in the event that one or more sections or provisions are invalidated, stayed, or enjoined; thus, the severance of any provisions, sections, or applications of the standard will not render the standard ineffective or unlawful as a whole. Consequently, the remainder of the standard should be allowed to take effect.

With respect to this rulemaking, it is OSHA's intent that all provisions and sections be considered severable. In this regard, the agency intends that: (1) in the event that any provision within a section of the standard is stayed, enjoined, or invalidated, all remaining provisions within remain workable and shall remain effective and operative; (2) in the event that any whole section of the standard is stayed, enjoined, or invalidated, all remaining sections remain workable and shall remain effective and operative; and (3) in the event that any application of a provision is stayed, enjoined, or invalidated, the provision shall be construed so as to continue to give the maximum effect to the provision permitted by law.

Although OSHA always intends for a presumption of severability to be applied to its standards, the agency has opted to include an explicit severability clause in this standard to remove any potential for doubt as to its intent. OSHA believes that this clarity is useful because of the multilayered programmatic approach to risk reduction it proposes here. The agency has preliminarily determined that the suite of programmatic

requirements described in Section VII., Explanation of Proposed Requirements, is reasonably necessary and appropriate to protect employees from the significant risks posed by exposure to heat in the workplace. While OSHA preliminarily finds that these requirements substantially reduce the risk of occupational injury and illness from exposure to heat when implemented together, the agency also believes that each individual requirement will independently reduce this risk to some extent, and that each requirement added to the first will result in a progressively greater reduction of risk. For example, should a reviewing court find the requirement of paragraph (f)(2), requiring 15 minute rest breaks every two hours in high heat conditions invalid for some reason, the remainder of controls required by the standard in those conditions would still provide necessary protections to employees, and OSHA would intend that the rest of the standard should stand. Therefore, OSHA intends to have as many of the protective measures in this standard implemented as possible to reduce employees' risk of occupational injury, illness, and death from exposure to heat. Should a court of competent jurisdiction determine that any provision or section of this standard is invalid on its face or as applied, the court should presume that OSHA would have issued the remainder of the standard without the invalidated provision(s) or application(s). Similarly, should a court of competent jurisdiction determine that any provision, section, or application of this standard is required to be stayed or enjoined, the court should presume that OSHA intends for the remainder of the standard to take effect. See, e.g., *Am. Dental Ass'n v. Martin,* 984 F.2d 823, 830–31 (7th Cir. 1993) (affirming and allowing most of OSHA's bloodborne pathogens standard to take effect while vacating application of the standard to certain employers).

VIII. Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis

OSHA has examined the impacts of this rulemaking as required by Executive Order 12866 on Regulatory Planning and Review (September 30, 1993), Executive Order

13563 on Improving Regulation and Regulatory Review (January 18, 2011), Executive Order 14094 entitled "Modernizing Regulatory Review" (April 6, 2023), the Regulatory Flexibility Act (RFA) (September 19, 1980, Pub. L. 96354), section 202 of the Unfunded Mandates Reform Act of 1995 (March 22, 1995; Pub. L. 104-4), and Executive Order 13132 on Federalism (August 4, 1999).

Executive Orders 12866 and 13563 direct agencies to assess all costs and benefits of available regulatory alternatives and, if regulation is necessary, to select regulatory approaches that maximize net benefits (including potential economic, environmental, public health and safety effects, distributive impacts, and equity).[5] The Executive Order 14094 entitled "Modernizing Regulatory Review" (hereinafter, the Modernizing E.O.) amends section 3(f)(1) of Executive Order 12866 (Regulatory Planning and Review). The amended section 3(f) of Executive Order 12866 defines a "significant regulatory action" as an action that is likely to result in a rule: (1) having an annual effect on the economy of $200 million or more in any 1 year (adjusted every 3 years by the Administrator of the Office of Information and Regulatory Affairs (OIRA) for changes in gross domestic product), or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, territorial, or Tribal governments or communities; (2) creating a serious inconsistency or otherwise interfering with an action taken or planned by another agency; (3) materially altering the budgetary impacts of entitlement grants, user fees, or loan programs or the rights and obligations of recipients thereof; or (4) raise legal or policy issues for which centralized review would meaningfully further the President's priorities or the principles set forth in this Executive Order, as specifically authorized in a timely manner by the Administrator of OIRA in each case.

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[5] While OSHA presents the following analysis under the requirements of Executive Orders 12866 and 13563, the agency ultimately cannot simply maximize net benefits due to the overriding legal requirements in the OSH Act.

A regulatory impact analysis (RIA) must be prepared for regulatory actions that are significant per section 3(f)(1) ($200 million or more in any 1 year). OMB's OIRA has determined this rulemaking is significant per section 3(f)(1) as measured by the $200 million or more in any 1 year. Accordingly, OSHA has prepared this Preliminary Economic Analysis (PEA)[6] that to the best of the agency's ability presents the costs and benefits of the rulemaking. OIRA has reviewed this proposed standard, and the agency has provided the following assessment of its impact.

A. Market Failure and Need for Regulation.

I. Introduction.

Executive Order 12866 (58 FR 51735 (September 30, 1993)) and Executive Order 13563 (76 FR 3821 (January 18, 2011)) direct regulatory agencies to assess whether, from a legal or an economic view, a Federal regulation is needed to the extent it is not "required by law." Executive Order 12866 states: "Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people." This Executive Order further requires that each agency "identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action)" and instructs agencies to "identify and assess available alternatives to direct regulation." (58 FR 51735 (September 30, 1993)). This section addresses those issues of market failure and alternatives to regulation as directed by the Executive Order.

OSHA is proposing a new standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings (29 CFR 1910.148) because the agency has

[6] OSHA historically has referred to their regulatory impact analyses (RIAs) as Economic Analyses in part because performing an analysis of economic feasibility is a core legal function of their purpose. But a PEA (or Final Economic Analysis) should be understood as including an RIA.

preliminarily determined, based on the evidence in the record, that there is a compelling public need for a comprehensive standard addressing employees' occupational exposure to hazardous heat. OSHA presents the legal requirements governing this standard and its preliminary findings and conclusions supporting the proposed standard in Section II., Pertinent Legal Authority, and throughout other sections of the preamble.

As detailed in Section VIII.B., Profile of Affected Industries, OSHA has preliminarily determined that millions of employees are exposed to occupational heat hazards that place them at a significant risk of serious injury, illness, and death. Employees exposed to heat suffer higher rates of non-fatal heat-related injuries and illnesses (HRIs) and heat-related fatalities, including heat stroke, heat exhaustion, heat syncope, rhabdomyolysis, heat cramps, hyponatremia, heat edema, and heat rash; and heat-related injuries, including falls, collisions, and other workplace accidents (see Section IV., Health Effects for additional information). OSHA estimates that the proposed standard would prevent 531 heat-related fatalities (of the estimated 559 annual fatalities) and 16,027 HRIs per year (of the estimated 24,656 annual HRIs).

These estimates have potential limitations. The parameters used to estimate the magnitude of underreporting of HRIs and the effectiveness of the proposed standard have considerable uncertainty. Furthermore, these estimates do not account for other expected benefits from the rule (e.g., reduction in indirect traumatic injuries due to heat and reduction in worker disutility). For additional discussion see Sections VIII.E.IV., Additional Unquantified Potential Benefits and VIII.E.V., Uncertainty in Benefits.

OSHA has also preliminarily determined that the standard is technologically and economically feasible (see Section IX., Technological Feasibility and Section VIII.D., Economic Feasibility). The agency not only finds that this proposed standard is necessary and appropriate to ensure the safety and health of employees exposed to heat, as required by the OSH Act, but also demonstrates, in this section, that this standard corrects a

market failure in which labor markets fail to adequately protect employee health and safety.

Even a perfectly functioning market maximizes efficient allocation of goods and services at the expense of other important social values to which the market (as reflected in the collective actions of its participants) is indifferent or undervalues. In such cases, government intervention might be justified to address a compelling public need. The history and enactment of the OSH Act indicate a Congressional view that American markets undervalued occupational safety and health when it set forth the Act's protective purposes and authorized the Secretary of Labor to promulgate occupational safety and health standards.

As discussed in this section, OSHA concludes there is a demonstrable failure of labor markets to protect employees from exposure to significant, unnecessary risks from heat exposure. The agency recognizes that many firms and governments have responded to the risks from heat exposure by implementing control programs for their employees. Information that OSHA has collected suggests that many employees with occupational exposure to hazardous heat currently receive some level of protection against heat hazards and some existing control programs may be as protective as the proposed standard. Nevertheless, the effectiveness of labor markets in providing the level of employee health and safety required by the OSH Act is not universal, as many other employers in the same sectors fail to provide their employees with adequate protection against heat hazards. This is evidenced by the documented injuries, illnesses, and deaths discussed throughout this preamble. Accordingly, the existence of adequate protections in some workplaces speaks to the feasibility of the standard, not necessarily to the lack of need.

In this case, OSHA has preliminarily determined that protections are needed to ensure the safety and health of employees exposed to heat. This section is devoted to

showing that markets fail with respect to optimal risk for occupational exposure to heat hazards. Other sections of this preamble address whether, given that markets fail, a new regulation is needed.

The discussion below considers why labor markets, as well as information dissemination programs, workers' compensation systems, and tort liability options, each may fail to protect employees from heat hazards, resulting in the need for a more protective OSHA standard.

II. Labor Market Imperfections.

Under suitable conditions, a market system is economically efficient in the following sense: resources are allocated where they are most highly valued; the appropriate mix of goods and services, embodying the desired bundle of characteristics, is produced; and further improvements in the welfare of any member of society cannot be attained without making at least one other member worse off.

Economic theory, supported by empirical data, posits that, in the labor market, employers and their potential employees bargain over the conditions of employment, including not only salary and other employee benefits, but also occupational risks to employee safety and health. Employers compete among themselves to attract employees. In order to induce potential employees to accept hazardous jobs, employers must offer a higher salary—termed a "wage premium for risk" or "risk premium" for short—to compensate for the additional job risk.[7] Because employers must pay higher wages for more hazardous work, they have an incentive to make the workplace safer by making safety-related investments in equipment and training or by using more costly but safer work practices. According to economic theory, the operation of the labor market will

[7] The concept of compensating wage differentials for undesirable job characteristics, including occupational hazards, goes back to Adam Smith's *The Wealth of Nations*, which was originally published in 1776. More recent empirical investigation has tended to validate the core theory, with the acknowledgement of labor market imperfections, as otherwise noted in this section (e.g., Lavetti, 2023).

provide the optimal level of occupational risk when each employer's additional cost for job safety just equals the avoided payout in risk premiums to employees (Lavetti, 2023). The theory assumes that each employer is indifferent to whether it pays the higher wage or pays for a safer or more healthful workplace but will opt for whichever costs less or improves productivity more.

For the labor market to function in a way that leads to optimal levels of occupational risk, three conditions must be satisfied. First, potential employees and employers must have the same, perfect information—that is, they must be fully informed about their workplace options, including job hazards, or be able to acquire such information. Second, participants in the labor market must directly bear all the costs and obtain all the benefits of their actions. In other words, none of the direct impacts of labor market transactions can be externalized to outside parties. Third, the relevant labor markets must be perfectly competitive, which requires a large number of employers, a large number of employees, and other conditions such that no individual economic agent is able to influence the risk-adjusted wage, and such that the risk-adjusted wage, net of other amenities, is equal to the marginal revenue associated with their output (Card, 2022).

The discussion below examines (1) imperfect information, (2) externalities, and (3) imperfect competition in the labor market in more detail, with particular emphasis on employee exposure to heat hazards, as appropriate.[8]

A. Imperfect Information.

As described below, imperfect information about job hazards is present at several levels that reinforce each other: employers frequently lack knowledge about workplace hazards and how to reduce them; employees are often unaware of the workplace risks to

[8] The section on workers' compensation insurance later in this section identifies and discusses other related market imperfections.

which they are exposed; and employees typically have difficulty in understanding the risk information they are able to obtain. Imperfect information at these various levels has likely impeded the efficient operation of the labor market regarding workplace risk because employees—unaware of job hazards—do not seek, or receive, full compensation for the risks they bear. As a result, even if employers have full knowledge about the risk, their employees do not. If employees do not have full knowledge about the risk, employers have less incentive to invest in safer working conditions than they would in the presence of full information since wages are suppressed below what full knowledge by the employees would yield.

I. Lack of Employer Information.

In the absence of regulation, employers may lack economic incentives to optimally identify the safety and health risks that their employees face.[9] Furthermore, employers have an economic incentive to withhold the information they do possess about job hazards from their employees, whose response would be to demand safe working conditions or higher wages to compensate for the risk. Relatedly, in the absence of regulation, employers, as well as third parties, may have fewer incentives to develop new technological solutions to protect employees on the job.[10]

This suggests that, without regulation, and the incentives that come with it, many employers are unlikely to make themselves aware of the magnitude of heat-related safety and health risks in the workplace or of the availability of effective ways of ameliorating or eliminating these risks. OSHA believes that requiring employers to monitor heat conditions will help to alleviate situations in which employers and/or employees may not realize situations when heat becomes hazardous.

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[9] Other private parties may lack sufficient incentives to invest resources to collect and analyze occupational risk data due to the public-good nature of the information. See Ashford and Caldart (1996).

[10] For evidence of regulatory stimuli inducing innovations to improve employee health and safety, see, for example, Ashford et al. (1985), as well as more recent evidence from OSHA's regulatory reviews under section 610 of the RFA (5 U.S.C. 610).

II. Lack of Employee Information about Health Hazards.

Markets cannot adequately address the risks of occupational heat exposure if employees and employers are unaware of the changes in risk brought about by an employer's actions or inaction. Even if employees and employers are aware of a risk, the employer may have limited economic motivation to install controls unless the employees are able to accurately assess the effects of those controls on their occupational risks.

Accordingly, even if employees have a general understanding that they are at increased risk of injury or illness from occupational exposure to heat, it is unrealistic to expect, absent mandatory regulatory requirements, that they know the precise risks associated with different exposure levels or the exposures they are experiencing, much less that they can use that knowledge to negotiate a significant reduction in exposures and other protections or (if more desirable) trade it for greater hazard pay.

Both experimental studies and observed market behavior suggest that individuals have considerable difficulty rationally processing information about low-probability, high-consequence events such as occupational fatalities and long-term disabilities.[11] For example, many individuals may not be able to comprehend or rationally act on risk information when it is presented, as risk analysis often is, in mathematical terms—a 1/1,000 versus a 1/10,000 versus a 1/100,000 annual risk of death from occupational causes.

Of course, in the abstract, many of the problems that employers and employees face in obtaining and processing occupational risk can lead employees to overestimate as well as underestimate the risk. However, some of the impacts of heat exposure may be

[11] The literature documenting risk perception problems is extensive. See the classic work of Tversky and Kahneman (1974). For a recent summary of risk perception problems and their causes (Thaler and Sunstein, 2009).

sufficiently infrequent, unfamiliar, or unobvious that many employees (and at least some employers) may be completely unaware of the risk, and therefore will underestimate it.

In addition, for markets to optimally address this risk, employees need to be aware of the changes in risk brought about by an employer's actions. Even if employees are aware of a risk, the employer may have limited economic motivation to install controls or implement protective measures unless the employees are able to accurately assess the effects of those controls or measures on their occupational risks. Furthermore, there is substantial evidence that most individuals are unrealistically optimistic, even in high-stakes, high-risk situations and even if they are aware of the statistical risks (Thaler and Sunstein, 2009). Although the agency lacks specific evidence on the effect of these attitudes on assessing occupational safety and health risks, this suggests that some employees underestimate their own risk of work-related injury or illness and, therefore, even in situations where they have the bargaining power to do so, may not bargain for or receive adequate compensation for bearing those risks. Finally, the difficulty that employees have in distinguishing marginal differences in risk at alternative worksites, both within an industry and across industries, creates a disincentive for employers to incur the costs of reducing workplace risk.

B. Externalities.

Externalities arise when an economic transaction generates direct positive or negative spillover effects on third parties not involved in the transaction. The resulting spillover effect, which leads to a divergence between private and social costs, undermines the efficient allocation of resources in the market because the market is imparting inaccurate cost and price signals to the transacting parties. Applied to the labor market, when costs are externalized, they are not reflected in the decisions that employers and their potential employees make—leading to allocative distortions in that market.

Negative externalities exist in the labor market because many of the costs of occupational injury and illness are borne by parties other than individual employers or employees. The major source of these negative externalities is the occupational injury or illness cost that workers' compensation does not cover.[12] Employees and their employers often bear only a portion of these costs. Outside of workers' compensation, employees incapacitated by an occupational injury or illness and their families often receive health care, rehabilitation, retraining, direct income maintenance, or life insurance benefits, much of which are paid for by society through Social Security and other social insurance and social welfare programs.[13]

Furthermore, substantial portions of the medical care system in the United States are heavily subsidized by the government so that part of the medical cost of treating injured or ill employees is paid for by the rest of society (Nichols and Zeckhauser, 1977). To the extent that employers and employees do not bear the full costs of occupational injury and illness, they will ignore these externalized costs in their labor market negotiations. The result may be an inefficiently high level of occupational risk.

C. Imperfect Competition.

In the idealized labor market, the actions of large numbers of buyers and sellers of labor services establish the market-clearing, risk-compensated wage, so that individual employers and employees effectively take that wage as given. However, the labor market is not one market, but many markets differentiated by location, occupation, and other factors; entrants in the labor market face search frictions because of limited information

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[12] Workers' compensation is discussed separately later in this section. As described there, in many cases (particularly for smaller firms), the premiums that an individual employer pays for workers' compensation are only loosely related, or unrelated, to the occupational risks that that employer's employees bear. In addition, workers' compensation does not cover chronic occupational diseases in most instances. For that reason, negative externalities tend to be a more significant issue in the case of occupational exposures that result in diseases.

[13] In addition, many occupational injuries and most occupational illnesses are not processed through the workers' compensation system at all. In these instances, employees receive care from their own private physician rather than from their employer's physician.

on employment options; and, furthermore, in wage negotiations with their own employees, employers are typically in an advantageous position relative to all other potential employers (e.g., Card, 2022). In these situations, discussed below, employers may have sufficient power to influence or to determine the wage their employees receive. This may undermine the conditions necessary for perfect competition and can result in inadequate compensation for employees exposed to workplace hazards. Significant unemployment levels, local or national, may also undermine the conditions necessary for adequate compensation for exposure to workplace hazards (Hirsch et al., 2018).

Beyond the classic—but relatively rare—example of a town dominated by a single company, there is significant evidence that some employers throughout the economy are not wage-takers but, rather, face upward-sloping labor supply curves and enjoy some market power in setting wages and other conditions of employment.[14] An important source of this phenomenon is the cost of a job search and the employer's relative advantage, from size and economies of scale, in acquiring labor market information.[15] Another potentially noteworthy problem in the labor market is that, contrary to the model of perfect competition, employees with jobs cannot without cost quit and obtain a similar job at the same wage with another employer. Employees leaving their current job may be confronted with the expense and time requirements of a job search, the expense associated with relocating to take advantage of better employment opportunities, the loss of firm-specific human capital (i.e., firm-specific skills and knowledge that the employee possesses[16]), the cost and difficulty of upgrading job skills, and the risk of a prolonged period of unemployment. Finally, employers derive market

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[14] See Borjas (2000), Ashenfelter et al. (2010), and Boal and Ransom (1997). The term "monopsony" power or "oligopsony" power are sometimes applied to this situation.

[15] See Borjas (2000). As supplemental authorities, Weil (2014) presents theory and evidence both in support of this proposition and to show that, in many situations, larger firms have more market power than smaller firms, while Boal and Ransom (1997) note that the persistent wage dispersion observed in labor markets is a central feature of equilibrium search models.

[16] MacLeod and Nakavachara (2007) note the correlation between firm-specific skills and relatively high income.

power from the fact that a portion of the compensation their employees receive is not transferable to other jobs. Examples include job-specific training and associated compensation, seniority rights and associated benefits, and investments in a pension plan.

Under the conditions described above, employers would not have to take the market-clearing wage as given but could offer a lower wage than would be observed in a perfectly competitive market,[17] including less than full compensation for workplace health and safety risks. As a result, relative to the idealized competitive labor market, employers would have less incentive to invest in workplace safety. In any event, for reasons already discussed, an idealized wage premium is not an adequate substitute for a workplace that puts a premium on health and safety.

III. Non-Market and Quasi-Market Alternatives.

The following discussion considers whether non-market and quasi-market alternatives to the proposed standard would be capable of protecting employees from heat hazards. The alternatives under consideration are information dissemination programs, workers' compensation systems, and tort liability options.

A. Information Dissemination Programs.

One alternative to OSHA's proposed standard could be the dissemination of information, either voluntarily or through compliance with a targeted mandatory information rule, akin to OSHA's Hazard Communication standard (29 CFR 1910.1200), which would provide more information about the safety and health risks associated with exposure to environmental heat. Better informed potential employees could more accurately assess the occupational risks associated with different jobs, thereby facilitating, through labor market transactions, higher risk premiums for more hazardous work and inducing employers to make the workplace less hazardous. The proposed

[17] For a graphical demonstration that an employer with monopsony power will pay less than the competitive market wage, see Borjas (2000).

standard recognizes the link between the dissemination of information and workplace risks by requiring that employees exposed to heat be provided with information and training about the risks they encounter and ways to mitigate those risks. There are several reasons, however, why reliance on information dissemination programs alone would not yield the level of employee protection achievable through the proposed standard, which incorporates hazard communication as part of a comprehensive approach designed to control the hazard in addition to providing for the disclosure of information about it.

First, in the case of voluntary information dissemination programs, absent a regulation, there may be significant economic incentives, for all the reasons discussed in section VIII.A.II. above, for the employer *not* to gather relevant exposure data or distribute occupational risk information so that the employees would not change jobs or demand higher wages to compensate for their newly identified occupational risks.

Second, even if employees were better informed about workplace risks and hazards, all of the defects in the functioning of the private labor market previously discussed—the limited ability of employees to evaluate risk information, externalities, and imperfect competition—would still apply. Because of the existence of these defects, better information alone would not lead to wage premiums for risk that would incentivize employers to make workplaces safer, in accordance with compensating differentials theory (Lavetti, 2023). Regardless, as mentioned above in section VIII.A.I., even the level of employee safety and health attained by the wage premium under efficient markets may be lower than the level justified by other important social values that efficient markets may undervalue. Finally, as discussed in Section VIII.E., Benefits, a number of additional safety provisions under the proposed standard would complement information and training provided by other regulatory vehicles.

Thus, while improved access to information about heat-related hazards can provide for more rational decision-making in the private labor market, OSHA concludes

that information dissemination programs would not, by themselves, produce an adequate level of employee protection.

B. Workers' Compensation Systems.

Another theoretical alternative to OSHA regulation could be to determine that no standard is needed because State workers' compensation programs augment the workings of the labor market to limit occupational risks to employee safety and health. After all, one of the objectives of the workers' compensation system is to shift the costs of occupational injury and illness from employees to employers in order to induce employers to improve working conditions. Two other objectives relevant to this discussion are to provide fair and prompt compensation to employees for medical costs and lost wages resulting from workplace injury and illness and, through the risk-spreading features of the workers' compensation insurance pool, to prevent individual employers from suffering a catastrophic financial loss (Ashford, 2007).

OSHA identifies two primary reasons, discussed below, why the workers' compensation system has fallen short of the goal of shifting to employers the costs of workplace injury and illness—including, in particular, the costs of employee exposure to heat-related hazards. As a result, OSHA concludes that workers' compensation programs alone do not adequately protect employees.

I. Limitations on Payouts.

The first reason that employers do not fully pay the costs of work-related injuries and illnesses under the workers' compensation system is that, even for those claims that are accepted into the system, States have imposed significant limitations on payouts. Depending on the State, these limitations and restrictions include:

- Caps on wage replacement based on the average wage in the State rather than the injured employee's actual wage;

- Restrictions on which medical care services are compensated and the amount of that compensation;
- No compensation for non-pecuniary losses, such as pain and suffering or impairment not directly related to earning power;
- Either no, or limited, cost-of-living increases;
- Restrictions on permanent, partial, and total disability benefits, either by specifying a maximum number of weeks for which benefits can be paid or by imposing an absolute ceiling on dollar payouts; and
- A low absolute ceiling on death benefits.

II. A Divergence between Workers' Compensation Premiums and Workplace Risk.

The second reason workers' compensation does not adequately shift the costs of work-related injuries and illnesses to employers is that the risk-spreading objective of workers' compensation conflicts with, and ultimately helps to undermine, the cost-internalization objective.[18] For the 99 percent of employers who rely on workers' compensation insurance,[19] the payment of premiums represents their primary cost for occupational injuries and illnesses, such as heat-related injuries and illnesses. However, the mechanism for determining an employer's workers' compensation insurance premium typically fails to reflect the actual occupational risk present in that employer's workplace.

Approximately 85 percent of employers have their premiums set based on a "class rating," which is based on *industry* illness and injury history. Employers in this class are typically the smallest firms and represent only about 15 percent of employees (Ashford,

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[18] Recall from the earlier discussion of externalities that the failure to internalize costs leads to allocative distortions and inefficiencies in the market.

[19] Only the largest firms, constituting approximately 1 percent of employers and representing approximately 15 percent of employees, are self-insured. These individual firms accomplish risk-spreading as a result of the large number of employees they cover (Ashford, 2007). From 2000 to 2020, the share of Workers' Compensation Benefits paid by self-insured employers rose from 22.0 percent to 24.7 percent (Murphy and Wolf, 2022).

2007). Small firms are often ineligible for experience rating because of insufficient claims history or because of a high year-to-year variance in their claim rates. These firms are granted rate reductions only if the experience of the entire class improves. The remaining 14 percent of employers, larger firms representing approximately 70 percent of employees, have their premiums set based on a combination of "class rating" and "experience rating," which adjusts the class rating to reflect a firm's individual claims experience. A firm's experience rating is generally based on the history of workers' compensation payments to employees injured at that firm's workplace, not on the quality of the firm's overall employee protection program or safety and health record. Thus, for example, the existence of circumstances that may lead to catastrophic future losses are not included in an experience rating—only actual past losses are included.[20] Insurance companies do have the right to refuse to provide workers' compensation insurance to an employer—and frequently exercise that right based on their inspections and evaluations of a firm's health and safety practices. However, almost all States have assigned risk pools that insist that any firm that cannot obtain workers' compensation policies from any insurer must be provided workers' compensation insurance at a State-mandated rate that reflects a combination of class and experience rating. Workers' compensation insurance does protect individual employers against a catastrophic financial loss due to work-related injury or illness claims. As a result of risk spreading, however, employers' efforts to reduce the incidence of occupational injuries and illnesses are not fully reflected in reduced workers' compensation premiums. Conversely, employers who devote fewer resources to promoting employee safety and health may not incur commensurately higher workers' compensation costs. This creates a type of moral hazard, in that the presence of

[20] In order to spread risks in an efficient manner, it is critical that insurers have adequate information to set individual premiums that reflect each individual employer's risks. As the preceding discussion has made clear, by and large, they do not. In that sense, insurers can be added to employers and employees as possessing imperfect information about job hazards.

risk spreading in workers' compensation insurance may induce employers to make fewer investments in equipment and training to reduce the risk of workplace injuries and illnesses.

In short, the premiums most individual employers pay for workers' compensation insurance coverage do not reflect the actual cost burden those employers impose on the worker's compensation system. Consequently, employers considering measures to lower the incidence of workplace injuries and illnesses can expect to receive a less-than-commensurate reduction in workers' compensation premiums. Thus, for all the reasons discussed above, the workers' compensation system does not provide adequate incentives to employers to control occupational risks to worker safety and health.

C. Tort Liability Options.

Another alternative to OSHA regulation could be for employees to use the tort system to seek redress for work-related injuries and illnesses, including heat-related ones.[21] A tort is a civil wrong (other than breach of contract) for which the courts can provide a remedy by awarding damages. The application of the tort system to occupational injury and illness would allow employees to sue their employer, or other responsible parties where applicable (e.g., "third parties" such as suppliers of hazardous material or equipment used in the workplace) to recover damages. In theory, the tort system could shift the liability for the direct costs of occupational injury and illness from the employee to the employer or to other responsible parties. In turn, the employer or third parties would be induced to improve employee safety and health.

With limited exceptions, the tort system has not been a viable alternative to occupational safety and health regulation. In addition, State statutes make workers'

[21] The OSH Act does not provide a private right of action that would allow affected workers to sue their employers for safety hazards subject to the Act (see *Am. Fed. of Gov. Employees, AFL-CIO v. Rumsfeld*, 321 F.3d 139, 143-44 (D.C. Cir. 2003)).

compensation the "exclusive remedy" for work-related injuries and illnesses. Workers' compensation is essentially a type of no-fault insurance. In return for employers' willingness to provide, through workers' compensation, timely wage-loss and medical coverage for workers' job-related injuries and illnesses, regardless of fault, employees are barred from suing their employers for damages, except in cases of intentional harm or, in some States, gross negligence (Ashford and Caldart, 1996). Even in cases of gross negligence where it is possible for employees to sue, establishing gross negligence in these incidences is complicated by heat conditions as these conditions may be temporary and localized, and not necessarily measured at the time of incident. Practically speaking, in most cases, workers' compensation is the exclusive legal remedy available to employees for workplace injuries and illnesses.

Employees are thus generally barred from suing their own employers in tort for occupational injuries or illnesses but may attempt to recover damages for work-related injuries and illnesses, where applicable, from third parties through the tort system. However, it is unlikely that a third party could be successfully sued for workplace exposure to hazardous heat since there is no third party responsible for exposing employees to dangerous conditions in these circumstances. This means that even this inadequate remedy would be unavailable to employees injured from heat exposure.

In sum, the use of the tort system as an alternative to regulation is severely limited because of the "exclusive remedy" provisions in workers' compensation statutes; because of the various legal and practical difficulties in seeking recovery from responsible third parties or the lack of a responsible third party altogether; and because of the substantial costs associated with a tort action. The tort system, therefore, does not adequately protect employees from exposure to hazards in the workplace.

IV. Summary.

OSHA's primary reasons for proposing this standard are based on the

requirements of the OSH Act, which are discussed in Section II., Pertinent Legal Authority. As shown in the preamble to the proposed standard and this PEA, OSHA has determined that employees in many industries are exposed to safety and health hazards from exposure to environmental and process heat in the workplace. This section has shown that labor markets—even when augmented by information dissemination programs, workers' compensation systems, and tort liability options—still operate at a level of risk for these employees that is higher than socially optimal due to a lack of information about safety and health risks, the presence of externalities or imperfect competition, and other factors discussed above.

B. Profile of Affected Industries.

I. Introduction.

This section presents a profile of the entities and employees for all industries that would be affected by OSHA's proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings. OSHA first outlines all industries that would be subject to the proposed standard. Next, OSHA summarizes the number of entities and employees that would be exempt from this proposed standard based on coverage under existing standards, jurisdiction of local or State government entities, or based on one of the exemptions in paragraph (a)(2) of this proposed standard. Lastly, OSHA provides summary statistics for the affected entities[22], including the number of affected entities and the number of affected employees. This information is provided for each industry (1) in total, (2) for small entities as defined by the Regulatory Flexibility Act (RFA) and by the Small Business Administration (SBA), and (3) for very small entities with fewer than 20 employees.

II. Potentially Affected Industries and Employees.

[22] Spreadsheet detailing all calculations discussed in this analysis are available in Analytical Support for OSHA's Preliminary Economic Analysis for the Heat Injury and Illness Prevention (OSHA, 2024c).

This section characterizes the industries and employees that are likely to be affected by the proposed standard.

A. Potentially Affected Industries.

OSHA broadly characterizes industries that are potentially within the scope of the regulatory framework as core industries[23] and all other covered industries. OSHA considers core industries to be those industries where employees have the most exposure to heat-related hazards, such as through exposure to high outdoor temperatures, radiant heat sources, or insufficient temperature control or ventilation in indoor work settings. Core industries include:

- Agriculture, Forestry, and Fishing;
- Building Materials and Equipment Suppliers;
- Commercial Kitchens;
- Construction;
- Drycleaning and Commercial Laundries;
- Landscaping and Facilities Support;
- Maintenance and Repair;
- Manufacturing;
- Oil and Gas;
- Postal and Delivery Services;
- Recreation and Amusement;
- Sanitation and Waste Removal;

[23] To identify core industries, OSHA reviewed multiple sources. The agency reviewed its OSHA Information System (OIS) database to identify industries with fatal and non-fatal heat-related injuries and illnesses. In addition, OSHA identified occupations with the most exposure to heat-related hazards by analyzing (1) occupational information on outdoor work settings from the Occupational Information Network (O*NET) and (2) occupation-level data from the Occupational Requirements Survey (ORS) on exposure to process heat. Occupations flagged by those two data sources were then mapped to detailed 2012 North American Industry Classification System (NAICS) codes using the Occupational Employment and Wage Statistics (OEWS). Finally, OSHA evaluated industries that were included in OSHA's National Emphasis Program for Outdoor and Indoor Heat Related Hazards, ANPRM comments, and stakeholder comments.

- Telecommunications;
- Temporary Help Services;
- Transportation;
- Utilities; and
- Warehousing.

While employee exposure to heat-related hazards is expected to be more frequent in the core industries, employees in all other industries within the agency's jurisdiction have the potential to experience occupational heat-related hazards and would also be covered by this proposed standard, with the exception of employers that meet the criteria for one of the scope exemptions in paragraph (a)(2) (discussed in detail in section VII.A., and below). For example, there are certain jobs, such as maintenance and landscaping occupations, regardless of the industry in which they are performed, that require physical exertion which may increase the risk of heat stress.

Most of the economic data on number of firms, number of establishments, employment[24], and annual receipts are sourced from the Census Bureau's Statistics of U.S. Businesses (SUSB) 2017 dataset (Census Bureau, 2021a). SUSB[25] presents these data[26] by North American Industry Classification System (NAICS) code, employee class size, and State. Unlike most other standards that OSHA proposes, costs will differ not

[24] For some industry-state combinations, the total employment in the SUSB data was less than the number of establishments. For these cases, OSHA adjusted total employment so that total employment is equal to the number of establishments.
[25] SUSB covers most NAICS industries excluding Crop and Animal Production (NAICS 111, 112); Rail Transportation (NAICS 482); Postal Service (NAICS 491); Pension, Health, Welfare, and Other Insurance Funds (NAICS 525110, 525120, 525190); Trusts, Estates, and Agency Accounts (NAICS 525920); Offices of Notaries (NAICS 541120); Private Households (NAICS 814); and Public Administration (NAICS 92). SUSB also excludes most establishments reporting government employees. (*https://www.census.gov/programs-surveys/susb/about.html*) To the extent that there are some establishments reporting government employees that are also captured in Government Units Survey or the Census of Governments database, OSHA's estimates may overstate the number of covered employees and establishments.
[26] These annual SUSB figures are based on the counts of these variables during the week of March 12th of the reference year.

just by industry, but also by the geographical location of workplaces due to variations in environmental conditions. See discussion of geographic location later in this section.

The SUSB glossary (Census Bureau, 2024b) defines the following terms as follows. Establishments are defined as an economic unit, typically a single physical location where business is conducted, services are performed, or industrial operations occur. Firms are legal business organizations and may consist of a single establishment or multiple establishments under common ownership or control. Employment is a measure of paid full- and part-time employees, including employees on paid sick leave, holidays, and vacations.[27] Annual receipts are defined as operating revenue for goods and services summed by industry, net of taxes collected from customers or clients.

There are instances where estimates are left undisclosed in the SUSB dataset because there are only a few companies in a certain industry in a given State. Relying solely on SUSB datafiles would result in an undercount of the potentially affected employers and employees due to the undisclosed data. For this reason, OSHA attempted to fill in these data gaps in these undisclosed industries with alternative data sources. These industries with data gaps are listed below, along with the alternative sources and methods for estimating the number of firms, number of establishments, employment, and annual receipts. OSHA welcomes additional data sources or alternative methodologies to fill these data gaps.

Agriculture*:* Most agricultural industries are not included in the SUSB dataset[28], so OSHA used the Department of Agriculture's 2017 Census of Agriculture (USDA, 2019) to derive estimates of the necessary industry profile information. OSHA used the

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[27] Employment includes salaried officers and executives and excludes sole proprietors and partners of unincorporated businesses.

[28] The NAICS industries that were estimated using this method are Oilseed and Grain Farming (111100), Vegetable and Melon Farming (111200), Fruit and Nut Tree Farming (111300), Greenhouse, Nursery, and Floriculture (111400), Other Crop Farming (111900), Cattle Ranch and Farming (112100), Hog and Pig Farming (112200), Poultry and Egg Production (112300), Sheep and Goat Farming (112400), Aquaculture (112500), and Other Animal Production (112900).

count of farms from chapter 2, table 44 "Farms by North American Industry Classification System" to represent the number of establishments for each agricultural industry. OSHA assumed that the number of firms is equal to the number of establishments.[29] OSHA used industry-level estimates of "workers" on hired labor farms and "total sales" from chapter 1, table 75 "Summary by North American Industry Classification System" to represent employment counts and annual receipts, respectively. OSHA welcomes feedback on alternative sources, estimation methods, and assumptions for estimations of firms, establishments, and employment in the agricultural sector.

Local Government[30]*:* The SUSB dataset excludes most government entities, including local governments. OSHA primarily relied on data from three alternative sources for local government estimates. To estimate the number of government entities, number of establishments, and employment, OSHA used the county-, city-, and town-level data from the Census Bureau's Government Units Survey (GUS) for 2022 (Census Bureau, 2023d) by State to estimate the number of firms per State. Then, OSHA assumed that each entity represented one firm which was equal to one establishment.[31] Since the GUS data do not include estimates for local government employment by State, OSHA used the 2022 Census of Governments' Survey of Public Employment & Payroll local employment data (Census Bureau, 2023b) to develop these estimates. OSHA distributed these local employees based on a ratio of local government employees to population served within each State as provided in the GUS, resulting in an estimate of employment for each local government entity within the GUS. These estimates were summed to the State level for OSHA's analysis.

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[29] Family farms account for 96 percent of all U.S. farms (https://www.nass.usda.gov/Newsroom/archive/2021/01-22-2021.php).
[30] In this analysis, OSHA only considered government entities in OSHA state plan states. See section VIII.B.III.H. later in this section for a discussion of exemptions based on OSHA jurisdiction.
[31] To the extent that there are multiple establishments for a single local government entity, this method underestimates the number of establishments.

OSHA's estimate for annual receipts per government entity also required two steps. First, OSHA estimated the average annual receipts per resident by State. The estimate was equal to the ratio of total local government receipts in the datasets found in the Census Bureau's 2021 Annual Survey of State and Local Government Finances (Census Bureau, 2023a) to the total population served in the GUS dataset. Then, OSHA multiplied the population associated with each government entity captured in the GUS with the ratio from step one to arrive at an estimate of total annual receipts per government entity. OSHA again aggregated these estimates to the State level for this analysis.

OSHA welcomes feedback on alternative sources, estimation methods, and assumptions for estimations of firms, establishments, and employment in local governments.

State Government: State government entities are excluded from the SUSB dataset, so OSHA relied on two alternative data sources for counts of firms and establishments, employment, and annual receipts. OSHA assumed that each State government is equal to one firm and that each State government firm is equal to one State government establishment.[32]

OSHA used the total State government full-time and part-time employment data from the 2022 Census of Governments' Survey of Public Employment & Payroll (Census Bureau, 2023b) to represent State government employment estimates. OSHA used the State government revenues estimated in the Census Bureau's 2021 Annual Survey of State and Local Government Finances (Census Bureau, 2023a) to estimate annual receipts for State governments.

[32] To the extent that state governments have multiple establishments, this method underestimates the number of establishments.

OSHA welcomes feedback on alternative sources, estimation methods, and assumptions for estimations of firms, establishments, and employment in State governments.

Rail Transportation[33], Postal Service, and Insurance and Employee Benefit Funds: SUSB data relied upon for the majority of the estimates in this industry profile do not include estimates for a small subset of non-agricultural industries: Rail Transportation (NAICS 4821), Postal and Delivery Services (NAICS 4911), and Insurance and Employment Benefit Funds (NAICS 5251). The economic data estimates for these three industries were derived from the Quarterly Census of Employment and Wages (QCEW) collected by the Bureau of Labor Statistics (BLS). OSHA used industry-level establishment and employment counts by State from the 2022 QCEW dataset (BLS, 2023f). OSHA assumed that each establishment was also a unique firm,[34] thus each firm equals one establishment. While the QCEW does not present revenue data, it does include total annual wages by industry and State. OSHA used the ratio of receipts to wages from the SUSB dataset for each State to convert the QCEW wage data into annual receipts by industry and State.

OSHA welcomes additional data sources or alternative methodologies to fill data gaps in the SUSB data for industries including agriculture, local and State governments. The agency is particularly interested in data and information on the number of firms, establishments, and employment. OSHA has assumed that one establishment is equal to one firm in industries where data on this parameter are not available including in

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[33] The Federal Railroad Administration (FRA) has promulgated regulations requiring the use of environmental controls to address heat hazards in three specific, limited contexts: non-steam-powered locomotives purchased or remanufactured after June 8, 2012 (49 CFR 229.119(g)), camp cars (49 CFR 228.313(c)), and certain on-track roadway maintenance machines (49 CFR 214.505(a)). OSHA's standard would apply to the working conditions of railroad employees in all other contexts, including within trains and machinery not covered by these regulations and during all outdoor work.

[34] To the extent that there are multiple establishments per firm, this will lead to an overestimate. OSHA welcomes feedback on this assumption and information on alternative data sources for the number of firms in these industries.

governments, agriculture, postal services, and rail transportation. The agency welcomes comment on this approach and suggestions for alternative approaches.

B. States and Geographic Regions.

For this PEA, OSHA categorized States into geographic regions based on the National Weather Service (NWS) regions.[35] Table VIII.B.1. presents the grouping of States into these regions.

Table VIII.B.1. States and Geographic Regions

Alaskan	Central	Eastern	Pacific	Southern	Western
Alaska	Colorado	Connecticut	American Samoa	Alabama	Arizona
	Iowa	Delaware	Guam	Arkansas	California
	Illinois	District of Columbia	Hawaii	Florida	Idaho
	Indiana	Maine	Northern Mariana Islands	Georgia	Montana
	Kansas	Maryland		Louisiana	Nevada
	Kentucky	Massachusetts		Mississippi	Oregon
	Michigan	New Hampshire		New Mexico	Utah
	Minnesota	New Jersey		Oklahoma	Washington
	Missouri	New York		Puerto Rico	Wyoming
	North Dakota	North Carolina		Tennessee	
	Nebraska	Ohio		Texas	
	South Dakota	Pennsylvania		U.S. Virgin Islands	
	Wisconsin	Rhode Island			
		South Carolina			
		Vermont			
		Virginia			
		West Virginia			

Source: NWS, 2024b.

C. Potentially Affected Employees Based on Work Conditions.

OSHA estimated the number of potentially affected employees across all affected industries based on their work conditions. To do so, OSHA used a combination of O*NET, Occupational Requirement Survey (ORS), and Occupational Employment and

[35] In the NWS groupings, three states were divided between two regions: Georgia (Eastern and Southern), Kentucky (Central and Eastern), and Wyoming (Central and Western). OSHA assigned these states to a single region, with Georgia assigned to the Southern region, Kentucky to the Central region, and Wyoming to the Western region.

Wage Statistics (OEWS) program data. Employment is characterized using the Standard Occupational Classification (SOC) detailed occupations (i.e., six-digit SOC code).

O*NET (O*NET, 2023) provides data on the percent of employees in a given occupation that work in certain climatic work conditions for specified frequencies.[36] The climatic work conditions that OSHA evaluated in this analysis are (1) Indoors, Environmentally Controlled; (2) Indoors, Not Environmentally Controlled; (3) Outdoors, Exposed to Weather; and (4) Outdoors, Under Cover. For modeling purposes, OSHA mapped the O*NET frequency categories (O*NET, 2023) to number and percentages of work days worked in certain climatic work conditions, as shown in table VIII.B.2. For the purposes of this analysis, OSHA assumes that employees in work conditions (2), (3), and (4) are in-scope of the proposed standard unless they meet exemptions discussed later.

Table VIII.B.2. Frequency of Work in Certain Conditions

Category No.	O*Net Frequency Category Name	Minimum number of Days for Category	Maximum Number of Days for Category	Estimated Percentage of Days [a]
1	Never	0	0	0%
2	Less than Monthly	1	<12	2.60%
3	Less than Weekly	12	<50	12.40%
4	Less than Daily	50	<250	60%
5	Every Day	250	250	100%

Sources: Frequency categories are defined by O*NET Online Resource Center (O*NET, 2023). Estimated percentage of days are based on methodology from Park et al. (2021).
[a] These percentages are based on a 250-day work year.

There are multiple SOC occupation codes for which the O*NET dataset does not provide the percentages of employees in an occupation for each of these brackets. In these instances, OSHA used the average frequency of work in these conditions from similar SOC occupation codes as representative of the missing SOC occupation code to estimate the frequency of work in these conditions for occupations with missing data.

Using the percentages of each occupation within the frequency categories and the estimated percentages of days worked by category presented in the table above, OSHA

[36] These frequency categories are defined as: (1) "Never;" (2) "Once a year or more but not every month;" (3) "Once a month or more but not every week;" (4) "Once a week or more but not every day;" (5) "Every day."

estimated the percentage of employees that would be working regularly in certain climatic work conditions by occupation. OSHA then multiplied these percentages by the percentage of total industry employment in a given occupation from the 2022 OEWS dataset (BLS, 2023c). The aggregation of these products by 4-digit NAICS code yields OSHA's estimate of the percentage of all employees in a given industry that work in the four climatic work conditions.

OSHA assumes that employees working indoors in environmentally controlled workspaces are not covered under the proposed standard unless they are exposed to process heat (e.g., kitchens, foundries). It is possible that employees exposed to process heat in indoor work settings are counted in the O*NET data as being in climatic work condition (2) Indoors, Not Environmentally Controlled, and therefore already captured in counts of potentially affected employees. However, to account for the possibility that some employees exposed to process heat are categorized in climatic work condition (1) Indoors, Environmentally Controlled (which is possible if survey respondents considered areas that were environmentally controlled but hot due to process heat to be within the definition of environmentally controlled), OSHA relied on the ORS dataset (BLS, 2023d) to identify occupations exposed to process heat. To the extent that employees exposed to process heat are included in both climatic work condition (2) Indoors, Not Environmentally Controlled and the ORS data on exposure to extreme heat, this method may overstate the number of employees exposed to process heat. The ORS dataset contains estimates for the percent of employees that are exposed (or not) to extreme heat.[37] The ORS data are available by SOC occupation code, although not all SOC codes have an estimate available for all data series. Similar to the estimation for climatic conditions described above, the percentage of employees exposed to extreme heat was

[37] ORS considers extreme heat present when (1) employees' exposure is related to critical tasks and not due to weather and (2) the atmosphere is dry with temperatures above 90°F, or the atmosphere is humid with temperatures above 85°F (BLS, 2021).

multiplied by the percentage of total industry employment in a given occupation from the 2022 OEWS dataset (BLS, 2023c), resulting in an estimate of the percentage of employees by industry exposed to process heat.

OSHA acknowledges that the temperature criteria for the ORS definition of exposure to extreme heat has a higher temperature criterion than the proposed standard's initial heat trigger of 80°F, which, to the extent employees are not otherwise included in this analysis because they are in climatic work condition (2) Indoors, Not Environmentally Controlled, may result in an undercount of employees exposed to process heat.

The percentage of employees exposed to process heat using this method was added to the percentage of employees in exposed climatic conditions to determine the total percentage of employees exposed to heat for all affected industries.[38] To estimate the total number of potentially affected employees for each industry, OSHA multiplied the percentage of total exposed employees in the industry by the OEWS for May 2022 (BLS, 2023c) employment totals for that industry.

Table VIII.B.3. shows a summary of potentially affected firms, establishments, and employees across all these industries by region.

Table VIII.B.3. Industry Profile Summarized by Region

Region	Entities	Establishments	Employees
Alaskan	18,563	21,940	314,444
Central	1,578,125	1,906,757	32,567,699
Eastern	2,157,549	2,631,175	47,954,519
Pacific	33,857	40,139	704,767
Southern	1,776,945	2,205,794	38,771,537
Western	1,432,624	1,720,933	29,839,496
Total	**6,997,663**	**8,526,738**	**150,152,463**

Source: OSHA, based on BLS, 2023c; BLS, 2023f; Census Bureau, 2021a; Census Bureau 2023a; Census Bureau, 2023b; Census Bureau, 2023d; Census Bureau, 2023a; USDA, 2019; and USFA, 2019.

[38] To the extent that the employees exposed to process heat are already accounted for as being in one of the affected climatic conditions (indoors-not environmentally controlled, outdoors- exposed to weather, and outdoors- under cover), this method may overestimate the percentage of employees and establishments that are affected by the proposed standard.

III. Entities Not Covered by the Proposed Standard.

The proposed standard would apply to all employers in the industries outlined in Section VIII.B.II., Potentially Affected Industries and Employees, unless they have a workforce that is exclusively performing work activities that meet one or more of following definitions: (1) work activities for which there is no reasonable expectation of exposure at or above the initial heat trigger; (2) work activities where the employee is exposed to temperatures above the initial heat trigger for fifteen minutes or less in any sixty-minute period; (3) emergency response activities of workplace emergency response teams or any emergency response activities already covered under 29 CFR 1910.120, 1910.146, 1910.156, part 1915, subpart P, 1926.65, and 1926.1211; (4) work activities performed in indoor work areas or vehicles where air conditioning consistently keeps ambient temperature below 80°F; (5) telework; and (6) sedentary work activities in indoor work areas where the work only involves some combination of the following: sitting, occasional standing and walking for brief periods of time, and occasional lifting of objects weighing less than ten pounds. Employees that are exclusively performing these types of work activities are also exempt from this standard. Where employers and employees are outside OSHA's jurisdiction, they are also not covered by the standard and OSHA's estimates of the types and number of such employers and employees is discussed in this section.

A. Work Activities with No Reasonable Expectation of Exposure at or Above Initial Heat Trigger.

OSHA assumes that the estimates of affected employees cover all employees potentially affected by the proposed standard (reported in Section VIII.B.II., Potentially Affected Industries and Employees) and excludes those employees who are exempt under the scope exemption for work activities with no reasonable expectation of exposure at or above the initial heat trigger. Employees that are working in "Indoors, Environmentally

Controlled" settings as identified by the O*NET data are considered out of scope based on this exemption unless they are also exposed to process heat. OSHA believes that this methodology, combined with the additional exemptions discussed below, removes from scope the employees who would fall under this exemption and thus does not make any additional adjustments for this specific exemption.

B. Short Duration Exposure at or Above Initial Heat Trigger.

To estimate the number of employees that might be exposed to temperatures at or above the initial heat trigger for fifteen minutes or less in any sixty-minute period, OSHA relied on the ORS dataset. For indoor work settings, OSHA used the percentages of employees not exposed to extreme heat and the percentage of employees seldomly[39] exposed to extreme heat as reflective of those employees that are exposed to temperatures at or above the initial heat trigger for fifteen minutes or less in any sixty-minute period. For outdoor work settings, OSHA used the percentages of employees that either do not work outdoors or seldomly work outdoors to estimate the number of employees exposed to temperatures at or above the initial heat trigger for fifteen minutes or less in any sixty-minute period. OSHA added the percentages for each SOC occupation code (OSHA, 2024d).

Using the 2022 OEWS data (BLS, 2023c) described in Section VIII.B.II., Potentially Affected Industries and Employees, OSHA multiplied the percentage of total industry employment in a given occupation and the summation of the percentages of employees in that same occupation that are either not exposed or seldomly exposed to extreme heat to estimate the percentage of employees in an SOC occupation code in a certain industry that meet the exemption criteria for indoor employees. These estimates were aggregated for each 4-digit NAICS industry to estimate the percentage of total

[39] ORS defines seldom as spending up to two percent of total time working in extreme heat, or less than ten minutes daily, less than 45 minutes weekly, or less than one week annually (BLS, 2021).

employment in that industry that is exposed to temperatures at or above the initial heat trigger for fifteen minutes or less in any sixty-minute period. For 4-digit NAICS industries otherwise captured in OSHA's economic analysis that are not available in the OEWS dataset, OSHA used the average percentage of employees meeting this definition within the same industry sector (2-digit NAICS). This same process also applies for the percentages of employees that either do not work outdoors or seldomly work outdoors.

Table VIII.B.4. shows the number of employees that OSHA estimates are exempt from the proposed standard because of qualification as employees with only short duration exposure.

Table VIII.B.4. Summary of Employees Exempt due to Short Duration Exposure

Region	Indoor Employees	Outdoor Employees
Alaskan	199,838	27,312
Central	21,511,842	2,957,214
Eastern	32,085,256	4,285,342
Pacific	458,099	66,205
Southern	25,520,407	3,497,694
Western	19,598,994	2,676,549
Total	**99,374,435**	**13,510,315**

Source: OSHA, based on Census Bureau, 2021a; USDA, 2019; Census Bureau, 2023a; Census Bureau, 2023d; USFA, 2023; BLS, 2023c; and BLS, 2023d.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

C. Emergency Response Activities.

OSHA's proposed standard exempts organizations whose primary function is the performance of firefighting; emergency response activities of workplace emergency response teams, emergency medical services, or technical search and rescue; and any emergency response activities already covered under 29 CFR 1910.120, 1910.146, 1910.156, part 1915, subpart P, 1926.65, and 1926.1211. See the *Explanation of the Proposed Requirement* for Paragraph (a) Scope for a full discussion of this exemption.[40]

[40] OSHA did not attempt to adjust the share of employee's time spent engaged in emergency response activities and aside from firefighters, did not remove any employees from the scope of the standard due to this exemption. To the extent that there are additional establishments where employees exclusively perform emergency response activities, this analysis may overstate the number of affected establishments and employees.

To identify exempt career firefighters, OSHA used the U.S. Fire Administration's National Fire Department Registry (USFA, 2023) to determine the number of firefighters in each State. Each fire department recorded in the National Fire Department Registry is considered a firm in the industry profile and each fire station is considered an establishment. Employment figures are based on the aggregation of counts of active career firefighters. Volunteer and paid-per-call firefighters are not included as employees in the data on government employees that form the basis of OSHA's estimates of government employees, so no adjustment was made to employment regarding these responders. (See OSHA-2007-0073-0118, chapter VII, for additional information). OSHA welcomes comment on these estimates including whether there are additional types of establishments or employees who should be considered out of scope for this analysis and suggestions on methodologies that could better represent this exemption.

D. Sedentary Work Activities at Indoor Work Areas.

To estimate the number of employees engaged in indoor sedentary work activities as defined in the proposed standard, OSHA used ORS and OEWS data. The ORS dataset includes estimates for the percent of employees involved in work where the strength required is considered sedentary.[41] These data are available by SOC code, although not all codes have an estimate available for all data series.

As described in section VIII.B.III.B., OEWS provides employment data for all SOC occupation codes within each 4-digit NAICS industry. OSHA multiplied the percentage of total industry employment in a given occupation by the percentage of employees in a given SOC code considered sedentary (OSHA, 2024d). Similar to the estimates for short duration exposure, these percentages were aggregated for each 4-digit NAICS industry to estimate the percentage of total employment in that NAICS industry

[41] Sedentary work involves less than or equal to one-third of the workday standing while only seldomly or occasionally lifting or carrying up to ten pounds.

that is considered sedentary. For 4-digit NAICS industries otherwise captured in OSHA's economic analysis that are not available in the OEWS dataset, OSHA used the average percentage of employees meeting this definition within the same sector.

Table VIII.B.5. shows the number of employees that OSHA estimates are exempt from the proposed standard because their work is sedentary.

Table VIII.B.5. Summary of Sedentary Employees Exempt from the Proposed Standard

Region	Employees
Alaskan	66,112
Central	7,236,687
Eastern	11,038,630
Pacific	142,075
Southern	8,543,839
Western	6,830,356
Total	**33,857,699**

Source: OSHA, based on Census Bureau, 2021a; USDA, 2019; Census Bureau, 2023a; Census Bureau, 2023d; USFA, 2023; BLS, 2023c; and BLS, 2023d.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

E. Telework.

To estimate the number of employees working remotely, OSHA used the 2022 BLS Business Response Survey (BRS) data (BLS, 2024a) on telework. The BRS provides percentages of employment by sector that are working remotely, on-site (i.e., non-remote work), or hybrid. OSHA applied these percentages of employment by sector to the employment data derived from the sources outlined in Section VIII.B.II., Potentially Affected Industries and Employees. Remote employees are considered exempt from the proposed standard and hybrid employees are considered exempt from the proposed standard during the time they are teleworking.

Table VIII.B.6. shows the number of employees that OSHA estimates work remotely, hybrid, and on-site.

Table VIII.B.6. Summary of On-Site, Remote, and Hybrid Employees

Region	Remote	Hybrid	On-Site
Alaskan	9,933	93,485	206,311
Central	1,100,860	10,324,319	20,885,970
Eastern	1,716,903	15,412,798	30,383,027
Pacific	22,912	195,421	483,328

Table VIII.B.6. Summary of On-Site, Remote, and Hybrid Employees

Region	Remote	Hybrid	On-Site
Southern	1,391,099	12,060,519	25,087,691
Western	1,100,879	9,289,249	19,318,010
Total	**5,342,586**	**47,375,792**	**96,364,336**

Source: OSHA, based on BLS 2024a; Census Bureau, 2021a; Census Bureau, 2023a; Census Bureau, 2023d; USDA, 2019; and USFA, 2023
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

F. Indoor Work Areas Where Temperature is Maintained Below 80°F.

To estimate the number of establishments that might qualify as having indoor work areas where the ambient temperature is maintained below 80°F (26.7°C), OSHA used the Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey (CBECS) data (EIA, 2022). The CBECS data provide estimates on the number of buildings by building activity with some percentage of cooled floorspace. OSHA assumed that buildings with at least 51 percent of floorspace cooled qualify as establishments where work activities take place in ambient temperatures below 80°F (26.7°C). OSHA assumed that employees likely work in environmentally controlled areas of buildings regardless of what percent of floorspace is cooled. For example, loading docks, storage areas, or areas where processes are automated may not be cooled but they also may not be regular work locations for employees.[42] OSHA mapped these building activities to sectors to estimate the percentage of establishments in a given sector that would fit the definition of this exemption. These estimates were applied to the number of establishments, as well as the number of firms, to determine those firms and establishments that are exempt from the proposed standard based on this exemption. OSHA welcomes comment on whether this is a reasonable assumption. If not, the agency welcomes comment on more appropriate methodologies or data source that might better

[42] To the extent this assumption is incorrect, this may result in too few establishments being considered in-scope of this proposed standard which potentially underestimates total establishment-based costs. However, this adjustment does not affect the number of covered employees who are included or excluded based on their job characteristics. The estimated employees who are covered by this proposed standard are distributed among the covered establishments. If OSHA is counting too few establishments as covered, this would mean that the affected employees are concentrated into fewer establishments than they truly are and the average cost per establishment may be too high.

allow OSHA to estimate which establishments would be covered by this proposed standard.

Table VIII.B.7. shows the number of firms and establishments where the ambient temperature indoors is maintained below 80°F (26.7°C).

Table VIII.B.7. Summary of Entities and Establishments with Sufficient Environmental Controls

Region	Entities	Establishments
Alaskan	11,047	13,469
Central	883,924	1,142,591
Eastern	1,362,384	1,739,119
Pacific	20,783	25,630
Southern	1,096,146	1,428,219
Western	922,625	1,146,582
Total	**4,296,908**	**5,495,610**

Source: OSHA, based on Census Bureau, 2021a; Census Bureau, 2023a; Census Bureau, 2023d; EIA, 2022; USDA, 2019; and USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

G. Employees Working in Cooled Vehicles.

To estimate the number of employees working in cooled vehicles, OSHA first estimated the percentage of employees working in vehicles by NAICS code. The estimated percentage of drivers is based on the percentage of total industry employment in occupations that involve driving. OSHA acknowledges that some non-driving occupations may work in vehicles and assumes that these occupations are already captured in estimates of other work conditions (e.g., they may be included in the group working indoors in environmentally controlled settings or working outdoors in covered areas). OSHA determined that the following SOC occupation codes represent occupations that involve driving vehicles exposed to outdoor heat conditions for most of their work activities:

- Postal Service Mail Carriers (43-5052);
- Agricultural Equipment Operators (45-2091);
- Paving, Surfacing, and Tamping Equipment Operators (47-2071);
- Pile Driver Operators (47-2072);

- Operating Engineers and Other Construction Equipment Operators (47-2073);
- Ambulance Drivers and Attendants, Except Emergency Medical Technicians (53-3011);
- Driver/Sales Workers (53-3031);
- Heavy and Tractor-Trailer Truck Drivers (53-3032);
- Light Truck Drivers (53-3033);
- Bus Drivers, School (53-3051);
- Bus Drivers, Transit and Intercity (53-3052);
- Shuttle Drivers and Chauffeurs (53-3053);
- Taxi Drivers (53-3054); and
- Refuse and Recyclable Material Collectors (53-7081).

OSHA then multiplied the percentage of total industry employment comprised of these SOC occupation codes by the percentage of drivers in vehicles with sufficiently cooled vehicle cabs. In the absence of data on the percentage of vehicles with sufficiently cooled vehicle cabs, OSHA estimates that 34 percent of postal service (Hooker and Baker, 2023) and assumes that 50 percent of all other delivery service drivers work in sufficiently cooled vehicle cabs. OSHA welcomes additional data on the percent of vehicle cabs that are sufficiently cooled for all types of drivers.

Table VIII.B.8. shows the total number of employees working as drivers and those OSHA estimates to be in-scope (i.e., those who are not working in sufficiently cooled vehicle cabs).

Table VIII.B.8. Summary of Drivers, Total and In-Scope

Region	Drivers	In-Scope Drivers
Alaskan	10,572	5,419
Central	1,062,955	543,165
Eastern	1,501,620	768,853
Pacific	21,039	10,736
Southern	1,249,063	637,255
Western	963,917	490,865
Total	**4,809,165**	**2,456,292**

Source: OSHA, based on Census Bureau, 2021a; Census Bureau, 2023a; U.S. Census Bureau, 2023d; Hooker and Baker, 2023; USDA, 2019; and USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

H. Exemptions based on OSHA Jurisdiction.

Beyond the exemptions laid out in the scope section of the proposed regulatory text, OSHA must factor in jurisdictional considerations when determining those establishments and employees that are in scope of the proposed standard. A subset of public entities is considered in-scope depending on whether or not the public entity is located in an OSHA State Plan State. Those public entities that are in non-State Plan States, as well as their employees, are considered out of scope. The following States and territories have State Plans [43]: Alaska, Arizona, California, Connecticut, Hawaii, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, U.S. Virgin Islands, Utah, Vermont, Virginia, Washington, and Wyoming.

I. Summary of Exempt Employees.

Table VIII.B.9. summarizes the total number of employees estimated to be exempt from the proposed standard by each exemption. OSHA welcomes comment and feedback on whether the approaches detailed above used to estimate the number of employees affected by the proposed standard's exemptions are appropriate. The agency

[43] Seven of these—Connecticut, Illinois, Maine, Massachusetts, New Jersey, New York, and U.S. Virgin Islands—only cover public sector employees. The private sector employees in those states are covered by Federal OSHA and have been included in this analysis.

welcomes additional data or information on how to appropriately account for the exemptions in the proposed standard.

Table VIII.B.9. Summary of Employees by Exemption Type by Region

Region	Indoor Short Duration	Outdoor Short Duration	Sedentary	Remote	Hybrid	Drivers
Alaskan	199,838	27,312	66,112	9,933	93,485	5,153
Central	21,511,842	2,957,214	7,236,687	1,100,860	10,324,319	519,790
Eastern	32,085,256	4,285,342	11,038,630	1,716,903	15,412,798	732,767
Pacific	458,099	66,205	142,075	22,912	195,421	10,302
Southern	25,520,407	3,497,694	8,543,839	1,391,099	12,060,519	611,808
Western	19,598,994	2,676,549	6,830,356	1,100,879	9,289,249	473,052
Total	**99,374,435**	**13,510,315**	**33,857,699**	**5,342,586**	**47,375,792**	**2,352,873**

Source: OSHA, based on BLS, 2023c; BLS, 2023d; BLS, 2024a; Census Bureau, 2021a; Census Bureau, 2023a; Census Bureau, 20203b; Hooker and Baker, 2023; USDA, 2019; and USFA, 2023.
Note: Many employees fit multiple exemption types outlined in this table. The total number of exempt employees is less than the summation of employees across all exemption types. Due to rounding, figures in the columns and rows may not sum to the totals shown.

OSHA welcomes comment and feedback on whether these approaches to estimate the number of employees affected by the proposed standard's exemptions are appropriate. The agency welcomes additional data or information on how to appropriately account for the exemptions in the proposed standard.

IV. Affected Employees.

The categories that employees impacted by the proposed exemptions fall into are likely to overlap. Employees that perform office work may (1) work indoors in climate control, (2) only perform sedentary work activities, and (3) may occasionally work remotely. In these situations, such employees may be included in the total estimate for each of these exemptions discussed above, therefore simply adding the totals of those exemptions may overstate the number of exempt employees. This section adjusts for that overlap and presents the number of estimated employees by work condition. This section also presents estimates on the number of affected employees by work shift which is used for specific cost estimates discussed in Section VIII.C., Costs of Compliance.

A. Affected Employees by Work Conditions.

This section estimates the percentage of affected employees by work conditions, using the number of employees potentially exposed to heat from section VIII.B.II. and the exemptions outlined in section VIII.B.III. OSHA recognizes that some employees are likely to fall under multiple exemptions. For example, an employee that teleworks and performs sedentary work in a climate-controlled environment is included in three exemption categories (telework, sedentary, and no reasonable expectation of exposure to heat). To avoid double-counting employees, OSHA relied on the following method to estimate the number of affected employees.

First, the agency excluded public-sector employees that are not within OSHA's jurisdiction, as discussed in section VIII.B.III.H. After excluding employees outside OSHA's jurisdiction, the agency applied the estimated percentages of employees engaged in sedentary work, as estimated in section VIII.B.III.D., to the percentage of employees working in indoor, not environmentally controlled work conditions since those employees performing sedentary work indoors are exempt regardless of the presence of climate control. OSHA assumes that the majority of employees estimated to be exempt due to telework, detailed in section VIII.B.III.E., are also captured by the sedentary work exemption, and therefore did not make an additional adjustment for these employees.

Next, OSHA applied the estimated percentage of employees exposed to extreme heat according to the ORS data (BLS, 2023d) to the percentage of employees working in indoor, environmentally controlled work conditions to account for employees exposed to process heat who are covered by this proposed standard. The percentages of outdoor employees (both under cover and exposed to weather) are adjusted to remove from scope employees that have short duration outdoor exposure as estimated in section VIII.B.III.B. OSHA assumed that indoor employees that are exempt based on short duration exposure are likely to be captured in the sedentary work exemption and did not make an additional adjustment for these employees.

These percentages were aggregated for each 4-digit NAICS industry to estimate the percentage of total employment in that industry that work in either indoor, environmentally controlled conditions (while only accounting for those employees that are exposed to process heat); indoor, not environmentally controlled conditions (while only accounting for those employees that are not sedentary); or outdoor conditions. For 4-digit NAICS industries otherwise captured in OSHA's economic analysis that are not available in the OEWS dataset, OSHA used the average percentage of employees meeting these definitions within the same sector.

Table VIII.B.10. shows the number of employees that are considered within the scope of the proposed standard, broken out by work conditions.

Table VIII.B.10. Summary of Employees by Work Condition

Region	Indoor, Not Environmentally Controlled	Indoor, Process Heat	Outdoor	Total
Alaskan	38,078	6,240	39,652	83,969
Central	4,119,613	688,813	3,110,084	7,918,510
Eastern	5,677,620	1,011,200	4,545,121	11,233,941
Pacific	80,274	19,346	74,030	173,649
Southern	4,473,460	822,673	3,448,321	8,744,454
Western	3,780,957	665,729	3,353,115	7,799,801
Total	**18,170,002**	**3,214,001**	**14,570,322**	**35,954,325**

Source: OSHA, based on BLS, 2023d; Census Bureau, 2021a; Census Bureau, 2023a; Census Bureau, 2023d; O*NET, 2023; USDA, 2019; and USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

B. Affected Employees by Shift Type.

To estimate the number of employees that work during certain periods of the day and therefore during different heat conditions, OSHA used the American Time Use Survey (ATUS) for 2017–2018 (BLS, 2023a). The ATUS outlines the percent of employees that work certain shifts by sector. For the purposes of estimating the variations in heat exposure over the course of a day, OSHA has categorized these into three shifts: daytime, evening, and overnight. OSHA mapped work shifts defined in the ATUS to these three categories in the following sections.

I. Daytime.

The daytime work shift category corresponds to the regular daytime schedule grouping in the ATUS. The ATUS defines regular daytime schedule as having a majority of respondents that worked between 6 a.m. and 6 p.m. For this analysis, employees categorized as daytime employees are assumed to work between 8 a.m. and 4 p.m. to adjust for overlap with the other work shift categories.

II. Evening.

The evening work shift category corresponds to the evening shift in the ATUS. The evening schedule is defined as having respondents work a majority of the time between 2 p.m. and midnight. For this analysis, employees categorized as evening employees are assumed to work between 4 p.m. and midnight.

III. Overnight.

The overnight work shift category corresponds to the night shift in the ATUS. The night schedule is defined as having respondents work a majority of the time between 9 p.m. and 8 a.m. For this analysis, employees categorized as overnight employees are assumed to work between midnight and 8 a.m.

IV. Other Shift Categories.

There are additional shift groups in the ATUS whose definitions do not fit neatly into a certain timeframe (e.g., rotating, irregular, split shift, other). The percentages of employees that fit these additional groups were evenly distributed across the other categories.

V. Estimates of the Number of In-Scope Employees by Work Shift.

Estimating the number of employees that work certain shifts is important because some requirements of the proposed standard are dependent on whether the heat index is at or above a trigger while employees are working. Employees working in the early afternoon will be exposed to warmer temperatures than those working during the evening or night hours, and thus will more often qualify for a required rest break, as an example.

Table VIII.B.11. shows the number of employees that OSHA estimates work certain work shifts.

Table VIII.B.11. Summary of In-Scope Employees by Work Shift and Work Condition

Region	Indoor, Not Environmentally Controlled	Indoor, Process Heat	Outdoor	Total
Daytime				
Alaskan	32,572	4,683	34,729	71,985
Central	3,520,992	513,412	2,727,273	6,761,677
Eastern	4,858,352	752,843	3,989,031	9,600,226
Pacific	67,919	13,914	64,780	146,614
Southern	3,837,670	601,003	3,046,594	7,485,266
Western	3,241,443	492,814	2,952,787	6,687,044
Subtotal	**15,558,949**	**2,378,669**	**12,815,194**	**30,752,813**
Evening				
Alaskan	3,151	1,114	2,643	6,908
Central	344,832	126,294	211,761	682,888
Eastern	476,846	186,505	309,284	972,635
Pacific	7,580	4,029	5,298	16,906
Southern	376,759	163,150	228,820	768,729
Western	315,621	125,450	221,400	662,471
Subtotal	**1,524,789**	**606,543**	**979,205**	**3,110,537**
Overnight				
Alaskan	2,355	442	2,280	5,076
Central	253,789	49,106	171,050	473,945
Eastern	342,421	71,853	246,806	661,079
Pacific	4,774	1,403	3,952	10,129
Southern	259,031	58,520	172,907	490,459
Western	223,893	47,465	178,928	450,287
Subtotal	**1,086,263**	**228,789**	**775,922**	**2,090,975**
Total				
Alaskan	38,078	6,240	39,652	83,969
Central	4,119,613	688,813	3,110,084	7,918,510
Eastern	5,677,620	1,011,200	4,545,121	11,233,941
Pacific	80,274	19,346	74,030	173,649
Southern	4,473,460	822,673	3,448,321	8,744,454
Western	3,780,957	665,729	3,353,115	7,799,801
Total	**18,170,002**	**3,214,001**	**14,570,322**	**35,954,325**

Source: OSHA, based on BLS, 2023a; BLS, 2023c; BLS 2023d; Census Bureau, 2021a; Census Bureau, 2023a; Census Bureau, 203d; O*NET, 2023; USDA, 2019; and USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

V. Affected Entities.

This section summarizes the total estimated number of entities, small entities, and very small entities impacted by the proposed standard.

A. Summary of Affected Entities.

Table VIII.B.12. summarizes the number of affected entities by core industry and region.

Table VIII.B.12. Profile of Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Entities	Establishments	Employees
Agriculture, Forestry, and Fishing			
Alaskan	483	490	892
Central	35,466	35,586	281,481
Eastern	18,684	18,729	160,691
Pacific	253	253	1,666
Southern	32,393	32,534	237,522
Western	18,176	18,287	453,041
Subtotal	**105,455**	**105,879**	**1,135,293**
Building Materials and Equipment Suppliers			
Alaskan	38	51	1,142
Central	2,912	4,090	105,785
Eastern	4,280	5,858	131,370
Pacific	72	93	2,030
Southern	3,692	5,338	122,798
Western	2,889	3,876	92,573
Subtotal	**13,884**	**19,306**	**455,698**
Commercial Kitchens			
Alaskan	517	623	6,270
Central	36,975	49,684	739,565
Eastern	66,334	83,069	1,100,671
Pacific	1,353	1,605	23,824
Southern	43,422	60,794	987,885
Western	39,486	52,286	733,222
Subtotal	**188,087**	**248,060**	**3,591,437**
Construction			
Alaskan	2,468	2,518	11,776
Central	161,546	163,268	867,865
Eastern	234,565	236,970	1,264,969
Pacific	3,436	3,477	24,954
Southern	168,126	171,053	1,232,019
Western	155,060	157,053	947,205
Subtotal	**725,200**	**734,340**	**4,348,789**
Drycleaning and Commercial Laundries			
Alaskan	18	20	114
Central	1,994	2,485	13,861
Eastern	5,711	6,383	25,423
Pacific	43	50	554
Southern	3,145	3,767	20,037
Western	2,396	2,706	14,349
Subtotal	**13,307**	**15,411**	**74,338**
Landscaping and Facilities Support			
Alaskan	111	127	4,334
Central	11,606	13,203	273,784
Eastern	18,686	21,487	443,136
Pacific	238	313	8,574
Southern	13,103	15,123	367,104

Table VIII.B.12. Profile of Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Entities	Establishments	Employees
Western	9,836	11,827	262,938
Subtotal	**53,581**	**62,080**	**1,359,870**
Maintenance and Repair			
Alaskan	189	217	1,291
Central	20,398	21,964	143,311
Eastern	27,230	29,112	185,126
Pacific	329	350	2,261
Southern	21,642	23,646	172,454
Western	17,080	18,515	129,094
Subtotal	**86,868**	**93,804**	**633,538**
Manufacturing			
Alaskan	174	207	3,489
Central	31,890	34,082	1,149,535
Eastern	37,652	39,539	1,064,032
Pacific	307	316	3,243
Southern	27,569	29,654	852,094
Western	26,893	28,053	551,798
Subtotal	**124,483**	**131,849**	**3,624,192**
Oil and Gas			
Alaskan	72	98	3,809
Central	3,210	3,976	27,709
Eastern	1,631	2,146	18,110
Pacific	0	0	0
Southern	11,216	14,406	173,419
Western	1,794	2,110	18,053
Subtotal	**17,924**	**22,736**	**241,099**
Postal and Delivery Services			
Alaskan	207	229	273
Central	8,796	9,820	48,711
Eastern	11,053	12,421	77,808
Pacific	112	131	776
Southern	7,782	9,144	55,205
Western	4,874	5,860	46,414
Subtotal	**32,824**	**37,605**	**229,188**
Recreation and Amusement			
Alaskan	261	272	1,156
Central	9,879	10,799	117,890
Eastern	14,551	16,161	196,438
Pacific	185	200	2,558
Southern	9,316	10,524	153,835
Western	7,815	9,004	138,003
Subtotal	**42,006**	**46,961**	**609,880**
Sanitation and Waste Removal			
Alaskan	19	22	691
Central	648	815	21,373
Eastern	982	1,176	36,177
Pacific	15	18	635
Southern	642	853	28,844
Western	441	576	22,484
Subtotal	**2,747**	**3,460**	**110,204**

Table VIII.B.12. Profile of Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Entities	Establishments	Employees
Telecommunications			
Alaskan	7	30	619
Central	418	1,853	32,035
Eastern	532	2,536	48,653
Pacific	6	28	580
Southern	479	2,227	44,194
Western	384	1,554	28,506
Subtotal	**1,825**	**8,228**	**154,587**
Temporary Help Services			
Alaskan	6	9	363
Central	910	1,623	340,619
Eastern	1,469	2,286	435,338
Pacific	14	22	10,226
Southern	1,192	1,941	704,748
Western	837	1,395	382,328
Subtotal	**4,428**	**7,276**	**1,873,621**
Transportation			
Alaskan	515	645	4,950
Central	36,839	39,510	214,151
Eastern	32,523	35,567	218,252
Pacific	374	443	7,332
Southern	31,794	36,180	290,503
Western	23,246	25,732	170,998
Subtotal	**125,290**	**138,077**	**906,187**
Utilities			
Alaskan	59	98	817
Central	1,481	4,192	61,651
Eastern	1,628	5,255	86,266
Pacific	20	36	336
Southern	2,678	5,894	73,865
Western	1,470	3,002	41,136
Subtotal	**7,336**	**18,477**	**264,071**
Warehousing			
Alaskan	21	22	126
Central	2,247	3,195	74,468
Eastern	2,877	4,040	109,065
Pacific	42	51	452
Southern	2,631	3,966	92,288
Western	2,068	3,000	70,103
Subtotal	**9,887**	**14,274**	**346,503**
Non-Core			
Alaskan	1,907	2,218	41,857
Central	138,849	171,223	3,404,715
Eastern	221,457	269,307	5,632,414
Pacific	3,497	4,224	83,648
Southern	169,479	211,935	3,135,642
Western	140,429	169,045	3,697,556
Subtotal	**675,618**	**827,952**	**15,995,832**
Total			
Alaskan	7,073	7,895	83,969

Table VIII.B.12. Profile of Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Entities	Establishments	Employees
Central	506,064	571,365	7,918,510
Eastern	701,843	792,041	11,233,941
Pacific	10,295	11,611	173,649
Southern	550,301	638,982	8,744,454
Western	455,175	513,879	7,799,801
Total	**2,230,750**	**2,535,774**	**35,954,325**

Source: OSHA, based on Census Bureau, 2021a; USDA, 2019; Census Bureau, 2023a; Census Bureau, 2023d; and USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

B. Determining Entity Size.

OSHA also estimates the number of firms, establishments, and employees that are considered small by both SBA regulations in 13 CFR 121.201 and the Regulatory Flexibility Act (RFA). Private entities are defined as small according to various employment- or revenue-based definitions by 6-digit NAICS code as laid out in the SBA table of size standards (SBA, 2023). Public entities (or "small governments") are defined as small if they serve a population of less than 50,000.[44] OSHA also looks at the economic impacts on very small entities, which, for all industries, the agency defines as those employing fewer than 20 employees.

For this PEA, OSHA analyzed costs at the 4-digit NAICS code and State level. Since there are no SBA definitions of small entities at the 4-digit level, OSHA aggregated the number of firms, establishments, and employees within each 6-digit NAICS industry to the 4-digit level. For employee-based SBA definitions, OSHA summed all economic data within employee-class sizes below the SBA-determined cut-off number of

[44] The RFA also includes small organizations defined as any not-for-profit enterprise which is independently owned and operated and is not dominant in its field. Traditionally, OSHA considers all non-profit organizations to be small entities based on this definition. This has the effect of including some very large organizations in the analysis of small entities (e.g., some major hospital systems with tens of thousands of employees are non-profit entities) thus skewing the costs and impacts for the average small entity. For this analysis, OSHA did not separately assess impacts on non-profit entities. To the extent that non-profit entities are similar in size to small for-profit entities (either based on the number of employees or revenues), the costs and impact estimates would be consistent. The costs of this proposed standard are largely employee based and the agency has not found there to be feasibility concerns for entities of any size. Including large non-profits in the profile of SBA/RFA defined small entities would not alter the findings of the Initial Regulatory Flexibility Analysis (See section VIII.F.).

employees. For revenue-based definitions, OSHA summed all economic data for all employee-class sizes under the largest employee-class size where the average revenue per firm was under the SBA-determined cut-off revenue. Where available, SUSB data is used to estimate firms, establishments, and employees by size class. As discussed in section VIII.B.II., there are some NAICS industries that are unavailable in the SUSB, so OSHA used alternative data sources, as discussed in section VIII.B.II.A., to estimate employment and establishment counts by size class in those instances.

For the private sector industries that were missing from the SUSB dataset due to data disclosure limitations, OSHA estimated the percentage of employment and establishments in each size class category using SUSB data where available for the sector and then applied that to the total counts of employment and establishments described in Section VIII.B.II., Potentially Affected Industries and Employees. OSHA used data from the Census of Agriculture (USDA, 2019) to estimate the industry characteristics for NAICS industries within the agriculture sector and QCEW data for the remaining NAICS industries that were missing size class information due to data disclosure limitations.

Local government data were drawn from the Census Bureau's (2023) GUS data for 2022 (BLS, 2023d). The data include the 2021 population of each city, county, and town served by the listed local governments. Using the GUS data, OSHA found that, of the 38,736 local governments listed, 18,028 are in State Plan States and 16,893 of these have a population of less than 50,000 and are, thus, considered small. No State governments are considered small under the RFA definition.

Based on the exemption for emergency response activities, OSHA estimated the number of fire departments that serve small governmental jurisdictions and the number of firefighters that they employ. To derive these estimates, OSHA estimated the median population served per fire department employee and used that to estimate how many employees a department would need to employ to serve a population greater than 50,000.

OSHA used data from two Firehouse Magazine surveys to determine the median population served per employee for career and mixed fire departments at various employment size classes to extrapolate to the entire universe of fire departments. Part 1 of the 2021 National Run Survey (Firehouse Magazine, 2022b) presents data from 229 career fire departments' statistics about population and staffing. Similarly, the 2021 Combination Fire Department Run Survey (Firehouse Magazine, 2022a) has mixed fire department data. Estimates of the median population served per employee derived from both surveys are multiplied by the number of employees for each department in the U.S. Fire Administration's (USFA, 2022) registry data (used for the Fire Department profile (see Section VIII.B.II., Potentially Affected Industries and Employees)) within each employee size class to determine how many departments serve populations of fewer than 50,000. These estimated counts of employees and fire departments corresponding to those departments were removed from the count of employees, entities, and establishments at affected small governments.

C. Summary of Small and Very Small Entities.

Table VIII.B.13. presents the number of small firms and establishments and the number of very small firms and establishments, as well as the number of employees estimated to work for these small and very small entities. In some industries with revenue-based SBA thresholds for small entities, the counts of small affected firms (establishments) are less than the counts for very small firms (establishments). This occurs when some very small firms (establishments) have revenue that exceeds the small entity revenue threshold and are therefore not included in the counts of small firms (establishments).

Table VIII.B.13. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Agriculture, Forestry, and Fishing						
Alaskan	475	478	831	466	466	544
Central	24,294	24,322	149,091	15,065	15,065	55,208
Eastern	16,193	16,208	115,421	12,736	12,738	53,826
Pacific	199	199	1,399	138	138	1,082
Southern	26,346	26,377	169,979	17,326	17,331	62,951
Western	16,211	16,268	314,889	10,009	10,012	58,338
Subtotal	**83,717**	**83,853**	**751,608**	**55,739**	**55,750**	**231,950**
Building Materials and Equipment Suppliers						
Alaskan	14	15	216	27	27	202
Central	1,192	1,282	25,975	2,192	2,231	18,113
Eastern	1,999	2,128	40,838	3,358	3,409	27,914
Pacific	38	41	679	52	52	395
Southern	1,814	1,946	34,426	2,855	2,898	23,385
Western	1,509	1,596	28,722	2,311	2,345	18,858
Subtotal	**6,566**	**7,009**	**130,856**	**10,795**	**10,962**	**88,866**
Commercial Kitchens						
Alaskan	509	579	4,603	430	432	1,745
Central	36,119	40,201	472,283	26,822	26,939	130,727
Eastern	65,298	69,963	724,441	51,676	51,830	233,251
Pacific	1,282	1,388	16,812	946	949	4,411
Southern	42,239	47,058	571,817	31,027	31,159	145,802
Western	38,954	43,511	487,920	29,838	30,051	149,486
Subtotal	**184,402**	**202,700**	**2,277,876**	**140,740**	**141,361**	**665,422**
Construction						
Alaskan	2,383	2,400	6,784	2,277	2,279	4,532
Central	158,425	158,752	562,118	147,997	148,028	315,449
Eastern	230,158	230,528	840,221	214,268	214,313	467,181
Pacific	3,308	3,317	15,761	2,986	2,986	8,179
Southern	163,896	164,295	695,987	149,782	149,827	359,212
Western	151,930	152,258	602,318	140,362	140,392	322,939
Subtotal	**710,101**	**711,550**	**2,723,189**	**657,671**	**657,825**	**1,477,491**
Drycleaning and Commercial Laundries						
Alaskan	17	19	95	16	17	69

Table VIII.B.13. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Central	1,929	2,171	8,814	1,754	1,797	4,391
Eastern	5,626	5,994	17,624	5,330	5,438	10,761
Pacific	39	41	313	32	34	83
Southern	3,087	3,449	12,989	2,843	2,951	7,977
Western	2,352	2,501	8,319	2,214	2,268	5,138
Subtotal	**13,051**	**14,174**	**48,155**	**12,190**	**12,506**	**28,419**
Landscaping and Facilities Support						
Alaskan	105	109	1,938	98	99	860
Central	11,364	11,974	165,112	10,565	10,796	82,930
Eastern	18,330	19,096	270,325	17,103	17,308	131,677
Pacific	223	250	5,027	202	203	2,067
Southern	12,805	13,271	200,425	11,867	11,974	101,006
Western	9,634	9,974	152,217	8,953	9,030	77,219
Subtotal	**52,461**	**54,673**	**795,043**	**48,789**	**49,410**	**395,758**
Maintenance and Repair						
Alaskan	174	186	1,055	174	176	821
Central	19,068	19,653	108,461	19,174	19,344	84,101
Eastern	25,688	26,211	144,821	25,704	25,857	113,180
Pacific	304	318	1,926	304	306	1,384
Southern	20,023	20,552	117,782	20,239	20,395	87,092
Western	15,931	16,477	100,556	16,000	16,166	72,908
Subtotal	**81,188**	**83,397**	**474,600**	**81,595**	**82,245**	**359,487**
Manufacturing						
Alaskan	161	180	1,703	141	147	430
Central	28,332	29,454	617,095	20,447	20,529	95,353
Eastern	33,582	34,481	611,009	25,312	25,388	112,950
Pacific	282	288	2,422	248	248	818
Southern	24,499	25,279	450,901	18,822	18,884	83,417
Western	24,347	24,818	337,592	19,945	19,989	76,876
Subtotal	**111,203**	**114,500**	**2,020,722**	**84,915**	**85,185**	**369,844**
Oil and Gas						
Alaskan	53	61	692	29	29	70
Central	2,861	3,003	15,645	2,423	2,443	4,948
Eastern	1,391	1,458	9,518	1,116	1,125	2,497
Pacific	0	0	0	0	0	0
Southern	10,562	11,375	87,027	8,658	8,691	17,744

Table VIII.B.13. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Western	1,561	1,631	9,034	1,306	1,308	2,807
Subtotal	**16,428**	**17,527**	**121,915**	**13,532**	**13,596**	**28,065**
Postal and Delivery Services						
Alaskan	21	33	34	18	18	26
Central	1,374	1,951	11,199	1,168	1,171	1,544
Eastern	2,238	3,001	18,998	1,899	1,900	2,351
Pacific	25	36	56	20	20	27
Southern	1,965	2,731	17,147	1,709	1,720	2,104
Western	1,533	2,081	17,285	1,302	1,309	1,733
Subtotal	**7,155**	**9,832**	**64,719**	**6,115**	**6,139**	**7,785**
Recreation and Amusement						
Alaskan	258	262	836	243	244	407
Central	9,660	9,978	76,652	8,093	8,131	23,284
Eastern	14,184	14,593	126,221	11,535	11,573	34,163
Pacific	176	182	1,996	131	131	387
Southern	9,058	9,335	79,313	7,510	7,547	22,207
Western	7,620	7,976	68,703	6,226	6,251	18,228
Subtotal	**40,956**	**42,326**	**353,720**	**33,738**	**33,877**	**98,674**
Sanitation and Waste Removal						
Alaskan	17	17	260	16	16	144
Central	598	613	11,803	519	519	5,716
Eastern	908	925	21,423	763	765	8,892
Pacific	13	16	510	10	10	186
Southern	579	600	13,810	481	482	5,650
Western	403	416	10,566	333	334	4,111
Subtotal	**2,517**	**2,586**	**58,372**	**2,120**	**2,125**	**24,699**
Telecommunications						
Alaskan	0	0	0	4	4	18
Central	6	6	28	281	303	1,237
Eastern	11	12	108	370	388	1,356
Pacific	0	0	0	2	3	13
Southern	14	16	124	341	361	1,341
Western	14	14	71	271	286	1,089
Subtotal	**46**	**48**	**332**	**1,269**	**1,344**	**5,054**
Temporary Help Services						
Alaskan	3	3	111	2	2	24

Table VIII.B.13. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Central	746	785	58,271	487	490	4,506
Eastern	1,258	1,305	92,651	845	847	7,409
Pacific	9	10	1,444	5	5	43
Southern	1,001	1,064	81,872	663	666	5,193
Western	734	765	47,601	520	525	3,995
Subtotal	**3,752**	**3,933**	**281,950**	**2,522**	**2,537**	**21,170**
Transportation						
Alaskan	472	551	2,648	402	407	779
Central	35,362	35,967	100,567	32,172	32,196	40,920
Eastern	30,938	31,687	109,558	27,247	27,290	38,381
Pacific	336	378	3,401	248	252	513
Southern	30,063	31,185	121,185	26,656	26,726	38,318
Western	22,303	23,056	77,739	19,941	20,008	26,654
Subtotal	**119,474**	**122,823**	**415,098**	**106,667**	**106,879**	**145,566**
Utilities						
Alaskan	56	86	742	34	37	110
Central	1,169	2,078	18,326	711	760	2,076
Eastern	1,235	2,285	22,667	835	957	2,177
Pacific	12	25	105	9	9	28
Southern	2,393	3,494	28,343	1,911	1,960	4,049
Western	1,279	1,717	11,810	1,067	1,103	3,123
Subtotal	**6,144**	**9,686**	**81,995**	**4,568**	**4,826**	**11,564**
Warehousing						
Alaskan	21	22	126	10	10	17
Central	2,193	3,078	70,279	732	753	1,639
Eastern	2,820	3,920	105,756	1,034	1,051	2,412
Pacific	42	51	449	8	8	34
Southern	2,570	3,800	87,420	965	975	2,066
Western	2,035	2,888	67,352	806	820	1,817
Subtotal	**9,681**	**13,759**	**331,382**	**3,555**	**3,618**	**7,985**
Non-Core						
Alaskan	1,503	1,582	14,497	1,594	1,620	5,729
Central	109,785	114,774	1,251,037	117,012	117,910	428,271
Eastern	175,885	181,593	1,867,095	189,755	190,941	648,153
Pacific	2,738	2,857	22,687	2,818	2,851	9,578
Southern	133,234	138,262	1,099,714	147,342	148,376	508,465

Table VIII.B.13. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Western	113,249	117,242	1,000,087	122,703	123,582	423,075
Subtotal	**536,394**	**556,310**	**5,255,118**	**581,225**	**585,280**	**2,023,270**
Total						
Alaskan	6,241	6,582	37,172	5,982	6,031	16,526
Central	444,478	460,042	3,722,756	407,614	409,405	1,300,411
Eastern	627,742	645,388	5,138,694	590,884	593,119	1,898,531
Pacific	9,027	9,397	74,988	8,161	8,205	29,227
Southern	486,148	504,089	3,870,261	450,999	452,925	1,477,979
Western	411,599	425,189	3,342,781	384,105	385,778	1,268,393
Total	**1,985,235**	**2,050,685**	**16,186,651**	**1,847,745**	**1,855,463**	**5,991,068**

Source: OSHA, based on BLS, 2023; Census Bureau, 2021a; Census Bureau, 2023a; Census Bureau, 2023b; Census Bureau, 2023d; Firehouse Magazine, 2022a; Firehouse Magazine 2022b; SBA 2023; USDA, 2019; USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

C. Costs of Compliance.

I. Introduction.

This section presents OSHA's preliminary analysis of the compliance costs associated with the proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings.

OSHA estimates that the proposed standard would cost annually $7.8 billion (in 2023 dollars) at a discount rate of 2 percent. On average, the annualized cost per establishment is estimated to be $3,085.[45] All costs were annualized using a discount rate of 2 percent, consistent with OMB Circular A-4 (OMB, 2023).[46] A 10-year period is used to annualize one-time costs or other costs that do not occur every year. Note that the benefits of the proposed standard, discussed in Section VIII.E., Benefits, are also annualized over a 10-year period. Therefore, the time horizon of OSHA's complete analysis of this proposed standard is 10 years. Employment and production in affected sectors are implicitly held constant over this time horizon for purposes of the analysis.

While some employers may be able to make fixed investments to reduce their marginal per-employee costs (e.g., on-site freezers, air conditioning) as a result of the proposed standard, for the purposes of this cost analysis OSHA assumes that employers do not make these adjustments. This assumption may result in an overestimate of the costs of compliance (e.g., for some firms it may be less costly to install air conditioning rather than increasing rest break time for employees). The agency also did not explore all potential societal costs (i.e., those that do not affect the proposed standard's economic feasibility). OSHA welcomes comment on other impacts the rule may have on employees

[45] Spreadsheet detailing all calculations discussed in this analysis are available in Analytical Support for OSHA's Preliminary Economic Analysis for the Heat Injury and Illness Prevention (OSHA, 2024c).
[46] Section VIII.C.V., Total Costs, presents total annualized costs, discounted (2 percent over a 10-year period) and undiscounted.

that the agency has not considered in this preliminary analysis but should consider in the final analysis.

The remainder of this section is organized as follows: first, OSHA discusses cost assumptions used in the analysis, followed by the derivation of the wage rates used to estimate labor costs. Next, OSHA presents unit and total costs by affected industry sector and region and by applicable provision of the proposed standard. The final section presents the total costs of the proposed standard for all affected entities and employees as well as those that meet the SBA/RFA definitions of small entities and those with fewer than 20 employees. Discussion of burden reducing regulatory alternatives and regulatory options that may increase costs of compliance are discussed in Section VIII.F.II.G., Alternatives and Regulatory Options to the Proposed Rule.

II. Cost Assumptions.

This section describes the cost assumptions used in this analysis including those relevant to baseline conditions, temperature, and heat-related incidence rates. OSHA welcomes comment on all assumptions and estimates discussed in this section. Additional data or suggestions on methodological changes the agency should consider are also welcome.

A. Baseline Non-Compliance Rates.

The estimated costs of the proposed standard are measured against the baseline activities of the affected industries, including core and non-core industries (see Section VIII.B., Profile of Affected Industries for a discussion and definition of core industries). The baseline for this analysis includes existing conformity ("compliance") with the provisions of the proposed standard. Compliance costs are estimated only for "non-compliant" entities with practices that currently do not conform to the proposed standard and who would therefore incur costs to comply with it.

OSHA developed baseline non-compliance rates (percent of non-compliant entities) based on a review of existing State requirements (e.g., State heat standards, non-heat-specific paid rest break State laws[47]), State-level workforce characteristics (e.g., prevalence of piece-rate pay, collective bargaining), and other industry practices when employees are exposed to heat-related hazards in the workplace, datasets and reports detailing current practices within specific industries, feedback from participants in the Small Business Advocacy Review (SBAR) Panel, and professional expertise of OSHA staff. OSHA prioritized the use of State-specific data sources wherever possible; however, in the absence of State-specific data, national data sources were used to develop baseline non-compliance rates. In some instances, no data were available to develop baseline non-compliance rates for certain provisions within certain industries. In these cases, OSHA assumed default non-compliance rates for those industries, in some cases distinguishing between core and non-core industries (see section VIII.B.II.A. for more information on core industries). For certain provisions (i.e., heat hazard evaluation and acclimatization), OSHA believes that non-compliance rates among core industries may be lower than those within non-core industries (i.e., employers in core industries are doing more of what OSHA would require under this proposed standard) because core industries have more affected employees, and more heat-related hazards present in their work processes. For this reason, core industries may be more likely to have policies and procedures in place to protect employees from heat-related hazards on their work sites than employers in non-core industries who may be less aware of heat hazards present in their workplace. However, for other provisions (e.g., providing drinking water and rest break policies) current employment practices are affected by factors beyond heat;

[47] In most cases, Federal law does not require the provision of rest breaks, see *https://www.dol.gov/general/topic/workhours/breaks*.

therefore, OSHA assumes default non-compliance rates for all industries, assuming they are the same for core and non-core industries.

Some States already have heat standards that address some or all settings in the State. While the agency estimates that all covered employers would incur some costs to comply with this proposed standard, employers in States that have heat standards will likely have lower compliance costs since they are already doing some of what would be required by OSHA. This is reflected in this analysis. Table VIII.C.1. shows the States with existing State heat standards and the corresponding industries and work settings within the scope of those State standards.

Table VIII.C.1. States and Industries with Existing State Heat Standards

Sector	State	Source
Outdoor Settings – NAICS 11, 23, 2111, 213111, 213112, 561730 [a]	California	Cal. Code of Regs. tit. 8, section 3395 (2005)
Indoor and Outdoor Settings – NAICS11	Colorado	7 Colo. Code Regs. section 1103-15 (2022)
Indoor Settings – All Sectors	Minnesota	Minn. R. 5205.0110 (1997)
Indoor and Outdoor Settings – All sectors	Oregon	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
Outdoor Settings – All Sectors	Washington	Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)

[a] California's standard only covers outdoor workers within select industries within sector 11. Covered agricultural sectors include 1111, 1112, 1113, 1114, 1119, 1121, 1122, 1123, 1124, 1125, 1129, 1151, and 1152.

Since all affected establishments would need to incur some cost to develop a HIIPP that meets OSHA's requirements, OSHA assumes that even establishments with existing HIIPPs in place would incur costs to review and modify their HIIPP to meet OSHA's requirements. Table VIII.C.2. shows the percentages of establishments estimated to have existing HIIPPs in place in certain industries and States.

Table VIII.C.2. Percentage of Establishments with Existing Heat Injury and Illness Prevention Plans

Sector	State	Percent of Establishments	Source
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [a]	California	100.0% [b]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 11	Colorado	100.0%	7 Colo. Code Regs. section 1103-15 (2022)

Table VIII.C.2. Percentage of Establishments with Existing Heat Injury and Illness Prevention Plans

Sector	State	Percent of Establishments	Source
All Sectors	Minnesota	100.0%	Minn. R. 5205.0110 (1997)
All Sectors	Oregon	100.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
All Sectors	Washington	100.0%	Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)
Sectors 23 and 31-33	National	75.0%	OSHA Estimate
Core Industries	National	50.0%	OSHA Estimate
Non-Core Industries	National	10.0%	OSHA Estimate

[a] California's standard only covers select industries within sector 11. Covered agricultural sectors include 1111, 1112, 1113, 1114, 1119, 1121, 1122, 1123, 1124, 1125, 1129, 1151, and 1152.
[b] California's standard specifies that 6-digit NAICS industries 213111, 213112, and 561730 need to follow the requirements of that rule. Since OSHA analyzes costs and economic impacts for this proposed standard at the 4-digit NAICS level, OSHA assumes that only a subset of NAICS 2131 and 5617 in California are already compliant with the requirements of OSHA's proposed standard. For NAICS 2131, OSHA assumes that 40 percent of NAICS 2131 are already compliant (since 213111 and 213112 represent two of the five 6-digit NAICS within the 4-digit NAICS 2131). For NAICS 5617, OSHA assumes that 20 percent of NAICS 5617 are already compliant (since 561730 represents one of the five 6-digit NAICS within the 4-digit NAICS 5617).

Table VIII.C.3. shows the estimated baseline non-compliance rates for rest breaks at both the initial and high heat triggers by State. OSHA estimated State-level non-compliance rates for rest breaks at the initial and high heat triggers based on a review of existing State requirements (State heat standards, non-heat-specific paid rest break State laws), State-level workforce characteristics (prevalence of piece-rate pay, collective bargaining), and existing paid rest breaks in collective bargaining agreements (Justia, 2022; DOL, 2023a; DOL, 2023b; NCFH, 2022; Gittleman and Pierce, 2013; Adams et al. 2009; Hirsch et al., n.d.; DOL, 2024b).

For each State, the State-level non-compliance rate for initial heat trigger rest breaks is assumed to be equal to the percentage of non-union piece-rate workers in that State.[48] Based on review of existing collective bargaining agreements, feedback from Small Entity Representatives during the SBAR Panel process reporting high current compliance with if-needed rest breaks (which is also consistent with worker surveys such

[48] Detailed formulas are available in Noncompliance Rates for Rest Breaks (OSHA, 2024e).

as Mirabelli et al. (2010) and Langer et al. (2021) reporting high current compliance with if-needed rest breaks), and evidence that piece-rate workers are incentivized to work faster and take fewer rest breaks than non-piece-rate workers as reported in focus group discussions with U.S. farmworkers (Wadsworth et al., 2019; Lam et al., 2013), OSHA assumes that, nationwide, all non-piece-rate workers and workers affiliated with a union (both piece-rate and non-piece-rate) are already allowed rest breaks if needed from their employer.

State-level non-compliance rates for high heat trigger rest breaks were calculated based on the State or territory's current paid rest break laws, State heat standards, prevalence of rest breaks in collective bargaining agreements, and the share of employees affiliated with a union (by membership or representation).[49] The rationale behind the formulas is as follows. Non-union piece-rate employees in any State are likely the least protected, currently assumed to be taking zero breaks at the high heat trigger.[50] Non-union non-piece-rate employees are likely most protected in States with a heat standard (i.e., these employees are getting most required scheduled rest breaks in addition to if-needed rest breaks), less protected in States with some non-heat-related paid break law (these workers are getting some scheduled rest breaks), and the least protected in States with no paid break law (these employees may be getting no scheduled rest breaks). Also, in any State, OSHA assumes that employees (both piece-rate and non-piece-rate) affiliated with a union are more protected than non-union employees by being provided

[49] Detailed formulas are available in Noncompliance Rates for Rest Breaks (OSHA, 2024e). In estimating unit costs of compliance with the high heat trigger breaks, OSHA estimates that employers that are fully noncompliant in outdoor and indoor settings will incur 47 minutes and 41 minutes per employee, respectively. However, in the State-level baseline compliance calculations OSHA assumes that employers (indoor and outdoor) that offer 47 minutes of break plus travel time are 100 percent compliant with the high heat trigger breaks. This simplifying assumption results in an underestimate of baseline compliance for indoor employers—employers with indoor workers that are technically currently 100 percent compliant by already providing 41 minutes of break time (including travel time) are calculated as being 87 percent compliant (41 minutes provided/47 minutes), instead of 100 percent (fully compliant).

[50] This assumption may overestimate non-compliance of employers of piece-rate workers in states that have laws requiring paid rest breaks for piece-rate workers (in all sectors for California, in the agricultural sector for Washington State).

some scheduled as well as if-needed rest breaks. Collective bargaining agreements differ across employers and States; however, collective bargaining agreements are likely more protective (meaning employees covered by a union are likely to get more scheduled rest breaks) in States with a heat standard or non-heat-related paid break law than in States with no paid break law.

OSHA acknowledges that there is limited information on current baseline non-compliance rates for rest breaks in (1) States without existing rest breaks laws and (2) States with existing rest break laws. OSHA welcomes feedback on the assumptions and estimates of rest break non-compliance by State (and territory) described above. OSHA is soliciting feedback on whether the assumptions regarding compliance differences by workforce characteristics (e.g., piece rate workers, union work, State break laws, State heat laws) are reasonable or if there are alternative methods, sources of data, or assumptions that should be considered. OSHA is especially interested in existing research or data sources that can be used to evaluate the impact of rest breaks in States with existing requirements.

Table VIII.C.3. Rest Break Non-Compliance Rates by State and Territory

State	Initial Heat Trigger	High Heat Trigger
Alabama	6.3%	67.7%
Alaska	6.0%	65.7% [a]
American Samoa [b]	6.2%	67.1%
Arkansas	6.4%	68.3%
Arizona	6.6%	70.0%
California	5.7%	13.7%
Colorado	6.3%	15.3%
Connecticut	6.0%	65.9%
District of Columbia	6.3%	67.9%
Delaware	6.3%	67.9%
Florida	6.6%	69.7%
Georgia	6.6%	69.5%
Guam [b]	6.2%	67.1%
Hawaii	4.8%	58.4%
Idaho	6.6%	69.5%
Illinois	5.8%	28.4%
Indiana	6.1%	66.3%
Iowa	6.3%	67.6%
Kansas	6.0%	66.2%
Kentucky	6.0%	29.0%

Table VIII.C.3. Rest Break Non-Compliance Rates by State and Territory

State	Initial Heat Trigger	High Heat Trigger
Louisiana	6.6%	69.6%
Maine	6.4%	68.2%
Maryland	6.2%	29.8%
Massachusetts	5.9%	65.6%
Michigan	5.6%	63.2%
Minnesota	5.9%	28.6%
Mississippi	6.0%	66.2%
Missouri	5.9%	65.5%
Montana	6.0%	66.0%
Nebraska	6.4%	68.4%
Nevada	5.6%	27.4%
New Hampshire	6.4%	68.4%
New Jersey	5.5%	62.9%
New Mexico	6.4%	68.7%
New York	5.2%	61.1%
North Carolina	6.7%	70.4%
North Dakota	6.4%	68.3%
Northern Mariana Islands [b]	6.2%	67.1%
Ohio	6.0%	65.6%
Oklahoma	6.6%	69.6%
Oregon	5.9%	5.9%
Pennsylvania	5.8%	64.9%
Puerto Rico [b]	6.2%	67.1%
Rhode Island	5.9%	65.0%
South Carolina	6.7%	70.6%
South Dakota	6.7%	70.5%
Tennessee	6.4%	68.6%
Texas	6.6%	69.7%
Utah	6.5%	68.8%
U.S. Virgin Islands [b]	6.2%	67.1%
Vermont	5.8%	64.9%
Virginia	6.6%	69.9%
Washington	5.5%	13.3%
West Virginia	6.0%	66.0%
Wisconsin	6.2%	67.1%
Wyoming	6.6%	69.5%

[a] The weather data (discussed in Section VIII.B., Profile of Affected Industries) do not show Alaska meeting or exceeding the high heat trigger. However, OSHA applied the same assumptions used for other States to arrive at a non-compliance rate for Alaska that would be applied if there were exposure to heat at or above the high heat trigger. In the current analysis, the cost for high heat trigger rest breaks is zero for employers in Alaska. In the event that the estimation methodology for exposure to heat used in the final analysis is changed in a manner that results in employees in Alaska being found to be exposed to heat at or above the high heat trigger, this non-compliance rate will be applied in those situations.

[b] Rest break non-compliance rates for U.S. territories were imputed using the employment-weighted average of the non-compliance rates of the States without any paid break law.

Source: OSHA estimates based on Justia, 2022; DOL, 2023a; DOL, 2023b; NCFH, 2022; Gittleman and Pierce, 2013; Adams et al. 2009; Hirsch et al., n.d.; DOL, 2024b; formulas in OSHA, 2024e.

Table VIII.C.4. shows the estimated baseline non-compliance rates for all other requirements of the proposed standard. Within certain provisions, OSHA outlines different non-compliance rates for certain requirements under each provision (e.g., OSHA found that some State rules require initial training on heat-related hazards for employees but do not require refresher training).

OSHA welcomes feedback on the baseline non-compliance estimates that are detailed in table VIII.C.4. OSHA seeks information and feedback on the following topics: alternative sources; existing employer practices in States with or without existing heat regulations; variation in non-compliance based on employer size, industry, and occupation; and the assumption that non-core industries tend to have lower baseline compliance (and higher non-compliance) than core industries.

Table VIII.C.4. Non-Compliance Rates by Provision

Industry/Sector	State	Non-Compliance Estimate	Source
Heat Injury and Illness Prevention Plan			
Develop or Modify HIIPP			
All Sectors [a]	National	100.0%	OSHA estimate
Review HIIPP			
All Sectors	National	50.0%	OSHA estimate
Employee Involvement			
All Sectors	National	75.0%	OSHA estimate
Identifying Heat Hazards			
Environmental Monitoring - Outdoor			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 11	Colorado	0.0%	7 Colo. Code Regs. section 1103-15 (2022)
All Sectors	Minnesota	0.0%	Minn. R. 5205.0110 (1997)
All Sectors	Oregon	0.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
All Sectors	Washington	0.0%	Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)
Sectors 23 and 31-33	National	16.7%	OSHA, 2023
All Other Industries	National	20.0%	OSHA Estimate
Environmental Monitoring - Indoor			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 11	Colorado	0.0%	7 Colo. Code Regs. section 1103-15 (2022)
All Sectors	Minnesota	0.0%	Minn. R. 5205.0110 (1997)

Table VIII.C.4. Non-Compliance Rates by Provision

Industry/Sector	State	Non-Compliance Estimate	Source
All Sectors	Oregon	0.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
All Sectors	Washington	0.0%	Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)
Sectors 23 and 31-33	National	16.7%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Hazard Evaluation			
NAICS 2211	National	28.3%	Kaltsatou et al., 2021
Sectors 23 and 31-33	National	7.7%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Employee Involvement			
All sectors	National	75.0%	OSHA Estimate
Requirements at or Above the Initial Heat Trigger			
Drinking Water			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 23	Texas	59.0%	Workers Defense Project, 2013
Sector 11 [d]	National	3.0%	DOL, 2022
All Other Industries	National	10.0%	OSHA Estimate
Break Area(s) at Outdoor Work Sites			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sectors 23 and 31-33	National	20.0%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Indoor Work Area and Break Area Controls			
All Sectors	Oregon	0.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
Sectors 23 and 31-33	National	50.0%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Acclimatization - New Employees			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sectors 23 and 31-33	National	44.8%	OSHA, 2023
NAICS 2111	National	72.0%	Ergodyne, 2020
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Acclimatization - Returning Employees			
Sector 11	Colorado	0.0%	7 Colo. Code Regs. section 1103-15 (2022)
All Sectors	Oregon	0.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
Sectors 23 and 31-33	National	67.2%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate

Table VIII.C.4. Non-Compliance Rates by Provision

Industry/Sector	State	Non-Compliance Estimate	Source
Effective Communication —- Supervisor [e]			
All sectors	National	25.0%	OSHA Estimate
Effective Communication —- Employee [e]			
All sectors	National	50.0%	OSHA Estimate
Requirements at or Above the High Heat Trigger			
Observation for Signs and Symptoms - Supervisor			
All Sectors	National	25.0%	OSHA Estimate
Observation for Signs and Symptoms - Employee			
All Sectors	National	50.0%	OSHA Estimate
Hazard Alert			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 11	Colorado	0.0%	7 Colo. Code Regs. section 1103-15 (2022)
Sectors 23 and 31-33	National	9.1%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Heat Illness and Emergency Response and Planning			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 11	Colorado	50.0%	7 Colo. Code Regs. section 1103-15 (2022)
Sectors 23 and 31-33	National	16.7%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Training			
Initial Training			
NAICS 11, 23, 2111, 213111, 213112, 4841, 4842, 4884, 4889, 561730 [b]	California	0.0% [c]	Cal. Code of Regs. tit. 8, section 3395 (2005)
Sector 11	Colorado	0.0%	7 Colo. Code Regs. section 1103-15 (2022)
All Sectors	Minnesota	0.0%	Minn. R. 5205.0110 (1997)
All Sectors	Oregon	0.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
All Sectors	Washington	0.0%	Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)
Sectors 23 and 31-33	National	20.0%	OSHA, 2023
NAICS 2211	National	26.1%	Kaltsatou et al., 2021
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Refresher Training			
Sector 11	Colorado	0.0%	7 Colo. Code Regs. section 1103-15 (2022)
All Sectors	Minnesota	0.0%	Minn. R. 5205.0110 (1997)
All Sectors	Oregon	0.0%	Or. Admin. R. 437-002-0156 (2022); Or. Admin. R. 437-004-1131 (2022)
All Sectors	Washington	0.0%	Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296-307-097 through 296-307-09760 (2023)

Table VIII.C.4. Non-Compliance Rates by Provision

Industry/Sector	State	Non-Compliance Estimate	Source
Sectors 23 and 31-33	National	0.0%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate
Recordkeeping			
Sectors 23 and 31-33	National	64.3%	OSHA, 2023
All Other Core Industries	National	50.0%	OSHA Estimate
All Other Non-Core Industries	National	90.0%	OSHA Estimate

[a] OSHA assumes that all employers will need to develop a HIIPP, either by creating a new HIIPP or reviewing and updating an existing HIIPP to comply with the proposed standard. More discussion of the calculation of HIIPP total costs can be found in section VIII.C.V.B.
[b] The California State rule only covers select industries within sector 11. Covered agricultural sectors include NAICS 1111, 1112, 1113, 1114, 1119, 1121, 1122, 1123, 1124, 1125, 1129, 1151, and 1152.
[c] California's standard specifies that 6-digit NAICS 213111, 213112, and 561730 need to follow the requirements of that rule. Since OSHA analyzes costs and economic impacts for this proposed standard at the 4-digit NAICS level, OSHA assumes that only a subset of NAICS 2131 and 5617 in California are already compliant with the requirements of OSHA's proposed standard. For NAICS 2131, OSHA assumes that 40 percent of NAICS 2131 are already compliant (since NAICS 213111 and 213112 represent two of the five 6-digit NAICS within the 4-digit NAICS 2131). For NAICS 5617, OSHA assumes that 20 percent of NAICS 5617 are already compliant (since NAICS 561730 represents one of the five 6-digit NAICS industries within the 4-digit NAICS 5617). Using these assumptions, 60 percent of NAICS 2131 and 80 percent of NAICS 5617 are considered non-compliant.
[d] Only covers NAICS industry groups 1111, 1112, 1113, 1114, 1119, 1121, 1122, 1123, 1151, and 1152 within sector 11.
[e] Compliance with the effective communication provision of the proposed standard requires employers to maintain two-way communication with employees and to regularly communicate with employees. For the purposes of this cost analysis, OSHA assumes that 50 percent of employers are currently compliant with the provision. OSHA also assumes that half of the remaining non-compliant employers currently engage in one-way communication (from supervisor to employee) and would only incur costs for the employee's time communicating with or responding to the supervisor, which is reflected in the different non-compliance estimates (for employer and supervisor) for effective communication.

B. Cost Savings.

OSHA also considers potential cost savings from the proposed standard as a result of requiring employers to provide employees if-needed or scheduled rest breaks (see appendix A at the end of this section for additional details on the assumptions and estimates discussed in this section). The best available evidence indicates that when employees are exposed to heat and are not allowed to take rest breaks or adjust their work hours, they must pace themselves (i.e., work more slowly) to counteract the effects of heat exposure. OSHA has preliminarily determined that when employees are offered rest breaks, cost savings will accrue to employers who are currently noncompliant with the rest break requirements because their employees will work more efficiently (i.e., pace themselves less) during work time not spent on rest breaks. For the purposes of this analysis, OSHA assumes that when calculating the unit cost of rest break requirements, these accrued cost savings partially offset the wage cost of the employee's time spent in required rest breaks.

OSHA has estimated how many minutes of work time are lost due to employees pacing themselves when the heat index is equal to the initial and high heat triggers.[51] OSHA bases these estimates on empirical studies and assumed that the employees in these studies represent a nationwide average employee (for any State, industry, type of worksite, etc.). Some studies included employees who took no rest breaks. Some studies included employees who took only if-needed rest breaks but not scheduled rest breaks,

[51] The extent of labor productivity loss due to pacing is evaluated when the heat index is equal to the initial or high heat triggers. However, the annual number of work hours used in the calculation of total labor cost savings from the required rest breaks capture work hours when the heat index is at or above the triggers (see discussion of temperature data in the following section VIII.C.II.C.). That is, in the calculation of the total labor cost savings, for example, a worker exposed to 95°F heat index is assumed to lose the same amount of labor productivity as a worker exposed to 90°F heat index (the high heat trigger). This discrepancy and other simplifying assumptions would result in potential misestimate of labor productivity losses from pacing and therefore potential misestimate of total labor cost savings, as discussed in more detail in appendix A.

and others included employees who took both if-needed and scheduled rest breaks. OSHA found that there was a decrease in pacing among employees who took if-needed rest breaks and a greater decrease in pacing among those who took scheduled rest breaks as well as if-needed rest breaks, as compared with employees who took no rest breaks. Reductions in pacing at the initial heat trigger from adding if-needed rest breaks and reductions in pacing at the high heat trigger from adding scheduled rest breaks are translated into equivalent minutes of work time saved as a share of the full unit time-cost of these rest breaks, which are then monetized to derive total labor costs saved for employers.

C. Temperature.

Some of the requirements of the proposed standard would only be required when the heat index meets or exceeds a certain heat trigger (i.e., the initial heat trigger at 80°F or the high heat trigger at 90°F). Requirements dependent on the heat index meeting or exceeding certain triggers include, among other things:

- Rest breaks (at both the initial and high heat triggers),
- Acclimatization (at the initial heat trigger),
- Effective communication (initial heat trigger),
- Observation for signs and symptoms (high heat trigger), and
- Hazard Alert (high heat trigger).

In order to calculate the number of times these costs would be incurred by entities on a state-by-state basis, OSHA used heat index data from the NOAA Local Climatological Data (LCD) for 2020 through 2022 (NOAA, 2023b). The LCD data included heat index measurements on an hourly basis for NWS stations across the country. Due to limited data availability, OSHA reviewed a subset of 245 weather stations, ultimately analyzing 238 stations for the calculation. For each station, OSHA determined the number of

workday[52] hours that met or exceeded each of the heat triggers within each shift type as outlined in Section VIII.B., Profile of Affected Industries. From here, OSHA took the average of the number of workday hours meeting or exceeding each of the heat triggers across stations in each State.[53] OSHA excluded seven of the 245 stations for which 10 percent or more of all heat index measurements across all three years of data analyzed were missing.[54] OSHA also evaluated the temperature data to identify States with relatively low levels of humidity[55] (Arizona, Nevada, New Mexico, and Utah) to inform costs related to dehumidification. OSHA used outdoor weather data as a proxy for high heat conditions in indoor settings without adequate climate control. Logically, where a building does not have air conditioning, there is a correlation between the temperature indoors and the temperature outdoors. This may overstate or understate the effects of outdoor temperature on indoor temperatures. A well-insulated building without air conditioning may be cooler than the outside environment, but a poorly insulated, poorly ventilated building that absorbs considerable direct sunlight may be hotter. Even though exposure to process heat may be exacerbated by outdoor temperatures (e.g., on a hot day existing climate control may be inadequate in a hot kitchen), there may be instances where exposure to process heat occurs on relatively cool days. The agency lacks data to make a finer estimate than using outdoor weather as a proxy for indoor heat conditions but welcomes data and suggestions for improved estimation methodology. The results of this analysis are presented in table VIII.C.5.

Table VIII.C.5. Average Annual Hours Exceeding Heat Triggers by State and Work Shift

State	Daytime Shift	Evening Shift	Overnight Shift

[52] Workday hours in the LCD data are defined as hours on weekdays Monday through Friday for each shift type.
[53] OSHA acknowledges that this may be imprecise in states where the climate varies widely between different parts of the state. However, the agency lacks data that would allow for employers and employees to be more precisely located within a given state. OSHA welcomes comment on this issue and suggestions for methodologies to more precisely represent employee exposure within States.
[54] Based on this methodology, seven stations were excluded: McGrath, AK; St. Paul Island, AK; North Little Rock, AR; Eureka, CA; Marquette, MI; Minneapolis, MN; and Mt. Washington, NH.
[55] OSHA acknowledges that due to intrastate variation in climatic conditions, this method may underestimate the number of geographic areas that have relatively low humidity.

	Initial Heat Trigger	High Heat Trigger	Initial Heat Trigger	High Heat Trigger	Initial Heat Trigger	High Heat Trigger
Alaska	2	0	2	0	0	0
Alabama	766	372	347	93	101	15
American Samoa [a]	1,481	231	576	11	168	0
Arkansas	674	376	498	218	145	15
Arizona	701	321	536	233	239	55
California	452	158	256	75	41	0
Colorado	401	61	155	15	8	0
Connecticut	312	87	152	22	22	0
District of Columbia [b]	535	236	278	75	68	2
Delaware	457	182	245	55	54	3
Florida	1,259	669	781	273	440	103
Georgia	740	339	393	115	49	1
Guam [a]	1,481	231	576	11	168	0
Hawaii	1,481	231	576	11	168	0
Iowa	389	119	214	51	24	1
Idaho	347	86	237	49	15	0
Illinois	446	123	205	44	36	2
Indiana	413	113	214	43	28	2
Kansas	565	242	334	108	57	1
Kentucky	474	158	272	67	42	4
Louisiana	925	516	585	220	310	61
Massachusetts	225	61	96	15	22	1
Maryland	539	243	286	77	68	0
Maine	150	30	42	4	6	0
Michigan	243	35	120	13	6	0
Minnesota	186	29	78	10	5	0
Missouri	546	214	325	98	75	7
Mississippi	789	420	389	132	107	15
Montana	250	39	141	17	2	0
North Carolina	566	222	297	72	51	4
North Dakota	270	55	163	29	7	0
Nebraska	482	169	286	79	30	1
New Hampshire	248	68	93	13	8	0
New Jersey	451	176	243	60	66	5
New Mexico	579	125	304	41	33	0
Nevada	557	189	328	99	130	14
New York	256	48	106	9	17	1
Northern Mariana Islands [a]	1,481	231	576	11	168	0
Ohio	357	73	179	26	12	0
Oklahoma	643	334	456	182	132	10
Oregon	245	56	141	28	4	0
Pennsylvania	342	87	184	31	23	1
Puerto Rico	1,942	1,115	1,604	502	1,104	126
Rhode Island	304	108	118	23	23	1
South Carolina	687	301	361	92	73	3
South Dakota	377	96	203	44	18	0
Tennessee	571	214	334	88	63	7
Texas	908	498	676	277	279	38
Utah	489	136	368	71	55	0
U.S. Virgin Islands [c]	1,942	1,115	1,604	502	1,104	126

Virginia	532	230	270	74	67	4
Vermont	229	46	115	12	15	0
Washington	170	36	94	16	5	0
Wisconsin	310	68	145	26	22	1
West Virginia	318	58	143	23	4	0
Wyoming	323	28	110	5	3	0

Source: NOAA, 2023b.

[a] The NOAA data OSHA used did not have data available for American Samoa, Guam, and the Northern Mariana Islands. Estimates for these island areas are set equal to Hawaii's estimates.

[b] The NOAA data OSHA used did not have data available for the District of Columbia. These estimates reflect the midpoint between Maryland and Virginia's estimates presented in this table.

[c] The NOAA data OSHA used did not have data available for the U.S. Virgin Islands. Estimates for the USVI are set equal to Puerto Rico's estimates given their relative proximity.

D. Heat-Related Illnesses – Counts and Incidence Rates.

The provisions of the proposed standard addressing Heat Illness and Emergency Response and Planning would require establishments to develop and implement a plan to treat employees experiencing heat-related illnesses, including heat emergencies. The proposed standard requires additional actions for employers when the heat-related illness is considered a heat emergency; therefore, it is important to estimate separately the incidents of heat-related illnesses that are heat emergencies and those that are not heat emergencies. Using the methods detailed in Section VIII.E., Benefits, OSHA estimated the average expected annual number of heat-related illnesses by industry sector after the implementation of the proposed standard, including adjustments for effectiveness and undercount as described below. Using the estimates of heat-related fatal and non-fatal illnesses by industry sector from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) (BLS, 2024c) and Survey of Occupational Injuries and Illnesses (SOII) from 2011–2022 (BLS, 2023b), OSHA assumed an undercount by a factor of 7.5 for non-fatal heat-related illnesses and 3 for fatal heat-related illnesses. As also discussed in Section V.C., Risk Reduction and Section VIII.E., Benefits, OSHA also assumed an effectiveness rate of 95 percent in reducing heat-related fatal illnesses and 65 percent for non-fatal illnesses. Finally, since costs are dependent on the severity of

illness, OSHA assumed that 5.3 percent[56] of heat-related illnesses are emergencies, and all others are considered non-emergencies for this analysis. Then, the number of estimated incidents for each sector was divided by the number of establishments deemed in-scope of the proposed standard to calculate the estimated per-establishment incident rate for each sector. OSHA welcomes feedback on the data, assumptions, and methods used to estimate the number of heat-related illnesses (emergencies and non-emergencies) by sector, as well as the per-establishment incidence rates by sector.

Table VIII.C.6. shows the total estimated number of heat-related illness emergencies and non-emergencies anticipated annually with the proposed standard in place for each sector, as well as per-establishment incidence rates for each sector.[57]

OSHA welcomes feedback on the assumptions, methods of estimation, and data used to estimate per-establishment incidence rates (emergencies and non-emergencies) for each sector. OSHA acknowledges the possibility that there may be variability in underreporting by industry sector, occupation, or some other measure and welcomes additional data or information on that possibility.

Table VIII.C.6. Summary of Heat-Related Illnesses – Non-Emergencies and Emergencies by Sector

Sector	Non-Emergencies		Emergencies	
	Annual Incidents	Incidence Rate	Annual Incidents	Incidence Rate
11	249	0.002	16	0.000
21	120	0.006	8	0.000
22	68	0.004	4	0.000
23	1,270	0.002	80	0.000
31-33	1,056	0.007	62	0.000
42	325	0.008	19	0.000
44-45	456	0.003	26	0.000
48-49	808	0.004	46	0.000
51	236	0.011	14	0.001
52	27	0.000	2	0.000
53	141	0.003	8	0.000

[56] OSHA estimated the percentage of heat-related illnesses that would be considered emergencies using Harduar Morano and Watkins (2017). Using their results reported in table 2 in that paper, OSHA calculated the percentage of all HRIs reviewed (emergency room visits, hospitalizations, and deaths) that were coded as heat stroke (5.3 percent).

[57] This assumes that rates in the future will be the same as rates in the recent past. This may be inaccurate if rates are reduced due to the efficacy of this proposed standard or if rates increase if more workers are exposed to hot environments.

Table VIII.C.6. Summary of Heat-Related Illnesses – Non-Emergencies and Emergencies by Sector

Sector	Non-Emergencies		Emergencies	
	Annual Incidents	Incidence Rate	Annual Incidents	Incidence Rate
54	102	0.001	6	0.000
55	51	0.007	3	0.000
56	729	0.013	44	0.001
61	23	0.001	1	0.000
62	207	0.005	12	0.000
71	112	0.001	7	0.000
72	255	0.001	15	0.000
81	259	0.001	15	0.000
92	1,643	0.317	94	0.018

Source: OSHA estimate derived from BLS, 2023b, and BLS, 2024c.

III. Labor Rates.

Labor costs associated with the proposed standard are derived using wage data from BLS' cross-industry Occupational Employment and Wage Statistics (OEWS) for May 2022 (BLS, 2023c). For the purposes of this cost analysis, two employee types are used to represent affected employees: "designated person" and "at-risk worker." For each industry sector, OSHA estimated the average hourly wage for these two employee types.

For the purpose of estimating costs, wages for the designated person position were derived by filtering the OEWS data for occupations that included "Manager," "Supervisor," or "Director" in their Standard Occupational Classification (SOC) title and then reviewing those occupations to identify those that may be expected to directly supervise employees exposed to heat-related hazards.[58] Occupations used in the analysis include those (1) that have detailed occupation codes (i.e., six-digit SOC code), (2) deemed to supervise potentially at-risk employees, (3) with recorded employment numbers, and (4) with recorded median hourly wage data. For these occupations, OSHA calculated the percentage of each industry sector's total available employment that each detailed occupation represented. OSHA then calculated the weighted average hourly

[58] Although for purposes of this cost analysis OSHA distinguishes between a "designated person" and "at-risk workers," this terminology is not intended to suggest that supervisors or managers who supervise workers exposed to heat related hazards are not themselves also "at risk" when exposed to the same hazards.

wage for each sector using the product of these percentages and the corresponding median hourly wage estimates from the OEWS. OSHA assumes that the average hourly wages calculated for each represent those for designated workers. OSHA acknowledges that this method of estimation may lead to an overestimate in wage costs as the designated person does not necessarily have to be a supervisor, manager, or director in all cases. For this analysis, OSHA also uses these wages developed for designated persons to represent supervisors' wages. OSHA welcomes feedback on the assumptions, methods, and data used to estimate the wages of a designated person.

Wages for at-risk workers are calculated using a process similar to the process used to calculate the number of affected employees in section VIII.B.IV.A. The main differences for determining the wages for at-risk workers are that the methodology for estimating wages uses OEWS data at the 2-digit NAICS sector level instead of the 4-digit NAICS industry group level and that some occupations that are otherwise used to determine the percentage of employees that are exposed to heat-related hazards are not included for the wage calculation because the relevant employment and/or wage data are undisclosed. OSHA calculated the percentage of a given sector's at-risk employment made up by each SOC code and multiplied this percentage by the hourly median wage from OEWS. Finally, OSHA summed these products for each sector to estimate the weighted average hourly wage for at-risk workers in each sector.

OSHA uses the estimated hourly wage rates to calculate a loaded wage rate that includes three types of cost: hourly base wage, fringe benefits, and overhead costs.

For the calculation of fringe benefit costs, OSHA used data from BLS' Employer Costs for Employee Compensation (ECEC) for December 2023 (BLS, 2024b) to determine that fringe benefits can be estimated as 45 percent of base wages or 31.1 percent of total compensation.

OSHA also accounts for indirect expenses that cannot be tied to producing a specific product or service, called overhead costs. Common examples include rent, utilities, and office equipment. There is no consensus on the cost elements that fit this definition and the lack of a common definition has led to a wide range of overhead estimates. Consequently, the treatment of overhead costs needs to be case-specific. In this analysis, OSHA used an overhead rate of 17 percent of base wages (EPA, 2002; Rice, 2002). This 17 percent rate is based on an estimate of overhead costs for safety and health professionals in large private organizations. This overhead rate is consistent with, for example, the overhead rate used in the Final Economic Analysis (FEA) in support of OSHA's 2023 final rule amending its occupational injury and illness recordkeeping (88 FR 47254) and the economic feasibility analysis in support of OSHA's 2021 Healthcare Emergency Temporary Standard (Healthcare ETS).[59] (86 FR 32376). OSHA expects that this rate is likely an overestimate in this context, as this reflects a component of *average* overhead; in this case, however, the agency anticipates that, for example, designated persons and at-risk workers will be able to work within the general physical infrastructure in which they currently operate. A rate of 17 percent of base wages is equivalent to 11.71 percent of the hourly wage rate with fringe applied.[60]

To calculate the fully loaded hourly labor cost, OSHA added the three components together: base wages + fringe benefits (31.1 percent of total compensation) + applicable overhead (17 percent of base wages). Table VIII.C.7. shows the loaded hourly

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[59] See the FEAs in in the Improved Tracking of Workplace Injuries and Illnesses FEA (*https://www.govinfo.gov/content/pkg/FR-2023-07-21/pdf/2023-15091.pdf*) and the feasibility analysis support of OSHA's 2021 Healthcare ETS (86 FR 32376) (*https://www.govinfo.gov/content/pkg/FR-2021-06-21/pdf/2021-12428.pdf*).The methodology was modeled after an approach used by the EPA. More information on this approach can be found at: U.S. Environmental Protection Agency, "Wage Rates for Economic Analyses of the Toxics Release Inventory Program," June 10, 2002 (Ex. 2066). This analysis itself was based on a survey of several large chemical manufacturing plants: Heiden Associates, *Final Report: A Study of Industry Compliance Costs Under the Final Comprehensive Assessment Information Rule*, Prepared for the Chemical Manufacturers Association, December 14, 1989, Ex. 2065.

[60] The fringe-adjusted overhead rate, 11.71%, is calculated as 68.9 percent * 17 percent, i.e., the percent of wages that are the base hourly rate exclusive of fringe (68.9 percent) multiplied by the overhead rate as a percentage of base hourly wages (17 percent).

wages used in the analysis. OSHA welcomes feedback on the assumptions, methods, and data used to estimate the wages of a designated person and at-risk worker.

Table VIII.C.7. Wage Rates Used in the Analysis (2023$)

Sector	Median Hourly Wage [a]	Fringe [b]	Fringe-Adjusted Overhead [c]	Loaded Hourly Wage [d]
Designated Person				
11	$30.73	45.0%	11.7%	$49.83
21	$50.76	45.0%	11.7%	$82.31
22	$57.93	45.0%	11.7%	$93.94
23	$42.26	45.0%	11.7%	$68.53
31-33	$43.15	45.0%	11.7%	$69.97
42	$42.41	45.0%	11.7%	$68.77
44-45	$26.45	45.0%	11.7%	$42.89
48-49	$37.37	45.0%	11.7%	$60.59
51	$54.75	45.0%	11.7%	$88.78
52	$49.94	45.0%	11.7%	$80.98
53	$36.94	45.0%	11.7%	$59.91
54	$59.00	45.0%	11.7%	$95.67
55	$60.81	45.0%	11.7%	$98.62
56	$34.51	45.0%	11.7%	$55.97
61	$36.68	45.0%	11.7%	$59.49
62	$34.49	45.0%	11.7%	$55.92
71	$28.83	45.0%	11.7%	$46.75
72	$20.50	45.0%	11.7%	$33.24
81	$33.58	45.0%	11.7%	$54.45
92	$45.08	45.0%	11.7%	$73.10
At-Risk Worker				
11	$16.53	45.0%	11.7%	$26.80
21	$28.65	45.0%	11.7%	$46.46
22	$46.58	45.0%	11.7%	$75.53
23	$27.10	45.0%	11.7%	$43.95
31-33	$22.62	45.0%	11.7%	$36.68
42	$26.11	45.0%	11.7%	$42.34
44-45	$16.21	45.0%	11.7%	$26.28
48-49	$20.52	45.0%	11.7%	$33.27
51	$35.48	45.0%	11.7%	$57.54
52	$35.92	45.0%	11.7%	$58.24
53	$23.09	45.0%	11.7%	$37.44
54	$47.08	45.0%	11.7%	$76.34
55	$54.28	45.0%	11.7%	$88.02
56	$17.00	45.0%	11.7%	$27.56
61	$20.15	45.0%	11.7%	$32.68
62	$17.56	45.0%	11.7%	$28.48
71	$15.55	45.0%	11.7%	$25.21
72	$14.88	45.0%	11.7%	$24.13
81	$21.17	45.0%	11.7%	$34.33
92	$31.28	45.0%	11.7%	$50.72

Table VIII.C.7. Wage Rates Used in the Analysis (2023$)

Sector	Median Hourly Wage [a]	Fringe [b]	Fringe-Adjusted Overhead [c]	Loaded Hourly Wage [d]

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.
[a] Median hourly wage rates are drawn from BLS' sector-level OEWS for May 2022. For the designated person, the wages represent a weighted average of wage across SOC codes that would directly supervise potentially at-risk workers. For the at-risk worker, the wages reflect weighted averages between SOC codes that are deemed in-scope for this proposed standard.
[b] The fringe rate is drawn from BLS' ECEC for December 2023 (BLS, 2024b).
[c] The overhead rate is derived from EPA (2002) and Rice (2002).
[d] The loaded hourly wage = median hourly wage *(1+fringe rate)*(1+fringe-adjusted overhead rate)

IV. Estimated Unit Costs of Compliance.

This section presents the estimated unit costs of the proposed standard by industry sector and proposed provision. Unless otherwise noted in this section, the time estimates for complying with proposed provisions are based on OSHA's professional expertise, considering what the proposed standard requires and estimates of the hours necessary to comply with similar requirements in other OSHA rules. OSHA welcomes comment on all estimates discussed here. Additional data or suggestions on methodological changes the agency should consider are also welcome.

A. Rule Familiarization.

All employers affected by the proposed standard would need to review the requirements under the proposed standard. While some employers will read the standard, many will likely rely on compliance assistance documents prepared by OSHA or by trade or industry associations that will provide the needed information in a simpler manner that would take less time to review and digest than the regulatory language. OSHA estimates that rule familiarization would take a designated person one hour to complete. Table VIII.C.8. shows the unit costs for rule familiarization by industry sector.

Table VIII.C.8. Unit Costs – Rule Familiarization (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
11	1.0	$49.83	Designated Person	Establishment	One-Time
21	1.0	$82.31	Designated Person	Establishment	One-Time

Table VIII.C.8. Unit Costs – Rule Familiarization (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
22	1.0	$93.94	Designated Person	Establishment	One-Time
23	1.0	$68.53	Designated Person	Establishment	One-Time
31-33	1.0	$69.97	Designated Person	Establishment	One-Time
42	1.0	$68.77	Designated Person	Establishment	One-Time
44-45	1.0	$42.89	Designated Person	Establishment	One-Time
48-49	1.0	$60.59	Designated Person	Establishment	One-Time
51	1.0	$88.78	Designated Person	Establishment	One-Time
52	1.0	$80.98	Designated Person	Establishment	One-Time
53	1.0	$59.91	Designated Person	Establishment	One-Time
54	1.0	$95.67	Designated Person	Establishment	One-Time
55	1.0	$98.62	Designated Person	Establishment	One-Time
56	1.0	$55.97	Designated Person	Establishment	One-Time
61	1.0	$59.49	Designated Person	Establishment	One-Time
62	1.0	$55.92	Designated Person	Establishment	One-Time
71	1.0	$46.75	Designated Person	Establishment	One-Time
72	1.0	$33.24	Designated Person	Establishment	One-Time
81	1.0	$54.45	Designated Person	Establishment	One-Time
92	1.0	$73.10	Designated Person	Establishment	One-Time

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

B. Heat Injury and Illness Prevention Plan (HIIPP).

Under paragraph (c) of the proposed standard, employers must create a written HIIPP,[61] with the input from employees. OSHA acknowledges that some employers may already have an existing HIIPP that may only need to be modified to comply with the proposed standard. The HIIPP must include:

- A comprehensive list of the types of work activities covered by the plan;
- All policies and procedures necessary to comply with the requirements of this proposed standard including those to protect employees while wearing vapor-impermeable clothing; and
- Identification of the heat metric (i.e., heat index or wet bulb globe temperature) the employer will monitor to identify heat hazards.

Further, the employer must designate one or more heat safety coordinators to implement and monitor the HIIPP, make the HIIPP readily available to all employees in a language that all employees understand, and review the HIIPP whenever a heat-related

[61] Employers with 10 or fewer employees do not have to write out their HIIPP.

incident occurs those results in death, days away from work, medical treatment beyond first aid, or loss of consciousness. The review of the HIIPP must occur at least annually.

For employers with an existing HIIPP in place, OSHA assumes that employers will designate someone to review their HIIPP and make any modifications necessary to comply with the proposed standard. OSHA estimates this process will require 2.5 hours of the designated person's time. Employers that do not have an existing HIIPP could either choose to use a HIIPP template (for example, one provided by OSHA as part of rollout materials or one from a trade organization) or write a HIIPP from scratch. Because writing a HIIPP from scratch without the help of a template would be considerably more onerous, OSHA expects that most employers would not choose this option and would, instead, opt to use a template which the agency estimates would require approximately six hours of a designated person's time to locate, review, identify relevant sections, and fill in worksite-specific information on hazards, controls, and procedures. For employers that are exempt from writing their HIIPP (i.e., those with ten or less employees) OSHA assumes that they will spend four hours using a template to guide their creation of a HIIPP. OSHA assumes that five percent of employers will have complex or unique situations where a template would not be usable. For these employees, OSHA estimates that it will take 30 hours of a designated person's time to prepare the HIIPP. OSHA welcomes comments and input on these estimates and assumptions. The agency would like information and data on how these estimates correspond to the costs incurred by employers who have developed written HIIPPs, whether the time estimates are reasonable, and what method employers have taken when developing their plans.

Additionally, the proposed standard would require employers to review and update the HIIPP periodically. Regardless of how employers develop or modify their HIIPPs initially, OSHA estimates that the process of reviewing and updating the HIIPP would take the person designated on average one hour per year to do so.

The proposed standard would also require that employers involve non-managerial employees in the creation or initial modification of the HIIPP, as well as in the process of periodically reviewing and updating the HIIPP. OSHA assumes that a representative group of employees (four employees per establishment) will take one hour each during the initial development of the HIIPP to provide feedback, regardless of whether the employer has an existing HIIPP. This same representative group of employees would take 20 minutes each during the review and update of the HIIPP to provide feedback. OSHA welcomes comments and input on these estimates and assumptions. The agency would like information and data on how these estimates correspond to the costs incurred by employers who have developed written HIIPPs, whether the time estimates are reasonable, and what method employers have taken when developing their plans.

Table VIII.C.9. shows the units costs for developing and updating the HIIPP by industry sector.

Table VIII.C.9. Unit Costs – Heat Injury and Illness Prevention Plan (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
Write HIIPP from Scratch					
11	30.0	$1,494.92	Designated Person	Establishment	One-Time
21	30.0	$2,469.40	Designated Person	Establishment	One-Time
22	30.0	$2,818.32	Designated Person	Establishment	One-Time
23	30.0	$2,055.78	Designated Person	Establishment	One-Time
31-33	30.0	$2,099.13	Designated Person	Establishment	One-Time
42	30.0	$2,063.18	Designated Person	Establishment	One-Time
44-45	30.0	$1,286.74	Designated Person	Establishment	One-Time
48-49	30.0	$1,817.75	Designated Person	Establishment	One-Time
51	30.0	$2,663.34	Designated Person	Establishment	One-Time
52	30.0	$2,429.29	Designated Person	Establishment	One-Time
53	30.0	$1,797.15	Designated Person	Establishment	One-Time
54	30.0	$2,869.97	Designated Person	Establishment	One-Time
55	30.0	$2,958.49	Designated Person	Establishment	One-Time
56	30.0	$1,678.99	Designated Person	Establishment	One-Time
61	30.0	$1,784.56	Designated Person	Establishment	One-Time
62	30.0	$1,677.73	Designated Person	Establishment	One-Time
71	30.0	$1,402.49	Designated Person	Establishment	One-Time
72	30.0	$997.21	Designated Person	Establishment	One-Time
81	30.0	$1,633.62	Designated Person	Establishment	One-Time
92	30.0	$2,193.10	Designated Person	Establishment	One-Time
Review and Modify HIIPP – Existing Plan in Place					
11	2.5	$124.58	Designated Person	Establishment	One-Time
21	2.5	$205.78	Designated Person	Establishment	One-Time

Table VIII.C.9. Unit Costs – Heat Injury and Illness Prevention Plan (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
22	2.5	$234.86	Designated Person	Establishment	One-Time
23	2.5	$171.31	Designated Person	Establishment	One-Time
31-33	2.5	$174.93	Designated Person	Establishment	One-Time
42	2.5	$171.93	Designated Person	Establishment	One-Time
44-45	2.5	$107.23	Designated Person	Establishment	One-Time
48-49	2.5	$151.48	Designated Person	Establishment	One-Time
51	2.5	$221.94	Designated Person	Establishment	One-Time
52	2.5	$202.44	Designated Person	Establishment	One-Time
53	2.5	$149.76	Designated Person	Establishment	One-Time
54	2.5	$239.16	Designated Person	Establishment	One-Time
55	2.5	$246.54	Designated Person	Establishment	One-Time
56	2.5	$139.92	Designated Person	Establishment	One-Time
61	2.5	$148.71	Designated Person	Establishment	One-Time
62	2.5	$139.81	Designated Person	Establishment	One-Time
71	2.5	$116.87	Designated Person	Establishment	One-Time
72	2.5	$83.10	Designated Person	Establishment	One-Time
81	2.5	$136.14	Designated Person	Establishment	One-Time
92	2.5	$182.76	Designated Person	Establishment	One-Time
Use HIIPP Template					
11	6.0	$298.98	Designated Person	Establishment	One-Time
21	6.0	$493.88	Designated Person	Establishment	One-Time
22	6.0	$563.66	Designated Person	Establishment	One-Time
23	6.0	$411.16	Designated Person	Establishment	One-Time
31-33	6.0	$419.83	Designated Person	Establishment	One-Time
42	6.0	$412.64	Designated Person	Establishment	One-Time
44-45	6.0	$257.35	Designated Person	Establishment	One-Time
48-49	6.0	$363.55	Designated Person	Establishment	One-Time
51	6.0	$532.67	Designated Person	Establishment	One-Time
52	6.0	$485.86	Designated Person	Establishment	One-Time
53	6.0	$359.43	Designated Person	Establishment	One-Time
54	6.0	$573.99	Designated Person	Establishment	One-Time
55	6.0	$591.70	Designated Person	Establishment	One-Time
56	6.0	$335.80	Designated Person	Establishment	One-Time
61	6.0	$356.91	Designated Person	Establishment	One-Time
62	6.0	$335.55	Designated Person	Establishment	One-Time
71	6.0	$280.50	Designated Person	Establishment	One-Time
72	6.0	$199.44	Designated Person	Establishment	One-Time
81	6.0	$326.72	Designated Person	Establishment	One-Time
92	6.0	$438.62	Designated Person	Establishment	One-Time
No Written HIIPP					
11	4.0	$199.32	Designated Person	Establishment	One-Time
21	4.0	$329.25	Designated Person	Establishment	One-Time
22	4.0	$375.78	Designated Person	Establishment	One-Time
23	4.0	$274.10	Designated Person	Establishment	One-Time
31-33	4.0	$279.88	Designated Person	Establishment	One-Time
42	4.0	$275.09	Designated Person	Establishment	One-Time
44-45	4.0	$171.57	Designated Person	Establishment	One-Time
48-49	4.0	$242.37	Designated Person	Establishment	One-Time
51	4.0	$355.11	Designated Person	Establishment	One-Time
52	4.0	$323.91	Designated Person	Establishment	One-Time

Table VIII.C.9. Unit Costs – Heat Injury and Illness Prevention Plan (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
53	4.0	$239.62	Designated Person	Establishment	One-Time
54	4.0	$382.66	Designated Person	Establishment	One-Time
55	4.0	$394.46	Designated Person	Establishment	One-Time
56	4.0	$223.87	Designated Person	Establishment	One-Time
61	4.0	$237.94	Designated Person	Establishment	One-Time
62	4.0	$223.70	Designated Person	Establishment	One-Time
71	4.0	$187.00	Designated Person	Establishment	One-Time
72	4.0	$132.96	Designated Person	Establishment	One-Time
81	4.0	$217.82	Designated Person	Establishment	One-Time
92	4.0	$292.41	Designated Person	Establishment	One-Time
HIIPP Development Involvement – Employee					
11	1.0	$26.80	At-Risk Worker	Establishment	One-Time
21	1.0	$46.46	At-Risk Worker	Establishment	One-Time
22	1.0	$75.53	At-Risk Worker	Establishment	One-Time
23	1.0	$43.95	At-Risk Worker	Establishment	One-Time
31-33	1.0	$36.68	At-Risk Worker	Establishment	One-Time
42	1.0	$42.34	At-Risk Worker	Establishment	One-Time
44-45	1.0	$26.28	At-Risk Worker	Establishment	One-Time
48-49	1.0	$33.27	At-Risk Worker	Establishment	One-Time
51	1.0	$57.54	At-Risk Worker	Establishment	One-Time
52	1.0	$58.24	At-Risk Worker	Establishment	One-Time
53	1.0	$37.44	At-Risk Worker	Establishment	One-Time
54	1.0	$76.34	At-Risk Worker	Establishment	One-Time
55	1.0	$88.02	At-Risk Worker	Establishment	One-Time
56	1.0	$27.56	At-Risk Worker	Establishment	One-Time
61	1.0	$32.68	At-Risk Worker	Establishment	One-Time
62	1.0	$28.48	At-Risk Worker	Establishment	One-Time
71	1.0	$25.21	At-Risk Worker	Establishment	One-Time
72	1.0	$24.13	At-Risk Worker	Establishment	One-Time
81	1.0	$34.33	At-Risk Worker	Establishment	One-Time
92	1.0	$50.72	At-Risk Worker	Establishment	One-Time
Review and Update HIIPP					
11	1.0	$49.83	Designated Person	Establishment	Annual
21	1.0	$82.31	Designated Person	Establishment	Annual
22	1.0	$93.94	Designated Person	Establishment	Annual
23	1.0	$68.53	Designated Person	Establishment	Annual
31-33	1.0	$69.97	Designated Person	Establishment	Annual
42	1.0	$68.77	Designated Person	Establishment	Annual
44-45	1.0	$42.89	Designated Person	Establishment	Annual
48-49	1.0	$60.59	Designated Person	Establishment	Annual
51	1.0	$88.78	Designated Person	Establishment	Annual
52	1.0	$80.98	Designated Person	Establishment	Annual
53	1.0	$59.91	Designated Person	Establishment	Annual
54	1.0	$95.67	Designated Person	Establishment	Annual
55	1.0	$98.62	Designated Person	Establishment	Annual
56	1.0	$55.97	Designated Person	Establishment	Annual
61	1.0	$59.49	Designated Person	Establishment	Annual
62	1.0	$55.92	Designated Person	Establishment	Annual
71	1.0	$46.75	Designated Person	Establishment	Annual
72	1.0	$33.24	Designated Person	Establishment	Annual

Table VIII.C.9. Unit Costs – Heat Injury and Illness Prevention Plan (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
81	1.0	$54.45	Designated Person	Establishment	Annual
92	1.0	$73.10	Designated Person	Establishment	Annual
HIIPP Review and Update Involvement – Employee					
11	0.33	$8.93	At-Risk Worker	Establishment	Annual
21	0.33	$15.49	At-Risk Worker	Establishment	Annual
22	0.33	$25.18	At-Risk Worker	Establishment	Annual
23	0.33	$14.65	At-Risk Worker	Establishment	Annual
31-33	0.33	$12.23	At-Risk Worker	Establishment	Annual
42	0.33	$14.11	At-Risk Worker	Establishment	Annual
44-45	0.33	$8.76	At-Risk Worker	Establishment	Annual
48-49	0.33	$11.09	At-Risk Worker	Establishment	Annual
51	0.33	$19.18	At-Risk Worker	Establishment	Annual
52	0.33	$19.41	At-Risk Worker	Establishment	Annual
53	0.33	$12.48	At-Risk Worker	Establishment	Annual
54	0.33	$25.45	At-Risk Worker	Establishment	Annual
55	0.33	$29.34	At-Risk Worker	Establishment	Annual
56	0.33	$9.19	At-Risk Worker	Establishment	Annual
61	0.33	$10.89	At-Risk Worker	Establishment	Annual
62	0.33	$9.49	At-Risk Worker	Establishment	Annual
71	0.33	$8.40	At-Risk Worker	Establishment	Annual
72	0.33	$8.04	At-Risk Worker	Establishment	Annual
81	0.33	$11.44	At-Risk Worker	Establishment	Annual
92	0.33	$16.91	At-Risk Worker	Establishment	Annual

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

C. Identifying Heat Hazards.

The proposed standard would require employers to assess where and when employees are exposed to temperatures at or above the initial and high heat triggers. For outdoor work sites, the proposed standard would require employers to monitor heat conditions using either local heat index forecasts or on-site measurement of heat index or wet bulb globe temperature (WBGT). OSHA assumes that all outdoor employers without current monitoring practices will choose the option to monitor local forecasts since the time necessary to do so would be minimal (and many individuals check local forecasts regularly without regard to this proposed standard). Employers may have a designated person at each work site track local forecasts of ambient temperature and humidity provided by the National Weather Service (NWS) (or others) to determine the daily maximum heat index, which the employer would then use to determine which protocols

are triggered, if any. For this analysis, OSHA assumes that employers, on average, will take approximately 15 seconds twice a day to monitor the local forecast via a smart phone app.

Alternatively, employers can set up monitoring devices as close as possible to the work area to conduct on-site monitoring. Employers may choose between measuring the heat index or WBGT using monitoring devices. Employers with indoor work sites do not have the option of monitoring local weather forecasts. The first approach, measuring the heat index, would require the employer to designate someone to take measurements of the heat index, or to measure separately the ambient temperature and humidity to calculate heat index (if needed, using the OSHA-NIOSH Heat Safety Tool App as a calculator or the online calculator available from the NWS). OSHA estimates that on average, it will take the designated person 1 minute each time they measure the heat index or ambient temperature and humidity, including calculating the heat index (e.g., by consulting the OSHA-NIOSH App or NWS's online calculator). OSHA also assumes that measurements will be taken on average twice per work day (260 days per year) and that employers using this approach will use a temperature and humidity logger that is capable of automatically uploading relevant environmental information for recordkeeping purposes. OSHA assumes that the designated person will spend 15 minutes to read the logger's user manual. OSHA also assumes that all indoor employers without current monitoring in place will adopt this option.

The second approach, measuring the WBGT, would require the employer to designate someone to take measurements of wet bulb globe temperature. This approach would require the purchase of one WBGT thermometer for each worksite and some of a designated person's time to read the thermometer manual. OSHA assumes that no employers will adopt this option, however some employers may already be using this

method. Those employers can continue to use this method under this proposed standard and are not estimated to incur any costs to do so since they are already in compliance.

Employers with indoor work sites would be required to conduct a hazard evaluation to identify the work areas where there is a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger. OSHA estimates that conducting the hazard evaluation would require about 3 hours in total.

Employers would be required to seek the input and involvement of non-managerial employees and their representatives, if any, when evaluating the work site to identify work areas with a reasonable expectation of exposures at or above the initial heat trigger and in developing and updating monitoring plans. The time to develop monitoring plans, as well as the time for employee input, is already captured within the time estimate for HIIPP development and employee involvement in HIIPP development. Otherwise, OSHA estimates that employee input for evaluating work sites would require 15 minutes per employee providing input. For this analysis, OSHA assumes four employees per establishment would provide input.

The proposed standard would allow employers to forgo taking measurements if they assume that a work area meets or exceeds both heat triggers. Employers that elect to do this would not incur monitoring costs. These employers would be required to comply with all control measures required at both the initial and high heat triggers as though they took a measurement that meets or exceeds the high heat trigger. OSHA assumes that no employers will newly adopt this option, because the annual monitoring cost per establishment is relatively low compared to the costs to implement other parts of the rule that would be required for employers choosing this option. Most employers will find it less expensive to monitor temperatures and implement the requirements when a trigger is met or exceeded. OSHA welcomes feedback on this assumption, specifically the types of

employers that might forgo monitoring and assume that their workplace is at or above both heat triggers.

Table VIII.C.10. shows the labor-based unit costs for identifying heat hazards by industry sector. Table VIII.C.11. shows the equipment costs that employers would incur to comply with the requirements for identifying heat hazards.

Table VIII.C.10. Labor-Based Unit Costs – Identifying Heat Hazards (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
Outdoor Environmental Monitoring					
11	2.2	$107.97	Designated Person	Establishment	Annual
21	2.2	$178.35	Designated Person	Establishment	Annual
22	2.2	$203.55	Designated Person	Establishment	Annual
23	2.2	$148.47	Designated Person	Establishment	Annual
31-33	2.2	$151.60	Designated Person	Establishment	Annual
42	2.2	$149.01	Designated Person	Establishment	Annual
44-45	2.2	$92.93	Designated Person	Establishment	Annual
48-49	2.2	$131.28	Designated Person	Establishment	Annual
51	2.2	$192.35	Designated Person	Establishment	Annual
52	2.2	$175.45	Designated Person	Establishment	Annual
53	2.2	$129.79	Designated Person	Establishment	Annual
54	2.2	$207.28	Designated Person	Establishment	Annual
55	2.2	$213.67	Designated Person	Establishment	Annual
56	2.2	$121.26	Designated Person	Establishment	Annual
61	2.2	$128.88	Designated Person	Establishment	Annual
62	2.2	$121.17	Designated Person	Establishment	Annual
71	2.2	$101.29	Designated Person	Establishment	Annual
72	2.2	$72.02	Designated Person	Establishment	Annual
81	2.2	$117.98	Designated Person	Establishment	Annual
92	2.2	$158.39	Designated Person	Establishment	Annual
Indoor Environmental Monitoring					
11	8.7	$431.87	Designated Person	Establishment	Annual
21	8.7	$713.38	Designated Person	Establishment	Annual
22	8.7	$814.18	Designated Person	Establishment	Annual
23	8.7	$593.89	Designated Person	Establishment	Annual
31-33	8.7	$606.42	Designated Person	Establishment	Annual
42	8.7	$596.03	Designated Person	Establishment	Annual
44-45	8.7	$371.72	Designated Person	Establishment	Annual
48-49	8.7	$525.13	Designated Person	Establishment	Annual
51	8.7	$769.41	Designated Person	Establishment	Annual
52	8.7	$701.80	Designated Person	Establishment	Annual
53	8.7	$519.18	Designated Person	Establishment	Annual
54	8.7	$829.10	Designated Person	Establishment	Annual
55	8.7	$854.67	Designated Person	Establishment	Annual
56	8.7	$485.04	Designated Person	Establishment	Annual
61	8.7	$515.54	Designated Person	Establishment	Annual
62	8.7	$484.68	Designated Person	Establishment	Annual
71	8.7	$405.16	Designated Person	Establishment	Annual
72	8.7	$288.08	Designated Person	Establishment	Annual

Table VIII.C.10. Labor-Based Unit Costs – Identifying Heat Hazards (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
81	8.7	$471.94	Designated Person	Establishment	Annual
92	8.7	$633.56	Designated Person	Establishment	Annual
Indoor Identification of Heat-Exposed Work Areas					
11	3.0	$149.49	Designated Person	Establishment	Every 5 Years
21	3.0	$246.94	Designated Person	Establishment	Every 5 Years
22	3.0	$281.83	Designated Person	Establishment	Every 5 Years
23	3.0	$205.58	Designated Person	Establishment	Every 5 Years
31-33	3.0	$209.91	Designated Person	Establishment	Every 5 Years
42	3.0	$206.32	Designated Person	Establishment	Every 5 Years
44-45	3.0	$128.67	Designated Person	Establishment	Every 5 Years
48-49	3.0	$181.77	Designated Person	Establishment	Every 5 Years
51	3.0	$266.33	Designated Person	Establishment	Every 5 Years
52	3.0	$242.93	Designated Person	Establishment	Every 5 Years
53	3.0	$179.72	Designated Person	Establishment	Every 5 Years
54	3.0	$287.00	Designated Person	Establishment	Every 5 Years
55	3.0	$295.85	Designated Person	Establishment	Every 5 Years
56	3.0	$167.90	Designated Person	Establishment	Every 5 Years
61	3.0	$178.46	Designated Person	Establishment	Every 5 Years
62	3.0	$167.77	Designated Person	Establishment	Every 5 Years
71	3.0	$140.25	Designated Person	Establishment	Every 5 Years
72	3.0	$99.72	Designated Person	Establishment	Every 5 Years
81	3.0	$163.36	Designated Person	Establishment	Every 5 Years
92	3.0	$219.31	Designated Person	Establishment	Every 5 Years
Work Area Evaluation – Employee					
11	0.25	$6.70	At-Risk Worker	Establishment	Every 5 Years
21	0.25	$11.61	At-Risk Worker	Establishment	Every 5 Years
22	0.25	$18.88	At-Risk Worker	Establishment	Every 5 Years
23	0.25	$10.99	At-Risk Worker	Establishment	Every 5 Years
31-33	0.25	$9.17	At-Risk Worker	Establishment	Every 5 Years
42	0.25	$10.58	At-Risk Worker	Establishment	Every 5 Years
44-45	0.25	$6.57	At-Risk Worker	Establishment	Every 5 Years
48-49	0.25	$8.32	At-Risk Worker	Establishment	Every 5 Years
51	0.25	$14.38	At-Risk Worker	Establishment	Every 5 Years
52	0.25	$14.56	At-Risk Worker	Establishment	Every 5 Years
53	0.25	$9.36	At-Risk Worker	Establishment	Every 5 Years
54	0.25	$19.08	At-Risk Worker	Establishment	Every 5 Years
55	0.25	$22.01	At-Risk Worker	Establishment	Every 5 Years
56	0.25	$6.89	At-Risk Worker	Establishment	Every 5 Years
61	0.25	$8.17	At-Risk Worker	Establishment	Every 5 Years
62	0.25	$7.12	At-Risk Worker	Establishment	Every 5 Years
71	0.25	$6.30	At-Risk Worker	Establishment	Every 5 Years
72	0.25	$6.03	At-Risk Worker	Establishment	Every 5 Years
81	0.25	$8.58	At-Risk Worker	Establishment	Every 5 Years
92	0.25	$12.68	At-Risk Worker	Establishment	Every 5 Years
Review Monitoring Equipment User Manual – Indoor					
11	0.25	$12.46	Designated Person	Establishment	One-Time
21	0.25	$20.58	Designated Person	Establishment	One-Time
22	0.25	$23.49	Designated Person	Establishment	One-Time
23	0.25	$17.13	Designated Person	Establishment	One-Time
31-33	0.25	$17.49	Designated Person	Establishment	One-Time

Table VIII.C.10. Labor-Based Unit Costs – Identifying Heat Hazards (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
42	0.25	$17.19	Designated Person	Establishment	One-Time
44-45	0.25	$10.72	Designated Person	Establishment	One-Time
48-49	0.25	$15.15	Designated Person	Establishment	One-Time
51	0.25	$22.19	Designated Person	Establishment	One-Time
52	0.25	$20.24	Designated Person	Establishment	One-Time
53	0.25	$14.98	Designated Person	Establishment	One-Time
54	0.25	$23.92	Designated Person	Establishment	One-Time
55	0.25	$24.65	Designated Person	Establishment	One-Time
56	0.25	$13.99	Designated Person	Establishment	One-Time
61	0.25	$14.87	Designated Person	Establishment	One-Time
62	0.25	$13.98	Designated Person	Establishment	One-Time
71	0.25	$11.69	Designated Person	Establishment	One-Time
72	0.25	$8.31	Designated Person	Establishment	One-Time
81	0.25	$13.61	Designated Person	Establishment	One-Time
92	0.25	$18.28	Designated Person	Establishment	One-Time

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

Table VIII.C.11. Equipment-Based Unit Costs - Identifying Heat Hazards (2023$)

Item	Units	Unit Cost	Total Cost per Unit	Basis	Frequency
Monitoring Equipment – Indoor	1.0	$99.00	$99.00	Establishment	One-Time

Source: Kestrel Instruments, 2024.

D. Requirements at or Above the Initial Heat Trigger.

When employees are exposed to heat at or above the initial heat trigger, the proposed standard includes provisions related to drinking water, break areas, work area controls, acclimatization, rest breaks, and effective communication. The costs associated with the evaluation of fan use in paragraph I(6) are included as part of the planning and hazard evaluation discussed in section VIII.C.IV.C. OSHA has not included costs related to cooling PPE as included in proposed paragraph I(e)(10). Based on feedback from Small Entity Representatives who spoke on the topic during the SBAR Panel process, OSHA believes that use of cooling PPE is not widespread. Where employers are requiring or permitting the use of cooling PPE, OSHA expects that these employers will train employees to remove the PPE once it loses its cooling properties and will include

this requirement in their HIIPPs. The cost for this would be included in the costs associated with proposed paragraphs (c) and (h).

I. Drinking Water.

Employers would be required to provide access to one quart (32 fluid ounces) of suitably cool drinking water per employee per hour for the entire shift. To comply with this requirement at both outdoor and indoor work sites, OSHA assumes employers would purchase 40-quart water coolers (with spigots) sufficient to provide the required amount of water. For this analysis, OSHA estimates that the cost of one 40-quart cooler is incurred for every 40 employees. Employers are assumed to purchase one reusable water bottle per employee. Because existing OSHA standards already require employers to provide drinking water, OSHA assumes that nearly all employers currently provide water to their employees. The costs incurred to comply with this proposed standard are assumed to be a result of employers not providing the quantity of water specified by the proposed standard.

II. Break Area(s) at Outdoor Work Sites.

For outdoor work sites, OSHA would require employers to provide employees working outdoors with a break area. Break areas must be readily accessible to the work area and able to accommodate the number of employees on break. Additionally, break areas must have artificial or natural shade, or be an air-conditioned space (e.g., trailers, vehicles, structures). OSHA assumes that employers without existing break areas will use artificial shade in the form of a 12x12 foot tent that all employees on break can reasonably access.

III. Break Area(s) and Work Area(s) at Indoor Work Sites.

OSHA would require employers with indoor work sites to provide employees at those sites with a break area. These break areas must be readily accessible to the work area and able to accommodate the number of employees on break. This space must be air-

conditioned or have increased air movement and, if appropriate, de-humidification. OSHA assumes that employers without existing air-conditioned breakrooms will designate a room or an area large enough to accommodate employees on break and that these areas will contain adequate fans and dehumidifiers. Further, employers would be required to provide measures that reduce employee exposure to heat in the work area. One of the ways employers can comply with this requirement is by providing increased air movement and, if appropriate, de-humidification. Adequate fans and dehumidifiers could be used to comply with this requirement. Overall, OSHA assumes that, in all States and territories in the U.S., the average employer that does not already have air conditioning, fans, or dehumidifiers in place will provide two fans per ten employees and, in States where humid conditions may occur, the average employer would also provide two dehumidifiers per ten employees.

IV. Acclimatization.

The proposed standard would require employers to adopt protections for new and returning employees who may not be acclimatized to working in the heat at or above the initial heat trigger during their first week on the job or their first week back on the job after an employee is away from work for more than 14 days. For new employees, OSHA assumes that employers would implement a plan that incorporates the measures required in paragraph (f) when the initial heat trigger is met or exceeded during the first week of work. For purposes of estimating the cost of compliance with this provision, OSHA calculated the cost of rest breaks and observation for signs and symptoms during an employee's first week. While paragraph (f) also requires a hazard alert, OSHA assumes that the hazard alert can be provided by the designated person while conducting observation or during training (for new employees).

The cost of rest breaks and observation during the first week of work, assuming 8-hour shifts that coincide with heat index measurements that meet or exceed the initial

heat trigger but do not meet the high heat trigger, equates to roughly 41.75 minutes per day for every new indoor employee and 47.75 minutes per day for every new outdoor employee during the employee's first week on the job. These estimates are the same for returning employees during their first week after returning to work when the heat index is at or above the initial heat trigger. No additional costs were estimated for new or returning employees when the temperature meets or exceeds the high heat trigger, as employers are already required to follow the high heat procedures.

OSHA did not make an additional adjustment for cost savings (see Appendix A at the end of this section for a description of cost savings methodology) as the conditions of those additional rest breaks are different (i.e., different temperature range-rest break combination) than those at which the estimates of labor productivity loss due to pacing in the heat were calculated. To the extent that pacing is reduced for employees undergoing acclimatization protocols, this could overstate the costs of acclimatization. OSHA welcomes comment on this issue and whether the agency should extend the potential cost savings from reduced pacing to workers during their acclimatization period.

V. Rest Breaks if Needed.

The proposed standard would require that employers allow and encourage their employees to take paid rest breaks if needed once the initial heat trigger is met or exceeded to prevent overheating. OSHA assumes that, per 8-hour shift, at-risk employees will take one 10-minute if-needed rest break.[62] OSHA estimates, on average, an additional two minutes for indoor employees per break and an additional four minutes for

[62] If-needed rest breaks by new and returning employees when the temperature meets or exceeds the initial heat trigger and is below the high heat trigger are accounted for in the acclimatization costs (section VIII.C.IV.D.IV). To avoid double counting, if-needed rest breaks were not costed for these employees during their first week of work (for new hires) or the first week back from leave (for returning workers).

outdoor employees per break to account for the time to walk to and from the break area.[63] OSHA welcomes feedback on the assumption that an average employee will take one ten-minute if-needed rest break when the temperature is at or above the initial heat trigger and the assumptions for travel time to and from the break area for indoor and outdoor settings.

OSHA has preliminarily determined that when employees are offered rest breaks, cost savings will accrue to employers currently noncompliant with the rest break requirements, as their employees will work more efficiently during the work time not spent on rest breaks (i.e., pace less). At the initial heat trigger, some of the estimated unit cost for if-needed rest breaks (i.e., 10 minutes plus travel time) will be offset by this reduction in pacing, which OSHA considers as cost savings for employers.

For the purposes of calculating accrued employer cost savings, OSHA defined three groups of employees with varying existing break levels (see the introduction in appendix A at the end of this section for detailed definitions of each group). Group 1 corresponds to employees at establishments that do not currently provide rest breaks when the initial heat trigger is met or exceeded. Group 2 corresponds to employees at establishments that do provide if-needed rest breaks when the initial heat trigger is met or exceeded, but do not have required rest breaks for when the high heat trigger is met or exceeded. Group 3 captures employees at establishments that have already implemented rest breaks protocols that meet the rest break requirements outlined in this proposed standard.[64]

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[63] These estimates of time needed to walk to and from the break area are meant to be averages across all workers in all settings. In some large indoor settings like warehouses or large manufacturing facilities, the break area may be further from the work areas than other indoor settings where the break area may be directly adjacent to work areas. In outdoor settings, OSHA expects the employer will use a mobile break area set up that allows the break area to be relocated as close as possible to the location employees are working on a given day. However, OSHA recognizes that it may not always be possible to have a break area immediately adjacent to all outdoor work area(s) and some outdoor work sites may have workers spread over relatively large areas (e.g., some agricultural settings, large-scale infrastructure construction projects), which could result in slightly longer times needed to walk to and from the break area.

[64] OSHA estimates that approximately 6.1% of employees are in Group 1, 46.9% are in Group 2, and the remaining 47.0% are in Group 3.

As mentioned in section VIII.C.II.B. and detailed further in appendix A at the end of this section, OSHA estimated the minutes spent pacing for each of the three groups when they are working at or above the initial heat trigger. Table VIII.C.12. below shows the time (minutes) per 8-hour shift that OSHA estimates employees in each group currently spend pacing when the initial heat trigger is met or exceeded. Using these estimates, OSHA assumes that with the implementation of if-needed rest breaks, all employees in Group 1 (i.e., not currently taking any breaks) will behave like Group 2 (i.e., those currently taking if-needed rest breaks at or above the initial heat trigger but not scheduled rest breaks at or above the high heat trigger), reducing their pacing (working more efficiently) by 14.0 – 11.2 = 2.8 minutes per shift at the initial heat trigger.

For outdoor employees, this reduction in pacing translates into accrued cost savings of 20 percent (2.8 minutes of pacing reduced/14 minutes of if-needed rest break time[65]) of the unit time-cost per break. This effectively reduces the unit cost of if-needed rest breaks for outdoor employees from 14 to 11.2 minutes. Similarly, for indoor employees, this reduction in pacing reduces the unit time-cost by 2.8/12 = 23.33 percent, from 12[66] to 9.2 minutes per 8-hour shift.

Table VIII.C.12. Labor Productivity Loss from Pacing Above Initial Heat Trigger Before and After Implementation of Required If Needed Rest Breaks and Labor Cost Savings per 8-Hour Shift per Employee

Group	Group Description	Labor Productivity Loss from Pacing Before Required Initial Heat Trigger Rest Breaks (Minutes)	Labor Productivity Loss from Pacing After Required Initial Heat Trigger Rest Breaks (Minutes)	Estimated Labor Cost Savings (Minutes)
Group 1	Employees at establishments that do not currently provide any rest breaks.	14.0	11.2	2.8
Group 2	Employees at establishments that provide rest breaks that meet the initial heat trigger rest break	11.2	11.2	0.0

[65] 10 minutes of if-needed rest break time and 4 minutes of travel time.
[66] 10 minutes of if-needed rest break time and 2 minutes of travel time.

	requirements, but not the high heat trigger rest break requirements.			
Group 3	Employees at establishments that provide rest breaks that meet the initial and high heat trigger rest break requirements.	0.0	0.0	0.0

Source: OSHA estimate.
Note: OSHA estimates that approximately 6.1 percent of employees are in Group 1, 46.9 percent are in Group 2, and 47.0 percent are in Group 3.

VI. Effective Communication.

Employers would be required to maintain a means of effective two-way communication with employees whenever the initial heat trigger is met or exceeded. OSHA assumes that a designated person would communicate with each employee three times for every 8-hour shift that meets or exceeds the initial heat trigger and would spend 15 seconds on each communication. At-risk workers are assumed to spend the same amount of time in communication with the designated person. It is assumed that all employers and employees have a current method for effective two-way communication (e.g., cell phones, walkie talkies) that may be currently used to communicate information about work-related concerns and that these methods may be used when the initial heat trigger is met or exceeded. OSHA welcomes comments on existing methods of two-way communication between employees and employers.

Table VIII.C.13. shows the unit costs for the requirements at or above the initial heat trigger by industry sector. The rest break unit costs reported in table VIII.C.13. do not reflect the cost savings offset discussed above. Table VIII.C.14. shows the equipment costs (water coolers, water bottles, pedestal fans, dehumidifiers, and tents for artificial shade) that employers would incur to comply with the requirements when the initial heat trigger is met or exceeded.

Table VIII.C.13. Labor-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
New Employee Acclimatization – Designated Person					
11	0.01	$0.62	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
21	0.01	$1.03	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
22	0.01	$1.17	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
23	0.01	$0.86	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
31-33	0.01	$0.87	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
42	0.01	$0.86	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
44-45	0.01	$0.54	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
48-49	0.01	$0.76	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
51	0.01	$1.11	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
52	0.01	$1.01	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
53	0.01	$0.75	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
54	0.01	$1.20	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
55	0.01	$1.23	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
56	0.01	$0.70	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
61	0.01	$0.74	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
62	0.01	$0.70	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
71	0.01	$0.58	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
72	0.01	$0.42	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
81	0.01	$0.68	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
92	0.01	$0.91	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
Returning Employee Acclimatization – Designated Person					
11	0.01	$0.62	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
21	0.01	$1.03	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
22	0.01	$1.17	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
23	0.01	$0.86	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
31-33	0.01	$0.87	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
42	0.01	$0.86	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
44-45	0.01	$0.54	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
48-49	0.01	$0.76	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
51	0.01	$1.11	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
52	0.01	$1.01	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
53	0.01	$0.75	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
54	0.01	$1.20	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)

Table VIII.C.13. Labor-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
55	0.01	$1.23	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
56	0.01	$0.70	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
61	0.01	$0.74	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
62	0.01	$0.70	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
71	0.01	$0.58	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
72	0.01	$0.42	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
81	0.01	$0.68	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
92	0.01	$0.91	Designated Person	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
New Indoor Employee Acclimatization					
11	0.7	$18.65	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
21	0.7	$32.33	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
22	0.7	$52.56	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
23	0.7	$30.58	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
31-33	0.7	$25.52	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
42	0.7	$29.46	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
44-45	0.7	$18.29	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
48-49	0.7	$23.15	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
51	0.7	$40.04	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
52	0.7	$40.53	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
53	0.7	$26.05	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
54	0.7	$53.12	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
55	0.7	$61.25	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
56	0.7	$19.18	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
61	0.7	$22.74	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
62	0.7	$19.82	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
71	0.7	$17.54	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
72	0.7	$16.79	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
81	0.7	$23.88	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
92	0.7	$35.30	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
New Outdoor Employee Acclimatization					
11	0.8	$21.33	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
21	0.8	$36.97	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
22	0.8	$60.11	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
23	0.8	$34.97	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
31-33	0.8	$29.19	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
42	0.8	$33.69	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)

Table VIII.C.13. Labor-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
44-45	0.8	$20.92	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
48-49	0.8	$26.48	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
51	0.8	$45.79	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
52	0.8	$46.35	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
53	0.8	$29.80	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
54	0.8	$60.75	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
55	0.8	$70.05	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
56	0.8	$21.94	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
61	0.8	$26.01	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
62	0.8	$22.66	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
71	0.8	$20.06	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
72	0.8	$19.20	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
81	0.8	$27.32	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
92	0.8	$40.37	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
Returning Indoor Employee Acclimatization					
11	0.7	$18.65	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
21	0.7	$32.33	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
22	0.7	$52.56	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
23	0.7	$30.58	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
31-33	0.7	$25.52	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
42	0.7	$29.46	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
44-45	0.7	$18.29	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
48-49	0.7	$23.15	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
51	0.7	$40.04	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
52	0.7	$40.53	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
53	0.7	$26.05	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
54	0.7	$53.12	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
55	0.7	$61.25	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
56	0.7	$19.18	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
61	0.7	$22.74	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
62	0.7	$19.82	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
71	0.7	$17.54	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
72	0.7	$16.79	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
81	0.7	$23.88	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
92	0.7	$35.30	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
Returning Outdoor Employee Acclimatization					

Table VIII.C.13. Labor-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
11	0.8	$21.33	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
21	0.8	$36.97	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
22	0.8	$60.11	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
23	0.8	$34.97	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
31-33	0.8	$29.19	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
42	0.8	$33.69	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
44-45	0.8	$20.92	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
48-49	0.8	$26.48	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
51	0.8	$45.79	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
52	0.8	$46.35	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
53	0.8	$29.80	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
54	0.8	$60.75	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
55	0.8	$70.05	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
56	0.8	$21.94	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
61	0.8	$26.01	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
62	0.8	$22.66	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
71	0.8	$20.06	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
72	0.8	$19.20	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
81	0.8	$27.32	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
92	0.8	$40.37	At-Risk Worker	Employee	Daily at Initial Heat Trigger (Up to 5 Days)
Rest Breaks at Initial Heat Trigger – Indoor					
11	0.20	$5.36	At-Risk Worker	Employee	Daily at Initial Heat Trigger
21	0.20	$9.29	At-Risk Worker	Employee	Daily at Initial Heat Trigger
22	0.20	$15.11	At-Risk Worker	Employee	Daily at Initial Heat Trigger
23	0.20	$8.79	At-Risk Worker	Employee	Daily at Initial Heat Trigger
31-33	0.20	$7.34	At-Risk Worker	Employee	Daily at Initial Heat Trigger
42	0.20	$8.47	At-Risk Worker	Employee	Daily at Initial Heat Trigger
44-45	0.20	$5.26	At-Risk Worker	Employee	Daily at Initial Heat Trigger
48-49	0.20	$6.65	At-Risk Worker	Employee	Daily at Initial Heat Trigger
51	0.20	$11.51	At-Risk Worker	Employee	Daily at Initial Heat Trigger
52	0.20	$11.65	At-Risk Worker	Employee	Daily at Initial Heat Trigger
53	0.20	$7.49	At-Risk Worker	Employee	Daily at Initial Heat Trigger
54	0.20	$15.27	At-Risk Worker	Employee	Daily at Initial Heat Trigger
55	0.20	$17.60	At-Risk Worker	Employee	Daily at Initial Heat Trigger
56	0.20	$5.51	At-Risk Worker	Employee	Daily at Initial Heat Trigger
61	0.20	$6.54	At-Risk Worker	Employee	Daily at Initial Heat Trigger

Table VIII.C.13. Labor-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
62	0.20	$5.70	At-Risk Worker	Employee	Daily at Initial Heat Trigger
71	0.20	$5.04	At-Risk Worker	Employee	Daily at Initial Heat Trigger
72	0.20	$4.83	At-Risk Worker	Employee	Daily at Initial Heat Trigger
81	0.20	$6.87	At-Risk Worker	Employee	Daily at Initial Heat Trigger
92	0.20	$10.14	At-Risk Worker	Employee	Daily at Initial Heat Trigger
Rest Breaks at Initial Heat Trigger – Outdoor					
11	0.23	$6.25	At-Risk Worker	Employee	Daily at Initial Heat Trigger
21	0.23	$10.84	At-Risk Worker	Employee	Daily at Initial Heat Trigger
22	0.23	$17.62	At-Risk Worker	Employee	Daily at Initial Heat Trigger
23	0.23	$10.25	At-Risk Worker	Employee	Daily at Initial Heat Trigger
31-33	0.23	$8.56	At-Risk Worker	Employee	Daily at Initial Heat Trigger
42	0.23	$9.88	At-Risk Worker	Employee	Daily at Initial Heat Trigger
44-45	0.23	$6.13	At-Risk Worker	Employee	Daily at Initial Heat Trigger
48-49	0.23	$7.76	At-Risk Worker	Employee	Daily at Initial Heat Trigger
51	0.23	$13.43	At-Risk Worker	Employee	Daily at Initial Heat Trigger
52	0.23	$13.59	At-Risk Worker	Employee	Daily at Initial Heat Trigger
53	0.23	$8.74	At-Risk Worker	Employee	Daily at Initial Heat Trigger
54	0.23	$17.81	At-Risk Worker	Employee	Daily at Initial Heat Trigger
55	0.23	$20.54	At-Risk Worker	Employee	Daily at Initial Heat Trigger
56	0.23	$6.43	At-Risk Worker	Employee	Daily at Initial Heat Trigger
61	0.23	$7.63	At-Risk Worker	Employee	Daily at Initial Heat Trigger
62	0.23	$6.65	At-Risk Worker	Employee	Daily at Initial Heat Trigger
71	0.23	$5.88	At-Risk Worker	Employee	Daily at Initial Heat Trigger
72	0.23	$5.63	At-Risk Worker	Employee	Daily at Initial Heat Trigger
81	0.23	$8.01	At-Risk Worker	Employee	Daily at Initial Heat Trigger
92	0.23	$11.84	At-Risk Worker	Employee	Daily at Initial Heat Trigger
Effective Communication – Supervisor					
11	0.01	$0.62	Designated Person	Employee	Daily at Initial Heat Trigger
21	0.01	$1.03	Designated Person	Employee	Daily at Initial Heat Trigger
22	0.01	$1.17	Designated Person	Employee	Daily at Initial Heat Trigger
23	0.01	$0.86	Designated Person	Employee	Daily at Initial Heat Trigger
31-33	0.01	$0.87	Designated Person	Employee	Daily at Initial Heat Trigger
42	0.01	$0.86	Designated Person	Employee	Daily at Initial Heat Trigger
44-45	0.01	$0.54	Designated Person	Employee	Daily at Initial Heat Trigger
48-49	0.01	$0.76	Designated Person	Employee	Daily at Initial Heat Trigger
51	0.01	$1.11	Designated Person	Employee	Daily at Initial Heat Trigger

Table VIII.C.13. Labor-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
52	0.01	$1.01	Designated Person	Employee	Daily at Initial Heat Trigger
53	0.01	$0.75	Designated Person	Employee	Daily at Initial Heat Trigger
54	0.01	$1.20	Designated Person	Employee	Daily at Initial Heat Trigger
55	0.01	$1.23	Designated Person	Employee	Daily at Initial Heat Trigger
56	0.01	$0.70	Designated Person	Employee	Daily at Initial Heat Trigger
61	0.01	$0.74	Designated Person	Employee	Daily at Initial Heat Trigger
62	0.01	$0.70	Designated Person	Employee	Daily at Initial Heat Trigger
71	0.01	$0.58	Designated Person	Employee	Daily at Initial Heat Trigger
72	0.01	$0.42	Designated Person	Employee	Daily at Initial Heat Trigger
81	0.01	$0.68	Designated Person	Employee	Daily at Initial Heat Trigger
92	0.01	$0.91	Designated Person	Employee	Daily at Initial Heat Trigger
Effective Communication – Employee					
11	0.01	$0.33	At-Risk Worker	Employee	Daily at Initial Heat Trigger
21	0.01	$0.58	At-Risk Worker	Employee	Daily at Initial Heat Trigger
22	0.01	$0.94	At-Risk Worker	Employee	Daily at Initial Heat Trigger
23	0.01	$0.55	At-Risk Worker	Employee	Daily at Initial Heat Trigger
31-33	0.01	$0.46	At-Risk Worker	Employee	Daily at Initial Heat Trigger
42	0.01	$0.53	At-Risk Worker	Employee	Daily at Initial Heat Trigger
44-45	0.01	$0.33	At-Risk Worker	Employee	Daily at Initial Heat Trigger
48-49	0.01	$0.42	At-Risk Worker	Employee	Daily at Initial Heat Trigger
51	0.01	$0.72	At-Risk Worker	Employee	Daily at Initial Heat Trigger
52	0.01	$0.73	At-Risk Worker	Employee	Daily at Initial Heat Trigger
53	0.01	$0.47	At-Risk Worker	Employee	Daily at Initial Heat Trigger
54	0.01	$0.95	At-Risk Worker	Employee	Daily at Initial Heat Trigger
55	0.01	$1.10	At-Risk Worker	Employee	Daily at Initial Heat Trigger
56	0.01	$0.34	At-Risk Worker	Employee	Daily at Initial Heat Trigger
61	0.01	$0.41	At-Risk Worker	Employee	Daily at Initial Heat Trigger
62	0.01	$0.36	At-Risk Worker	Employee	Daily at Initial Heat Trigger
71	0.01	$0.32	At-Risk Worker	Employee	Daily at Initial Heat Trigger
72	0.01	$0.30	At-Risk Worker	Employee	Daily at Initial Heat Trigger
81	0.01	$0.43	At-Risk Worker	Employee	Daily at Initial Heat Trigger
92	0.01	$0.63	At-Risk Worker	Employee	Daily at Initial Heat Trigger

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

Table VIII.C.14. Equipment-Based Unit Costs - Requirements at or Above the Initial Heat Trigger (2023$)

Item	Units	Unit Cost	Total Cost per Unit	Basis	Frequency
Coolers with Spigot	1.0	$79.99	$79.99	Employee	One-Time
Reusable Water Bottle	1.0	$0.59	$0.59	Employee	One-Time
Outdoor Break Area Engineering Control	1.0	$119.99	$119.99	Establishment	One-Time
Air Movement	2.0	$134.99	$269.98	Employee	One-Time
Humidity Control	2.0	$39.19	$78.38	Employee	One-Time

Source: OSHA estimate based on Igloo Products Corp., 2024; DiscountMugs, 2024; Amazon.com, Inc, 2024a; Amazon.com, Inc., 2024b; and WebstaurantStore, 2024.

E. Requirements at or Above the High Heat Trigger.

When the high heat trigger is met or exceeded, this proposed standard includes provisions related to rest breaks, observation of employees for signs and symptoms of heat illness, hazard alerts, and excessively high heat areas.

I. Rest Breaks.

When the high heat trigger is met or exceeded, employers would be required to provide a minimum of 15-minute paid rest breaks at least every two hours. The proposed standard specifies that a meal break may count as a rest break, even if it is not otherwise required by law to be paid. For this analysis, OSHA assumes two paid 15-minute rest breaks and an unpaid meal break per at-risk worker per 8-hour shift where the high heat trigger is met or exceeded. At the high heat trigger, employers must also provide if-needed rest breaks (as part of the requirements of the initial heat trigger). Therefore, OSHA assumes that when the high heat trigger is met or exceeded, in addition to 30 minutes per 8-hour shift of scheduled rest break time, at-risk workers would take a five-minute if-needed rest break. The travel time to walk to and from the break area is also accounted for and OSHA assumes two minutes for indoor employees and four minutes for outdoor employees per rest break.

Similar to the discussion in section VIII.C.IV.D.V., OSHA estimated the amount of time that employees spend pacing themselves when the high heat trigger is met or exceeded over an 8-hour shift (see table VIII.C.15.). These estimates reflect three groups of employees based on their respective establishments' estimated compliance with the rest break requirements outlined in this proposed standard. Group 1 corresponds to employees at establishments that do not currently provide rest breaks that meet the requirements when the initial heat trigger is met. Group 2 corresponds to employees at establishments that do provide if-needed rest breaks when the initial heat trigger is met or

exceeded, but do not have required rest breaks for when the high heat trigger is met or exceeded. Group 3 captures employees at establishments that have already implemented rest breaks protocols that meet the initial and high heat trigger rest break requirements outlined in this proposed standard.

Based on the estimates for pacing mentioned in section VIII.C.II.B. and detailed further in appendix A at the end of this section, OSHA estimated the reduction in pacing at the high heat trigger; the estimates for pacing for each group are shown in table VIII.C.15. OSHA estimated that with the implementation of scheduled rest breaks as well as if-needed rest breaks at the high heat trigger, employees in Group 1 (i.e., that are currently noncompliant with scheduled rest breaks as well as if-needed rest breaks) will behave like those in Group 3 (i.e., rest break protocols are consistent with the requirements of the standard at both triggers) and therefore their pacing reduces by 40.6 – 8.4 = 32.2 minutes. This reduction in pacing translates into 32.2/47 = 68.51 percent of the unit time-cost for rest breaks of 47 minutes and 32.2/41 = 78.53 percent out of the unit time-cost for rest breaks of 41 minutes saved for outdoor and indoor employees, respectively.

Based on the estimates for pacing mentioned in section VIII.C.II.B. and detailed further in appendix A at the end of this section and displayed in table VIII.C.15., OSHA estimates that with the implementation of scheduled rest breaks at the high heat trigger, employees in Group 2 (i.e., that are currently noncompliant with only scheduled rest breaks and currently compliant with if-needed rest breaks) will now behave like those in Group 3 and for those employees pacing is reduced by 39.5 – 8.4 = 31.1 minutes per shift. This reduction in pacing (i.e., increase in worker efficiency) translates into 31.1/47 = 66.17 percent of the unit time-cost of 47 minutes[67] (31.1/41 = 75.85 percent out of the

[67] 2x(15-minute scheduled break + 4-minute travel time) + 1x(5-minute if-needed rest break + 4-minute travel time).

unit time-cost of 41 minutes[68]) saved for outdoor (indoor) employees that are currently in Group 2.[69]

Table VIII.C.15. Labor Productivity Loss from Spent Pacing at High Heat Trigger Before and After Implementation of Required If-needed and Scheduled Rest Breaks per 8-Hour Shift per Employee

Group	Group Description	Labor Productivity Loss from Pacing at Before Required High Heat Trigger Rest Breaks (Minutes)	Labor Productivity Loss from Pacing After Required High Heat Trigger Rest Breaks (Minutes)	Estimated Labor Cost Savings (Minutes)
Group 1	Employees at establishments that do not currently provide any rest breaks.	40.6	8.4	32.2
Group 2	Employees at establishments that provide rest breaks that meet the initial heat trigger rest break requirements.	39.5	8.4	31.1
Group 3	Employees at establishments that provide rest breaks that meet the initial and high heat trigger rest break requirements.	8.4	8.4	0.0

Source: OSHA estimate.
Note: OSHA estimates that approximately 6.1 percent of employees are in Group 1, 46.9 percent are in Group 2, and 47.0 percent are in Group 3.

II. Observation for Signs and Symptoms.

Employers would be required to observe employees for signs and symptoms of heat-related illness at or above the high heat trigger. The proposed standard provides

[68] 2x(15-minute scheduled break + 2-minute travel time) + 1x(5-minute if-needed rest break + 2-minute travel time).

[69] For Group 2 as well as Group 1, for presentation purposes, the denominator over which unit time cost savings is translated as a share of the unit time cost of high heat trigger rest breaks is presented as 47 minutes for outdoor employees (41 minutes for indoor employees). The fact that employees in Group 2 are already spending some portion of the 47 minutes or 41 minutes in if-needed rest breaks is already reflected in the estimated (State-level) share of employees in Group 2, which is equivalent to the difference between the (State-level) non-compliance rate for high heat trigger rest breaks (scheduled as well as if-needed rest breaks) and the (State-level) non-compliance rate for initial heat trigger rest breaks (if-needed rest breaks). Most of the employees in Group 2 (approximately 74 percent) are estimated to be already taking if-needed rest breaks but not scheduled breaks. The rest of the employees in Group 2 are, in addition to if-needed rest breaks, also already taking partial scheduled breaks that fall short of (i.e., are not fully compliant with) the scheduled breaks that are required in the proposed standard. The purpose of such classification of employees already taking partial scheduled breaks as part of Group 2 (employees at establishments that do not have required rest breaks for when the high heat trigger is met or exceeded) is to avoid overcomplicating the computation and presentation of the cost savings. Such classification may potentially result in the overestimation of cost savings from the high heat trigger rest breaks. However, as mentioned throughout this section, there are also reasons why the cost savings are also potentially underestimated (e.g., due to temperature data limitations as mentioned in section VIII.C.II.B.).

options for complying with this requirement, including a mandatory buddy system and observation of employees by a supervisor or heat safety coordinator. Additionally, the proposed standard has a provision for communication with employees who are lone workers every 2 hours. OSHA assumes that all employers will use supervisors[70] to conduct observation of employees[71] (with one supervisor or heat safety coordinator responsible for observing no more than 20 employees). OSHA estimates this option would require 15 seconds of the designated person's time three times per employee for every 8-hour shift that meets or exceeds the high heat trigger. This observation requirement would also take 15 seconds of each at-risk worker's time three times for every 8-hour shift that meets or exceeds the high heat trigger.

III. Hazard Alert.

When the high heat trigger is met or exceeded, OSHA would require employers to notify employees of the importance of staying hydrated, their right to take breaks, procedures to take in a heat emergency, and the locations of break areas and drinking water (for mobile work sites). OSHA estimates that it would take five minutes one time for a designated person to prepare and deliver the first notification message to employees for the year or heat season, and that for each subsequent notification, the designated person will use the same format and spend 30 seconds to update and resend the alert for each 8-hour shift at or above the initial heat trigger. OSHA assumes the time for at-risk workers to review the hazard alert is negligible and thus is not estimated to require any time.

IV. Warning Signs for Excessively High Heat Areas.

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[70] For this analysis, OSHA uses the wages developed for designated persons to represent supervisors' time as well.

[71] OSHA was unable to estimate the number of affected lone workers. OSHA assumes that the cost of lone workers communication with supervisors is the same as the cost of observation for the purposes of this analysis. The agency welcomes comment on this assumption and additional data that would allow OSHA to better estimate the costs for communication with lone workers.

For indoor workplaces, employers would be required to place warning signs at areas with ambient temperatures that regularly exceed 120°F. OSHA assumes that this requirement imposes costs only to certain industries that are likely to have radiant heat sources (e.g., furnaces, hot water systems, ovens, smelting processes). OSHA assumes that this control would require 1-2 warning signs for each establishment in industries where radiant heat sources are likely present (or an average of 1.5 signs per establishment). OSHA estimates it would take a designated person 5 minutes to install each sign.

Table VIII.C.16. shows the unit costs for the requirements under the high heat trigger conditions by industry sector. The rest break unit costs reported in table VIII.C.16. do not reflect the cost savings offset discussed above. Table VIII.C.17. shows the equipment costs that employers would incur in order to comply with the requirements when the high heat trigger is met or exceeded.

Table VIII.C.16. Labor-Based Unit Costs - Requirements at or Above the High Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
Rest Breaks at High Heat Trigger – Indoor					
11	0.68	$18.31	At-Risk Worker	Employee	Daily at High Heat Trigger
21	0.68	$31.74	At-Risk Worker	Employee	Daily at High Heat Trigger
22	0.68	$51.61	At-Risk Worker	Employee	Daily at High Heat Trigger
23	0.68	$30.03	At-Risk Worker	Employee	Daily at High Heat Trigger
31-33	0.68	$25.07	At-Risk Worker	Employee	Daily at High Heat Trigger
42	0.68	$28.93	At-Risk Worker	Employee	Daily at High Heat Trigger
44-45	0.68	$17.96	At-Risk Worker	Employee	Daily at High Heat Trigger
48-49	0.68	$22.74	At-Risk Worker	Employee	Daily at High Heat Trigger
51	0.68	$39.32	At-Risk Worker	Employee	Daily at High Heat Trigger
52	0.68	$39.80	At-Risk Worker	Employee	Daily at High Heat Trigger
53	0.68	$25.58	At-Risk Worker	Employee	Daily at High Heat Trigger
54	0.68	$52.16	At-Risk Worker	Employee	Daily at High Heat Trigger
55	0.68	$60.15	At-Risk Worker	Employee	Daily at High Heat Trigger
56	0.68	$18.84	At-Risk Worker	Employee	Daily at High Heat Trigger
61	0.68	$22.33	At-Risk Worker	Employee	Daily at High Heat Trigger
62	0.68	$19.46	At-Risk Worker	Employee	Daily at High Heat Trigger
71	0.68	$17.23	At-Risk Worker	Employee	Daily at High Heat Trigger
72	0.68	$16.49	At-Risk Worker	Employee	Daily at High Heat Trigger
81	0.68	$23.46	At-Risk Worker	Employee	Daily at High Heat Trigger
92	0.68	$34.66	At-Risk Worker	Employee	Daily at High Heat Trigger
Rest Breaks at High Heat Trigger – Outdoor					

Table VIII.C.16. Labor-Based Unit Costs - Requirements at or Above the High Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
11	0.78	$20.99	At-Risk Worker	Employee	Daily at High Heat Trigger
21	0.78	$36.39	At-Risk Worker	Employee	Daily at High Heat Trigger
22	0.78	$59.17	At-Risk Worker	Employee	Daily at High Heat Trigger
23	0.78	$34.43	At-Risk Worker	Employee	Daily at High Heat Trigger
31-33	0.78	$28.73	At-Risk Worker	Employee	Daily at High Heat Trigger
42	0.78	$33.17	At-Risk Worker	Employee	Daily at High Heat Trigger
44-45	0.78	$20.59	At-Risk Worker	Employee	Daily at High Heat Trigger
48-49	0.78	$26.06	At-Risk Worker	Employee	Daily at High Heat Trigger
51	0.78	$45.07	At-Risk Worker	Employee	Daily at High Heat Trigger
52	0.78	$45.62	At-Risk Worker	Employee	Daily at High Heat Trigger
53	0.78	$29.33	At-Risk Worker	Employee	Daily at High Heat Trigger
54	0.78	$59.80	At-Risk Worker	Employee	Daily at High Heat Trigger
55	0.78	$68.95	At-Risk Worker	Employee	Daily at High Heat Trigger
56	0.78	$21.59	At-Risk Worker	Employee	Daily at High Heat Trigger
61	0.78	$25.60	At-Risk Worker	Employee	Daily at High Heat Trigger
62	0.78	$22.31	At-Risk Worker	Employee	Daily at High Heat Trigger
71	0.78	$19.75	At-Risk Worker	Employee	Daily at High Heat Trigger
72	0.78	$18.90	At-Risk Worker	Employee	Daily at High Heat Trigger
81	0.78	$26.89	At-Risk Worker	Employee	Daily at High Heat Trigger
92	0.78	$39.73	At-Risk Worker	Employee	Daily at High Heat Trigger
Observation for Signs and Symptoms – Designated Person					
11	0.01	$0.62	Designated Person	Employee	Daily at High Heat Trigger
21	0.01	$1.03	Designated Person	Employee	Daily at High Heat Trigger
22	0.01	$1.17	Designated Person	Employee	Daily at High Heat Trigger
23	0.01	$0.86	Designated Person	Employee	Daily at High Heat Trigger
31-33	0.01	$0.87	Designated Person	Employee	Daily at High Heat Trigger
42	0.01	$0.86	Designated Person	Employee	Daily at High Heat Trigger
44-45	0.01	$0.54	Designated Person	Employee	Daily at High Heat Trigger
48-49	0.01	$0.76	Designated Person	Employee	Daily at High Heat Trigger
51	0.01	$1.11	Designated Person	Employee	Daily at High Heat Trigger
52	0.01	$1.01	Designated Person	Employee	Daily at High Heat Trigger
53	0.01	$0.75	Designated Person	Employee	Daily at High Heat Trigger
54	0.01	$1.20	Designated Person	Employee	Daily at High Heat Trigger
55	0.01	$1.23	Designated Person	Employee	Daily at High Heat Trigger
56	0.01	$0.70	Designated Person	Employee	Daily at High Heat Trigger
61	0.01	$0.74	Designated Person	Employee	Daily at High Heat Trigger
62	0.01	$0.70	Designated Person	Employee	Daily at High Heat Trigger
71	0.01	$0.58	Designated Person	Employee	Daily at High Heat Trigger
72	0.01	$0.42	Designated Person	Employee	Daily at High Heat Trigger
81	0.01	$0.68	Designated Person	Employee	Daily at High Heat Trigger
92	0.01	$0.91	Designated Person	Employee	Daily at High Heat Trigger
Observation for Signs and Symptoms – At–Risk Worker					
11	0.01	$0.33	At-Risk Worker	Employee	Daily at High Heat Trigger
21	0.01	$0.58	At-Risk Worker	Employee	Daily at High Heat Trigger
22	0.01	$0.94	At-Risk Worker	Employee	Daily at High Heat Trigger
23	0.01	$0.55	At-Risk Worker	Employee	Daily at High Heat Trigger
31-33	0.01	$0.46	At-Risk Worker	Employee	Daily at High Heat Trigger
42	0.01	$0.53	At-Risk Worker	Employee	Daily at High Heat Trigger
44-45	0.01	$0.33	At-Risk Worker	Employee	Daily at High Heat Trigger

Table VIII.C.16. Labor-Based Unit Costs - Requirements at or Above the High Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
48-49	0.01	$0.42	At-Risk Worker	Employee	Daily at High Heat Trigger
51	0.01	$0.72	At-Risk Worker	Employee	Daily at High Heat Trigger
52	0.01	$0.73	At-Risk Worker	Employee	Daily at High Heat Trigger
53	0.01	$0.47	At-Risk Worker	Employee	Daily at High Heat Trigger
54	0.01	$0.95	At-Risk Worker	Employee	Daily at High Heat Trigger
55	0.01	$1.10	At-Risk Worker	Employee	Daily at High Heat Trigger
56	0.01	$0.34	At-Risk Worker	Employee	Daily at High Heat Trigger
61	0.01	$0.41	At-Risk Worker	Employee	Daily at High Heat Trigger
62	0.01	$0.36	At-Risk Worker	Employee	Daily at High Heat Trigger
71	0.01	$0.32	At-Risk Worker	Employee	Daily at High Heat Trigger
72	0.01	$0.30	At-Risk Worker	Employee	Daily at High Heat Trigger
81	0.01	$0.43	At-Risk Worker	Employee	Daily at High Heat Trigger
92	0.01	$0.63	At-Risk Worker	Employee	Daily at High Heat Trigger
Initial Hazard Alert – Supervisor					
11	0.08	$4.15	Designated Person	Establishment	Annual
21	0.08	$6.86	Designated Person	Establishment	Annual
22	0.08	$7.83	Designated Person	Establishment	Annual
23	0.08	$5.71	Designated Person	Establishment	Annual
31-33	0.08	$5.83	Designated Person	Establishment	Annual
42	0.08	$5.73	Designated Person	Establishment	Annual
44-45	0.08	$3.57	Designated Person	Establishment	Annual
48-49	0.08	$5.05	Designated Person	Establishment	Annual
51	0.08	$7.40	Designated Person	Establishment	Annual
52	0.08	$6.75	Designated Person	Establishment	Annual
53	0.08	$4.99	Designated Person	Establishment	Annual
54	0.08	$7.97	Designated Person	Establishment	Annual
55	0.08	$8.22	Designated Person	Establishment	Annual
56	0.08	$4.66	Designated Person	Establishment	Annual
61	0.08	$4.96	Designated Person	Establishment	Annual
62	0.08	$4.66	Designated Person	Establishment	Annual
71	0.08	$3.90	Designated Person	Establishment	Annual
72	0.08	$2.77	Designated Person	Establishment	Annual
81	0.08	$4.54	Designated Person	Establishment	Annual
92	0.08	$6.09	Designated Person	Establishment	Annual
Subsequent Hazard Alert – Supervisor					
11	0.01	$0.42	Designated Person	Establishment	Daily at High Heat Trigger
21	0.01	$0.69	Designated Person	Establishment	Daily at High Heat Trigger
22	0.01	$0.78	Designated Person	Establishment	Daily at High Heat Trigger
23	0.01	$0.57	Designated Person	Establishment	Daily at High Heat Trigger
31-33	0.01	$0.58	Designated Person	Establishment	Daily at High Heat Trigger
42	0.01	$0.57	Designated Person	Establishment	Daily at High Heat Trigger
44-45	0.01	$0.36	Designated Person	Establishment	Daily at High Heat Trigger
48-49	0.01	$0.50	Designated Person	Establishment	Daily at High Heat Trigger
51	0.01	$0.74	Designated Person	Establishment	Daily at High Heat Trigger
52	0.01	$0.67	Designated Person	Establishment	Daily at High Heat Trigger
53	0.01	$0.50	Designated Person	Establishment	Daily at High Heat Trigger
54	0.01	$0.80	Designated Person	Establishment	Daily at High Heat Trigger
55	0.01	$0.82	Designated Person	Establishment	Daily at High Heat Trigger
56	0.01	$0.47	Designated Person	Establishment	Daily at High Heat Trigger

Table VIII.C.16. Labor-Based Unit Costs - Requirements at or Above the High Heat Trigger (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
61	0.01	$0.50	Designated Person	Establishment	Daily at High Heat Trigger
62	0.01	$0.47	Designated Person	Establishment	Daily at High Heat Trigger
71	0.01	$0.39	Designated Person	Establishment	Daily at High Heat Trigger
72	0.01	$0.28	Designated Person	Establishment	Daily at High Heat Trigger
81	0.01	$0.45	Designated Person	Establishment	Daily at High Heat Trigger
92	0.01	$0.61	Designated Person	Establishment	Daily at High Heat Trigger
Signage Placement					
11	0.08	$4.15	Designated Person	Establishment	One-Time
21	0.08	$6.86	Designated Person	Establishment	One-Time
22	0.08	$7.83	Designated Person	Establishment	One-Time
23	0.08	$5.71	Designated Person	Establishment	One-Time
31-33	0.08	$5.83	Designated Person	Establishment	One-Time
42	0.08	$5.73	Designated Person	Establishment	One-Time
44-45	0.08	$3.57	Designated Person	Establishment	One-Time
48-49	0.08	$5.05	Designated Person	Establishment	One-Time
51	0.08	$7.40	Designated Person	Establishment	One-Time
52	0.08	$6.75	Designated Person	Establishment	One-Time
53	0.08	$4.99	Designated Person	Establishment	One-Time
54	0.08	$7.97	Designated Person	Establishment	One-Time
55	0.08	$8.22	Designated Person	Establishment	One-Time
56	0.08	$4.66	Designated Person	Establishment	One-Time
61	0.08	$4.96	Designated Person	Establishment	One-Time
62	0.08	$4.66	Designated Person	Establishment	One-Time
71	0.08	$3.90	Designated Person	Establishment	One-Time
72	0.08	$2.77	Designated Person	Establishment	One-Time
81	0.08	$4.54	Designated Person	Establishment	One-Time
92	0.08	$6.09	Designated Person	Establishment	One-Time

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

Table VIII.C.17. Equipment-Based Unit Costs – Requirements at or Above the High Heat Trigger (2023$)

Item	Units	Unit Cost	Total Cost per Unit	Basis	Frequency
Warning Signs	1.5	$13.50	$20.25	Establishment	One-Time

Source: OSHA based on SafetySign.com, 2024.

F. Heat Illness and Emergency Response and Planning.

In addition to requirements for a heat emergency response plan that employers must include in their HIIPP, OSHA would require employers to undertake certain activities for any at-risk worker experiencing signs and symptoms of heat-related illness, including requiring immediate action appropriate to the severity of the illness or emergency. There are other methods to cool an individual experiencing a heat emergency, but OSHA is estimating costs here assuming that employers will implement the method recommended by the U.S. Army (Department of the Army, 2023). The agency welcomes comment on this issue and information on methods currently used for cooling.

In the case of a non-emergency heat-related illness, OSHA estimates that a designated person will spend 45 minutes per incident monitoring the employee. When an employee is suspected of a heat emergency, the proposed standard would require immediate action to reduce body temperature. OSHA estimates this would take 12.5 minutes per incident (based on Casa et al., 2007), accompanied by an immediate call to emergency medical services (EMS) taking an estimated 2 minutes.[72] For any employee experiencing a heat emergency working in a location that is off a roadway that needs EMS, a designated person will spend time transporting the employee to a location where EMS can reach them. OSHA estimated that, on average, it will take a designated person 30 minutes to transport an employee per incident.[73] Finally, OSHA would require employers to have a way to reduce an employee's body temperature when necessary.

[72] OSHA estimates that a heat emergency will require less time from a designated person because, in a heat emergency, the affected employee will be transported to a medical facility by EMS rather than monitored for the duration at the work site.

[73] This time estimate includes time for the designated person to return to the work site.

OSHA assumes that employers will use two sets of four bed sheets[74] that have been wetted and cooled per employee experiencing a heat emergency, with one set on the employee and one set in a cooler such that they can be swapped every three minutes. OSHA further assumes that employers will need to have supplies on hand to potentially handle two incidents concurrently. In all, this means that an employer would need 16 sheets (8 per individual to cool two individuals, where four sheets can be cooled while four are used which can then be switched and reused in a cycle of cooling then using the sheets) and two coolers at their establishment, as well as six seven-pound bags of ice[75] for each 8-hour shift that meets or exceeds the initial heat trigger.

See table VIII.C.6. for anticipated annual incidence rates by sector used in this analysis. Table VIII.C.18. shows the unit costs for the requirements to respond to and plan for heat-related illnesses by severity of illness and industry sector. Table VIII.C.19. shows the equipment costs that employers would incur in order to perform emergency response procedures in the event of a heat-related illness by severity of illness (emergency or non-emergency).

Table VIII.C.18. Labor-Based Unit Costs – Heat Illness and Emergency Response and Planning (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
Medical Response – Non–Emergency					
11	0.75	$37.37	Designated Person	Incident	Annual
21	0.75	$61.74	Designated Person	Incident	Annual
22	0.75	$70.46	Designated Person	Incident	Annual
23	0.75	$51.39	Designated Person	Incident	Annual
31-33	0.75	$52.48	Designated Person	Incident	Annual
42	0.75	$51.58	Designated Person	Incident	Annual
44-45	0.75	$32.17	Designated Person	Incident	Annual
48-49	0.75	$45.44	Designated Person	Incident	Annual
51	0.75	$66.58	Designated Person	Incident	Annual
52	0.75	$60.73	Designated Person	Incident	Annual
53	0.75	$44.93	Designated Person	Incident	Annual
54	0.75	$71.75	Designated Person	Incident	Annual
55	0.75	$73.96	Designated Person	Incident	Annual

[74] This assumption is based on guidance from the U.S. Army on treatment of heat casualties. The guidance suggests treating an ill person with two sheets, one to wrap their body and the other for their head, and to rotate between four sets of two sheets every three minutes (Department of the Army, 2023).
[75] OSHA assumes that approximately 50 percent of employers will make and/or store ice on their premises using existing freezers and/or ice machines.

Table VIII.C.18. Labor-Based Unit Costs – Heat Illness and Emergency Response and Planning (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
56	0.75	$41.97	Designated Person	Incident	Annual
61	0.75	$44.61	Designated Person	Incident	Annual
62	0.75	$41.94	Designated Person	Incident	Annual
71	0.75	$35.06	Designated Person	Incident	Annual
72	0.75	$24.93	Designated Person	Incident	Annual
81	0.75	$40.84	Designated Person	Incident	Annual
92	0.75	$54.83	Designated Person	Incident	Annual
Medical Response – Emergency					
11	0.21	$10.38	Designated Person	Incident	Annual
21	0.21	$17.15	Designated Person	Incident	Annual
22	0.21	$19.57	Designated Person	Incident	Annual
23	0.21	$14.28	Designated Person	Incident	Annual
31-33	0.21	$14.58	Designated Person	Incident	Annual
42	0.21	$14.33	Designated Person	Incident	Annual
44-45	0.21	$8.94	Designated Person	Incident	Annual
48-49	0.21	$12.62	Designated Person	Incident	Annual
51	0.21	$18.50	Designated Person	Incident	Annual
52	0.21	$16.87	Designated Person	Incident	Annual
53	0.21	$12.48	Designated Person	Incident	Annual
54	0.21	$19.93	Designated Person	Incident	Annual
55	0.21	$20.55	Designated Person	Incident	Annual
56	0.21	$11.66	Designated Person	Incident	Annual
61	0.21	$12.39	Designated Person	Incident	Annual
62	0.21	$11.65	Designated Person	Incident	Annual
71	0.21	$9.74	Designated Person	Incident	Annual
72	0.21	$6.93	Designated Person	Incident	Annual
81	0.21	$11.34	Designated Person	Incident	Annual
92	0.21	$15.23	Designated Person	Incident	Annual
Contact Emergency Medical Services					
11	0.03	$1.66	Designated Person	Incident	Annual
21	0.03	$2.74	Designated Person	Incident	Annual
22	0.03	$3.13	Designated Person	Incident	Annual
23	0.03	$2.28	Designated Person	Incident	Annual
31-33	0.03	$2.33	Designated Person	Incident	Annual
42	0.03	$2.29	Designated Person	Incident	Annual
44-45	0.03	$1.43	Designated Person	Incident	Annual
48-49	0.03	$2.02	Designated Person	Incident	Annual
51	0.03	$2.96	Designated Person	Incident	Annual
52	0.03	$2.70	Designated Person	Incident	Annual
53	0.03	$2.00	Designated Person	Incident	Annual
54	0.03	$3.19	Designated Person	Incident	Annual
55	0.03	$3.29	Designated Person	Incident	Annual
56	0.03	$1.87	Designated Person	Incident	Annual
61	0.03	$1.98	Designated Person	Incident	Annual
62	0.03	$1.86	Designated Person	Incident	Annual
71	0.03	$1.56	Designated Person	Incident	Annual
72	0.03	$1.11	Designated Person	Incident	Annual
81	0.03	$1.82	Designated Person	Incident	Annual
92	0.03	$2.44	Designated Person	Incident	Annual

Table VIII.C.18. Labor-Based Unit Costs – Heat Illness and Emergency Response and Planning (2023$)

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
Transport Worker					
11	0.50	$24.92	Designated Person	Incident	Annual
21	0.50	$41.16	Designated Person	Incident	Annual
22	0.50	$46.97	Designated Person	Incident	Annual
23	0.50	$34.26	Designated Person	Incident	Annual
31-33	0.50	$34.99	Designated Person	Incident	Annual
42	0.50	$34.39	Designated Person	Incident	Annual
44-45	0.50	$21.45	Designated Person	Incident	Annual
48-49	0.50	$30.30	Designated Person	Incident	Annual
51	0.50	$44.39	Designated Person	Incident	Annual
52	0.50	$40.49	Designated Person	Incident	Annual
53	0.50	$29.95	Designated Person	Incident	Annual
54	0.50	$47.83	Designated Person	Incident	Annual
55	0.50	$49.31	Designated Person	Incident	Annual
56	0.50	$27.98	Designated Person	Incident	Annual
61	0.50	$29.74	Designated Person	Incident	Annual
62	0.50	$27.96	Designated Person	Incident	Annual
71	0.50	$23.37	Designated Person	Incident	Annual
72	0.50	$16.62	Designated Person	Incident	Annual
81	0.50	$27.23	Designated Person	Incident	Annual
92	0.50	$36.55	Designated Person	Incident	Annual

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

Table VIII.C.19. Equipment-Based Unit Costs – Heat Illness and Emergency Response and Planning (2023$)

Item	Units	Unit Cost	Total Cost	Basis	Frequency
Ice Sheets	16.0	$9.99	$159.84	Establishment	One-Time
Ice	6.0	$0.69[a]	$4.14	Establishment	Daily at Initial Heat Trigger
Ice Cooler	2.0	$31.70	$63.40	Establishment	One-Time

Source: OSHA based on Amazon.com, Inc., 2024c; W.W. Grainger, Inc., 2024; and Walmart Inc., 2024.
[a] Under the assumption that approximately 50 percent of employers will make and/or store ice on their premises using existing freezers and/or ice machines, half of the unit cost of a seven-pound bags of ice = $ 1.38/2 = $0.69 is reported.

G. Training.

The proposed standard would require employers to develop and implement a training program for employees and supervisors. Training would be required at certain frequencies, including initially (e.g., prior to any work at or above the initial heat trigger), annual refresher training, and supplemental training when necessary (e.g., following each heat-related incident at the work site, new job tasks, or changes in employer policies and procedures). OSHA assumes the training program would be developed and implemented by a designated person.

OSHA estimates a designated person would spend four hours developing the initial employee training program, 30 minutes preparing for the initial employee training sessions, and one hour administering each initial training session.[76] OSHA estimates that a designated person would spend 15 minutes preparing for the refresher employee training(s) and 30 minutes conducting each refresher employee training. Finally, OSHA estimates that all employees would spend one hour each for the initial employee training and 30 minutes each for every refresher employee training.

For the supervisor and heat safety coordinator training, OSHA estimates that a designated person would spend four hours developing the initial training, 15 minutes preparing, and one hour per session to deliver the initial supervisor training. OSHA estimates that each supervisor and heat safety coordinator would spend one hour attending the supervisor training. For supervisor refresher training, OSHA estimates that a designated person would spend 15 minutes preparing for the refresher training and 30 minutes conducting the refresher training. Each supervisor and heat safety coordinator would spend 30 minutes attending the supervisor refresher training.

Finally, OSHA estimates that a designated person would spend 15 minutes preparing supplemental employee training and 30 minutes conducting each supplemental employee training. Each employee would spend 30 minutes attending the employee supplemental training. For this analysis, OSHA assumes that these supplemental trainings would be conducted by one percent of establishments each year and that one percent of employees would attend these supplemental trainings.

Table VIII.C.20. shows the unit costs for the training requirements by industry sector.

Table VIII.C.20. Labor-Based Unit Costs – Training (2023$)

[76] OSHA expects to provide training materials and templates. To the extent that employers are able to incorporate and develop training using those materials and templates, this estimate may overstate the amount of time needed to develop training. OSHA welcomes comment on this issue, how training is generally developed, how long that development takes, and/or information about any other costs related to training development.

Sector	Hours	Unit Cost	Labor Category	Basis	Frequency
Initial Employee Training Development					
11	4.0	$199.32	Designated Person	Establishment	One-Time
21	4.0	$329.25	Designated Person	Establishment	One-Time
22	4.0	$375.78	Designated Person	Establishment	One-Time
23	4.0	$274.10	Designated Person	Establishment	One-Time
31-33	4.0	$279.88	Designated Person	Establishment	One-Time
42	4.0	$275.09	Designated Person	Establishment	One-Time
44-45	4.0	$171.57	Designated Person	Establishment	One-Time
48-49	4.0	$242.37	Designated Person	Establishment	One-Time
51	4.0	$355.11	Designated Person	Establishment	One-Time
52	4.0	$323.91	Designated Person	Establishment	One-Time
53	4.0	$239.62	Designated Person	Establishment	One-Time
54	4.0	$382.66	Designated Person	Establishment	One-Time
55	4.0	$394.46	Designated Person	Establishment	One-Time
56	4.0	$223.87	Designated Person	Establishment	One-Time
61	4.0	$237.94	Designated Person	Establishment	One-Time
62	4.0	$223.70	Designated Person	Establishment	One-Time
71	4.0	$187.00	Designated Person	Establishment	One-Time
72	4.0	$132.96	Designated Person	Establishment	One-Time
81	4.0	$217.82	Designated Person	Establishment	One-Time
92	4.0	$292.41	Designated Person	Establishment	One-Time
Initial Employee Training – Designated Person					
11	1.50	$74.75	Designated Person	Establishment	One-Time
21	1.50	$123.47	Designated Person	Establishment	One-Time
22	1.50	$140.92	Designated Person	Establishment	One-Time
23	1.50	$102.79	Designated Person	Establishment	One-Time
31-33	1.50	$104.96	Designated Person	Establishment	One-Time
42	1.50	$103.16	Designated Person	Establishment	One-Time
44-45	1.50	$64.34	Designated Person	Establishment	One-Time
48-49	1.50	$90.89	Designated Person	Establishment	One-Time
51	1.50	$133.17	Designated Person	Establishment	One-Time
52	1.50	$121.46	Designated Person	Establishment	One-Time
53	1.50	$89.86	Designated Person	Establishment	One-Time
54	1.50	$143.50	Designated Person	Establishment	One-Time
55	1.50	$147.92	Designated Person	Establishment	One-Time
56	1.50	$83.95	Designated Person	Establishment	One-Time
61	1.50	$89.23	Designated Person	Establishment	One-Time
62	1.50	$83.89	Designated Person	Establishment	One-Time
71	1.50	$70.12	Designated Person	Establishment	One-Time
72	1.50	$49.86	Designated Person	Establishment	One-Time
81	1.50	$81.68	Designated Person	Establishment	One-Time
92	1.50	$109.66	Designated Person	Establishment	One-Time
Initial Employee Training – At-Risk Worker					
11	1.0	$26.80	At-Risk Worker	Employee	One-Time
21	1.0	$46.46	At-Risk Worker	Employee	One-Time
22	1.0	$75.53	At-Risk Worker	Employee	One-Time
23	1.0	$43.95	At-Risk Worker	Employee	One-Time
31-33	1.0	$36.68	At-Risk Worker	Employee	One-Time
42	1.0	$42.34	At-Risk Worker	Employee	One-Time
44-45	1.0	$26.28	At-Risk Worker	Employee	One-Time
48-49	1.0	$33.27	At-Risk Worker	Employee	One-Time

51	1.0	$57.54	At-Risk Worker	Employee	One-Time
52	1.0	$58.24	At-Risk Worker	Employee	One-Time
53	1.0	$37.44	At-Risk Worker	Employee	One-Time
54	1.0	$76.34	At-Risk Worker	Employee	One-Time
55	1.0	$88.02	At-Risk Worker	Employee	One-Time
56	1.0	$27.56	At-Risk Worker	Employee	One-Time
61	1.0	$32.68	At-Risk Worker	Employee	One-Time
62	1.0	$28.48	At-Risk Worker	Employee	One-Time
71	1.0	$25.21	At-Risk Worker	Employee	One-Time
72	1.0	$24.13	At-Risk Worker	Employee	One-Time
81	1.0	$34.33	At-Risk Worker	Employee	One-Time
92	1.0	$50.72	At-Risk Worker	Employee	One-Time
Initial Supervisor Training Development					
11	2.0	$99.66	Designated Person	Establishment	One-Time
21	2.0	$164.63	Designated Person	Establishment	One-Time
22	2.0	$187.89	Designated Person	Establishment	One-Time
23	2.0	$137.05	Designated Person	Establishment	One-Time
31-33	2.0	$139.94	Designated Person	Establishment	One-Time
42	2.0	$137.55	Designated Person	Establishment	One-Time
44-45	2.0	$85.78	Designated Person	Establishment	One-Time
48-49	2.0	$121.18	Designated Person	Establishment	One-Time
51	2.0	$177.56	Designated Person	Establishment	One-Time
52	2.0	$161.95	Designated Person	Establishment	One-Time
53	2.0	$119.81	Designated Person	Establishment	One-Time
54	2.0	$191.33	Designated Person	Establishment	One-Time
55	2.0	$197.23	Designated Person	Establishment	One-Time
56	2.0	$111.93	Designated Person	Establishment	One-Time
61	2.0	$118.97	Designated Person	Establishment	One-Time
62	2.0	$111.85	Designated Person	Establishment	One-Time
71	2.0	$93.50	Designated Person	Establishment	One-Time
72	2.0	$66.48	Designated Person	Establishment	One-Time
81	2.0	$108.91	Designated Person	Establishment	One-Time
92	2.0	$146.21	Designated Person	Establishment	One-Time
Initial Supervisor Training – Supervisor					
11	1.25	$62.29	Designated Person	Establishment	One-Time
21	1.25	$102.89	Designated Person	Establishment	One-Time
22	1.25	$117.43	Designated Person	Establishment	One-Time
23	1.25	$85.66	Designated Person	Establishment	One-Time
31-33	1.25	$87.46	Designated Person	Establishment	One-Time
42	1.25	$85.97	Designated Person	Establishment	One-Time
44-45	1.25	$53.61	Designated Person	Establishment	One-Time
48-49	1.25	$75.74	Designated Person	Establishment	One-Time
51	1.25	$110.97	Designated Person	Establishment	One-Time
52	1.25	$101.22	Designated Person	Establishment	One-Time
53	1.25	$74.88	Designated Person	Establishment	One-Time
54	1.25	$119.58	Designated Person	Establishment	One-Time
55	1.25	$123.27	Designated Person	Establishment	One-Time
56	1.25	$69.96	Designated Person	Establishment	One-Time
61	1.25	$74.36	Designated Person	Establishment	One-Time
62	1.25	$69.91	Designated Person	Establishment	One-Time
71	1.25	$58.44	Designated Person	Establishment	One-Time
72	1.25	$41.55	Designated Person	Establishment	One-Time

81	1.25	$68.07	Designated Person	Establishment	One-Time
92	1.25	$91.38	Designated Person	Establishment	One-Time
Initial Supervisor Training – Designated Person					
11	1.0	$49.83	Designated Person	Establishment	One-Time
21	1.0	$82.31	Designated Person	Establishment	One-Time
22	1.0	$93.94	Designated Person	Establishment	One-Time
23	1.0	$68.53	Designated Person	Establishment	One-Time
31-33	1.0	$69.97	Designated Person	Establishment	One-Time
42	1.0	$68.77	Designated Person	Establishment	One-Time
44-45	1.0	$42.89	Designated Person	Establishment	One-Time
48-49	1.0	$60.59	Designated Person	Establishment	One-Time
51	1.0	$88.78	Designated Person	Establishment	One-Time
52	1.0	$80.98	Designated Person	Establishment	One-Time
53	1.0	$59.91	Designated Person	Establishment	One-Time
54	1.0	$95.67	Designated Person	Establishment	One-Time
55	1.0	$98.62	Designated Person	Establishment	One-Time
56	1.0	$55.97	Designated Person	Establishment	One-Time
61	1.0	$59.49	Designated Person	Establishment	One-Time
62	1.0	$55.92	Designated Person	Establishment	One-Time
71	1.0	$46.75	Designated Person	Establishment	One-Time
72	1.0	$33.24	Designated Person	Establishment	One-Time
81	1.0	$54.45	Designated Person	Establishment	One-Time
92	1.0	$73.10	Designated Person	Establishment	One-Time
Annual Employee Refresher Training – Designated Person					
11	0.75	$37.37	Designated Person	Establishment	Annual
21	0.75	$61.74	Designated Person	Establishment	Annual
22	0.75	$70.46	Designated Person	Establishment	Annual
23	0.75	$51.39	Designated Person	Establishment	Annual
31-33	0.75	$52.48	Designated Person	Establishment	Annual
42	0.75	$51.58	Designated Person	Establishment	Annual
44-45	0.75	$32.17	Designated Person	Establishment	Annual
48-49	0.75	$45.44	Designated Person	Establishment	Annual
51	0.75	$66.58	Designated Person	Establishment	Annual
52	0.75	$60.73	Designated Person	Establishment	Annual
53	0.75	$44.93	Designated Person	Establishment	Annual
54	0.75	$71.75	Designated Person	Establishment	Annual
55	0.75	$73.96	Designated Person	Establishment	Annual
56	0.75	$41.97	Designated Person	Establishment	Annual
61	0.75	$44.61	Designated Person	Establishment	Annual
62	0.75	$41.94	Designated Person	Establishment	Annual
71	0.75	$35.06	Designated Person	Establishment	Annual
72	0.75	$24.93	Designated Person	Establishment	Annual
81	0.75	$40.84	Designated Person	Establishment	Annual
92	0.75	$54.83	Designated Person	Establishment	Annual
Annual Employee Refresher Training – At-Risk Worker					
11	0.50	$13.40	At-Risk Worker	Employee	Annual
21	0.50	$23.23	At-Risk Worker	Employee	Annual
22	0.50	$37.77	At-Risk Worker	Employee	Annual
23	0.50	$21.97	At-Risk Worker	Employee	Annual
31-33	0.50	$18.34	At-Risk Worker	Employee	Annual
42	0.50	$21.17	At-Risk Worker	Employee	Annual
44-45	0.50	$13.14	At-Risk Worker	Employee	Annual

48-49	0.50	$16.64	At-Risk Worker	Employee	Annual
51	0.50	$28.77	At-Risk Worker	Employee	Annual
52	0.50	$29.12	At-Risk Worker	Employee	Annual
53	0.50	$18.72	At-Risk Worker	Employee	Annual
54	0.50	$38.17	At-Risk Worker	Employee	Annual
55	0.50	$44.01	At-Risk Worker	Employee	Annual
56	0.50	$13.78	At-Risk Worker	Employee	Annual
61	0.50	$16.34	At-Risk Worker	Employee	Annual
62	0.50	$14.24	At-Risk Worker	Employee	Annual
71	0.50	$12.61	At-Risk Worker	Employee	Annual
72	0.50	$12.06	At-Risk Worker	Employee	Annual
81	0.50	$17.16	At-Risk Worker	Employee	Annual
92	0.50	$25.36	At-Risk Worker	Employee	Annual
Annual Supervisor Refresher Training – Supervisor					
11	0.63	$31.14	Designated Person	Establishment	Annual
21	0.63	$51.45	Designated Person	Establishment	Annual
22	0.63	$58.72	Designated Person	Establishment	Annual
23	0.63	$42.83	Designated Person	Establishment	Annual
31-33	0.63	$43.73	Designated Person	Establishment	Annual
42	0.63	$42.98	Designated Person	Establishment	Annual
44-45	0.63	$26.81	Designated Person	Establishment	Annual
48-49	0.63	$37.87	Designated Person	Establishment	Annual
51	0.63	$55.49	Designated Person	Establishment	Annual
52	0.63	$50.61	Designated Person	Establishment	Annual
53	0.63	$37.44	Designated Person	Establishment	Annual
54	0.63	$59.79	Designated Person	Establishment	Annual
55	0.63	$61.64	Designated Person	Establishment	Annual
56	0.63	$34.98	Designated Person	Establishment	Annual
61	0.63	$37.18	Designated Person	Establishment	Annual
62	0.63	$34.95	Designated Person	Establishment	Annual
71	0.63	$29.22	Designated Person	Establishment	Annual
72	0.63	$20.78	Designated Person	Establishment	Annual
81	0.63	$34.03	Designated Person	Establishment	Annual
92	0.63	$45.69	Designated Person	Establishment	Annual
Annual Supervisor Refresher Training – Designated Person					
11	0.5	$24.92	Designated Person	Establishment	Annual
21	0.5	$41.16	Designated Person	Establishment	Annual
22	0.5	$46.97	Designated Person	Establishment	Annual
23	0.5	$34.26	Designated Person	Establishment	Annual
31-33	0.5	$34.99	Designated Person	Establishment	Annual
42	0.5	$34.39	Designated Person	Establishment	Annual
44-45	0.5	$21.45	Designated Person	Establishment	Annual
48-49	0.5	$30.30	Designated Person	Establishment	Annual
51	0.5	$44.39	Designated Person	Establishment	Annual
52	0.5	$40.49	Designated Person	Establishment	Annual
53	0.5	$29.95	Designated Person	Establishment	Annual
54	0.5	$47.83	Designated Person	Establishment	Annual
55	0.5	$49.31	Designated Person	Establishment	Annual
56	0.5	$27.98	Designated Person	Establishment	Annual
61	0.5	$29.74	Designated Person	Establishment	Annual
62	0.5	$27.96	Designated Person	Establishment	Annual
71	0.5	$23.37	Designated Person	Establishment	Annual

72	0.5	$16.62	Designated Person	Establishment	Annual
81	0.5	$27.23	Designated Person	Establishment	Annual
92	0.5	$36.55	Designated Person	Establishment	Annual
Supplemental Employee Refresher Training – Designated Person					
11	0.75	$37.37	Designated Person	Establishment	Annual
21	0.75	$61.74	Designated Person	Establishment	Annual
22	0.75	$70.46	Designated Person	Establishment	Annual
23	0.75	$51.39	Designated Person	Establishment	Annual
31-33	0.75	$52.48	Designated Person	Establishment	Annual
42	0.75	$51.58	Designated Person	Establishment	Annual
44-45	0.75	$32.17	Designated Person	Establishment	Annual
48-49	0.75	$45.44	Designated Person	Establishment	Annual
51	0.75	$66.58	Designated Person	Establishment	Annual
52	0.75	$60.73	Designated Person	Establishment	Annual
53	0.75	$44.93	Designated Person	Establishment	Annual
54	0.75	$71.75	Designated Person	Establishment	Annual
55	0.75	$73.96	Designated Person	Establishment	Annual
56	0.75	$41.97	Designated Person	Establishment	Annual
61	0.75	$44.61	Designated Person	Establishment	Annual
62	0.75	$41.94	Designated Person	Establishment	Annual
71	0.75	$35.06	Designated Person	Establishment	Annual
72	0.75	$24.93	Designated Person	Establishment	Annual
81	0.75	$40.84	Designated Person	Establishment	Annual
92	0.75	$54.83	Designated Person	Establishment	Annual
Supplemental Employee Refresher Training – At-Risk Worker					
11	0.50	$13.40	At-Risk Worker	Employee	Annual
21	0.50	$23.23	At-Risk Worker	Employee	Annual
22	0.50	$37.77	At-Risk Worker	Employee	Annual
23	0.50	$21.97	At-Risk Worker	Employee	Annual
31-33	0.50	$18.34	At-Risk Worker	Employee	Annual
42	0.50	$21.17	At-Risk Worker	Employee	Annual
44-45	0.50	$13.14	At-Risk Worker	Employee	Annual
48-49	0.50	$16.64	At-Risk Worker	Employee	Annual
51	0.50	$28.77	At-Risk Worker	Employee	Annual
52	0.50	$29.12	At-Risk Worker	Employee	Annual
53	0.50	$18.72	At-Risk Worker	Employee	Annual
54	0.50	$38.17	At-Risk Worker	Employee	Annual
55	0.50	$44.01	At-Risk Worker	Employee	Annual
56	0.50	$13.78	At-Risk Worker	Employee	Annual
61	0.50	$16.34	At-Risk Worker	Employee	Annual
62	0.50	$14.24	At-Risk Worker	Employee	Annual
71	0.50	$12.61	At-Risk Worker	Employee	Annual
72	0.50	$12.06	At-Risk Worker	Employee	Annual
81	0.50	$17.16	At-Risk Worker	Employee	Annual
92	0.50	$25.36	At-Risk Worker	Employee	Annual

Source: OSHA estimate derived from BLS, 2023c; BLS, 2024b; O*NET, 2023; EPA, 2002; and Rice, 2002.

H. Recordkeeping.

The proposed standard would require that indoor work area measurements be retained for 6 months. OSHA assumes that employers would purchase a wireless temperature and humidity data logger described in section VIII.C.IV.C. (with the costs accounted for there) to meet this requirement. Since employers would purchase data loggers that can automatically record the heat index measurements in and around a work site, OSHA assumes employers would incur no additional cost to comply with this recordkeeping requirement.

V. Estimated Total Costs of Compliance.

This section summarizes the estimated total costs of compliance with the proposed standard. The total costs are generally calculated by multiplying the basis for each cost (the number of affected establishments or affected employees as shown in Section VIII.B. Profile of Affected Industries) by the unit costs shown in section VIII.C.IV. Each of these costs are then multiplied by their corresponding non-compliance rates (as shown in section VIII.C.II.A.) to determine total compliance-adjusted costs.

Many costs in this analysis are incurred one time, and most others are either annual or can be annualized based on days of exposure or events that happen multiple times per year. For the purposes of this cost analysis, total costs are annualized based on several assumptions, such as estimates of the number of hours at or above both heat triggers and incidence rates for HRIs and heat-related fatalities (see Section VIII.C.II., Cost Assumptions for additional detail). The exceptions are the identification and evaluation of heat-exposed work areas for indoor work sites and the corresponding employee involvement in that work area evaluation, which are assumed to impact 20 percent of establishments each year. Based on that assumption, OSHA estimates that these costs are both incurred every five years. In order to present compliance costs and benefits estimates on a consistent basis across proposed standard provisions, they are presented as annualized costs.

For each provision described below, this analysis annualizes one-time costs using a 2 percent discount rate over a 10-year period. For the two costs incurred every five years, OSHA calculated the present value of these costs assuming that they would be incurred in the first year and the sixth year after adoption of the proposed standard using a 2 percent discount rate. Using the present value of these costs, OSHA then annualized using a 2 percent discount rate. Annualized one-time and annual costs, plus the annualized period costs, are then summed to estimate total annualized costs.

For each provision in the proposed standard, OSHA also calculated the estimated total annualized undiscounted costs, using the same method as above but assuming a 0 percent discount rate over a 10-year period.

A. Rule Familiarization.

All affected establishments would incur rule familiarization costs. To calculate the total cost of rule familiarization, OSHA multiplies the number of affected establishments from table VIII.B.12. in Section VIII.B., Profile of Affected Industries, by the unit costs presented in table VIII.C.8. As all affected employers incur this cost, no compliance adjustment is necessary. Table VIII.C.21. shows the annualized one-time, annual, and total annualized costs for each of these requirements by industry category, discounted (2 percent over a 10-year period) and undiscounted.

Table VIII.C.21. Total Costs – Rule Familiarization (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Agriculture, Forestry, and Fishing	$527,603	$587,362	$0	$527,603	$587,362
Building Materials and Equipment Suppliers	$104,224	$116,029	$0	$104,224	$116,029
Commercial Kitchens	$846,038	$941,865	$0	$846,038	$941,865
Construction	$5,074,534	$5,649,302	$0	$5,074,534	$5,649,302
Drycleaning and Commercial Laundries	$83,921	$93,426	$0	$83,921	$93,426
Landscaping and Facilities Support	$342,744	$381,565	$0	$342,744	$381,565
Maintenance and Repair	$510,799	$568,655	$0	$510,799	$568,655
Manufacturing	$922,558	$1,027,052	$0	$922,558	$1,027,052
Oil and Gas	$180,543	$200,992	$0	$180,543	$200,992
Postal and Delivery Services	$227,857	$253,665	$0	$227,857	$253,665

Table VIII.C.21. Total Costs – Rule Familiarization (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Recreation and Amusement	$215,821	$240,265	$0	$215,821	$240,265
Sanitation and Waste Removal	$19,362	$21,555	$0	$19,362	$21,555
Telecommunications	$73,042	$81,316	$0	$73,042	$81,316
Temporary Help Services	$40,721	$45,333	$0	$40,721	$45,333
Transportation	$836,631	$931,392	$0	$836,631	$931,392
Utilities	$173,581	$193,241	$0	$173,581	$193,241
Warehousing	$86,490	$96,286	$0	$86,490	$96,286
Non-Core	$5,076,915	$5,651,954	$0	$5,076,915	$5,651,954
Total	**$15,343,382**	**$17,081,254**	**$0**	**$15,343,382**	**$17,081,254**

Source: OSHA estimate.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

B. Heat Injury and Illness Prevention Plan (HIIPP).

All affected establishments would incur costs for developing a HIIPP. For those establishments that already have a HIIPP, they are expected to review their HIIPP and make any modifications necessary to match the requirements outlined in this proposed standard. Section VIII.C.II.A. discusses the percentages of establishments with HIIPPs already in place in certain industries and States.

The proposed standard does not require establishments with ten or less employees to develop their HIIPP in writing. For the purpose of this analysis, OSHA assumed that all affected establishments with ten or less employees would choose to use OSHA's template to guide their development of an unwritten HIIPP. Of the remaining establishments that do not have an existing HIIPP and have more than ten employees, OSHA assumes that, as discussed in section VIII.C.IV.B., 90 percent of these establishments without an existing plan would choose the less burdensome option of using OSHA's template, while the other 10 percent would write their HIIPP from scratch.[77]

[77] The percentage of establishments overall that will choose to write a HIIPP from scratch as reported in section VIII.C.IV.B. is estimated using these assumptions. The percentage of establishments choosing to write the HIIPP from scratch is equal to the estimated percentage of establishments without an existing HIIPP (50 percent) multiplied by the percentage of establishments without a HIIPP that will write from scratch (10 percent), resulting in an estimate of 5 percent.

Affected establishments would have to review and update their HIIPPs annually. The time to perform this requirement (one hour) does not depend on the option that establishments choose when initially developing their HIIPP.

The proposed standard would also require that non-managerial employees be involved in the development, review, and update of the HIIPP. As discussed in section VIII.C.IV.B., OSHA assumed that four employees per establishment would spend one hour providing input on the development of the HIIPP and 20 minutes on the review and update of their establishments' HIIPP. These time estimates are assumed to be the same regardless of the option that the establishment chooses when developing, reviewing, and updating their HIIPP. Table VIII.C.22. shows the annualized one-time, annual, and total annualized costs for each of these requirements by industry category, discounted (2 percent over a 10-year period) and undiscounted.

Table VIII.C.22. Total Costs – Heat Injury and Illness Prevention Plan (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Write HIIPP from Scratch					
Agriculture, Forestry, and Fishing	$571,516	$636,249	$0	$571,516	$636,249
Building Materials and Equipment Suppliers	$79,076	$88,032	$0	$79,076	$88,032
Commercial Kitchens	$687,870	$765,782	$0	$687,870	$765,782
Construction	$736,175	$819,558	$0	$736,175	$819,558
Drycleaning and Commercial Laundries	$34,901	$38,854	$0	$34,901	$38,854
Landscaping and Facilities Support	$147,130	$163,795	$0	$147,130	$163,795
Maintenance and Repair	$149,423	$166,347	$0	$149,423	$166,347
Manufacturing	$316,372	$352,206	$0	$316,372	$352,206
Oil and Gas	$123,156	$137,105	$0	$123,156	$137,105
Postal and Delivery Services	$287,792	$320,388	$0	$287,792	$320,388
Recreation and Amusement	$123,726	$137,740	$0	$123,726	$137,740
Sanitation and Waste Removal	$13,733	$15,288	$0	$13,733	$15,288
Telecommunications	$90,704	$100,978	$0	$90,704	$100,978
Temporary Help Services	$41,207	$45,874	$0	$41,207	$45,874
Transportation	$336,424	$374,530	$0	$336,424	$374,530
Utilities	$196,764	$219,050	$0	$196,764	$219,050
Warehousing	$99,757	$111,055	$0	$99,757	$111,055
Non-Core	$4,758,864	$5,297,878	$0	$4,758,864	$5,297,878
Subtotal	**$8,794,588**	**$9,790,710**	**$0**	**$8,794,588**	**$9,790,710**
Review and Modify HIIPP – Existing Plan in Place					
Agriculture, Forestry, and Fishing	$602,197	$670,405	$0	$602,197	$670,405
Building Materials and Equipment Suppliers	$71,235	$79,303	$0	$71,235	$79,303
Commercial Kitchens	$640,861	$713,448	$0	$640,861	$713,448
Construction	$1,869,454	$2,081,199	$0	$1,869,454	$2,081,199
Drycleaning and Commercial Laundries	$30,363	$33,802	$0	$30,363	$33,802
Landscaping and Facilities Support	$127,030	$141,418	$0	$127,030	$141,418
Maintenance and Repair	$134,784	$150,051	$0	$134,784	$150,051
Manufacturing	$862,318	$959,989	$0	$862,318	$959,989

Table VIII.C.22. Total Costs – Heat Injury and Illness Prevention Plan (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Oil and Gas	$104,531	$116,371	$0	$104,531	$116,371
Postal and Delivery Services	$256,231	$285,253	$0	$256,231	$285,253
Recreation and Amusement	$111,630	$124,274	$0	$111,630	$124,274
Sanitation and Waste Removal	$12,418	$13,825	$0	$12,418	$13,825
Telecommunications	$81,702	$90,956	$0	$81,702	$90,956
Temporary Help Services	$36,857	$41,032	$0	$36,857	$41,032
Transportation	$348,769	$388,272	$0	$348,769	$388,272
Utilities	$172,636	$192,190	$0	$172,636	$192,190
Warehousing	$89,576	$99,722	$0	$89,576	$99,722
Non-Core	$645,831	$718,981	$0	$645,831	$718,981
Subtotal	**$6,198,424**	**$6,900,490**	**$0**	**$6,198,424**	**$6,900,490**
Use HIIPP Template					
Agriculture, Forestry, and Fishing	$1,028,729	$1,145,248	$0	$1,028,729	$1,145,248
Building Materials and Equipment Suppliers	$142,336	$158,458	$0	$142,336	$158,458
Commercial Kitchens	$1,238,166	$1,378,407	$0	$1,238,166	$1,378,407
Construction	$1,325,114	$1,475,204	$0	$1,325,114	$1,475,204
Drycleaning and Commercial Laundries	$62,822	$69,938	$0	$62,822	$69,938
Landscaping and Facilities Support	$264,834	$294,830	$0	$264,834	$294,830
Maintenance and Repair	$268,961	$299,425	$0	$268,961	$299,425
Manufacturing	$569,469	$633,971	$0	$569,469	$633,971
Oil and Gas	$221,681	$246,789	$0	$221,681	$246,789
Postal and Delivery Services	$518,025	$576,699	$0	$518,025	$576,699
Recreation and Amusement	$222,707	$247,932	$0	$222,707	$247,932
Sanitation and Waste Removal	$24,719	$27,519	$0	$24,719	$27,519
Telecommunications	$163,268	$181,761	$0	$163,268	$181,761
Temporary Help Services	$74,172	$82,574	$0	$74,172	$82,574
Transportation	$605,564	$674,153	$0	$605,564	$674,153
Utilities	$354,175	$394,291	$0	$354,175	$394,291
Warehousing	$179,562	$199,900	$0	$179,562	$199,900
Non-Core	$8,565,954	$9,536,180	$0	$8,565,954	$9,536,180
Subtotal	**$15,830,259**	**$17,623,278**	**$0**	**$15,830,259**	**$17,623,278**
No Written HIIPP					
Agriculture, Forestry, and Fishing	$384,875	$428,468	$0	$384,875	$428,468

Table VIII.C.22. Total Costs – Heat Injury and Illness Prevention Plan (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Building Materials and Equipment Suppliers	$197,485	$219,853	$0	$197,485	$219,853
Commercial Kitchens	$1,441,614	$1,604,899	$0	$1,441,614	$1,604,899
Construction	$16,325,441	$18,174,547	$0	$16,325,441	$18,174,547
Drycleaning and Commercial Laundries	$240,566	$267,814	$0	$240,566	$267,814
Landscaping and Facilities Support	$971,555	$1,081,599	$0	$971,555	$1,081,599
Maintenance and Repair	$1,628,310	$1,812,741	$0	$1,628,310	$1,812,741
Manufacturing	$1,888,694	$2,102,618	$0	$1,888,694	$2,102,618
Oil and Gas	$390,715	$434,970	$0	$390,715	$434,970
Postal and Delivery Services	$117,737	$131,073	$0	$117,737	$131,073
Recreation and Amusement	$519,705	$578,570	$0	$519,705	$578,570
Sanitation and Waste Removal	$39,269	$43,717	$0	$39,269	$43,717
Telecommunications	$40,508	$45,096	$0	$40,508	$45,096
Temporary Help Services	$48,969	$54,515	$0	$48,969	$54,515
Transportation	$2,339,927	$2,604,960	$0	$2,339,927	$2,604,960
Utilities	$155,752	$173,394	$0	$155,752	$173,394
Warehousing	$69,627	$77,514	$0	$69,627	$77,514
Non-Core	$12,929,181	$14,393,608	$0	$12,929,181	$14,393,608
Subtotal	**$39,729,931**	**$44,229,952**	**$0**	**$39,729,931**	**$44,229,952**
HIIPP Development Involvement – Employee					
Agriculture, Forestry, and Fishing	$851,195	$947,606	$0	$851,195	$947,606
Building Materials and Equipment Suppliers	$192,469	$214,269	$0	$192,469	$214,269
Commercial Kitchens	$1,817,682	$2,023,562	$0	$1,817,682	$2,023,562
Construction	$9,833,544	$10,947,344	$0	$9,833,544	$10,947,344
Drycleaning and Commercial Laundries	$158,699	$176,674	$0	$158,699	$176,674
Landscaping and Facilities Support	$576,337	$641,616	$0	$576,337	$641,616
Maintenance and Repair	$965,955	$1,075,364	$0	$965,955	$1,075,364
Manufacturing	$1,450,926	$1,615,265	$0	$1,450,926	$1,615,265
Oil and Gas	$304,839	$339,367	$0	$304,839	$339,367
Postal and Delivery Services	$375,365	$417,881	$0	$375,365	$417,881
Recreation and Amusement	$354,289	$394,418	$0	$354,289	$394,418
Sanitation and Waste Removal	$28,608	$31,849	$0	$28,608	$31,849
Telecommunications	$142,022	$158,108	$0	$142,022	$158,108

Table VIII.C.22. Total Costs – Heat Injury and Illness Prevention Plan (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Temporary Help Services	$60,166	$66,981	$0	$60,166	$66,981
Transportation	$1,378,241	$1,534,347	$0	$1,378,241	$1,534,347
Utilities	$418,672	$466,093	$0	$418,672	$466,093
Warehousing	$142,480	$158,618	$0	$142,480	$158,618
Non-Core	$10,068,354	$11,208,749	$0	$10,068,354	$11,208,749
Subtotal	**$29,119,844**	**$32,418,111**	**$0**	**$29,119,844**	**$32,418,111**
Review and Update HIIPP					
Agriculture, Forestry, and Fishing	$0	$0	$2,638,013	$2,638,013	$2,638,013
Building Materials and Equipment Suppliers	$0	$0	$521,118	$521,118	$521,118
Commercial Kitchens	$0	$0	$4,230,189	$4,230,189	$4,230,189
Construction	$0	$0	$25,372,668	$25,372,668	$25,372,668
Drycleaning and Commercial Laundries	$0	$0	$419,603	$419,603	$419,603
Landscaping and Facilities Support	$0	$0	$1,713,720	$1,713,720	$1,713,720
Maintenance and Repair	$0	$0	$2,553,994	$2,553,994	$2,553,994
Manufacturing	$0	$0	$4,612,791	$4,612,791	$4,612,791
Oil and Gas	$0	$0	$902,716	$902,716	$902,716
Postal and Delivery Services	$0	$0	$1,139,285	$1,139,285	$1,139,285
Recreation and Amusement	$0	$0	$1,079,103	$1,079,103	$1,079,103
Sanitation and Waste Removal	$0	$0	$96,811	$96,811	$96,811
Telecommunications	$0	$0	$365,212	$365,212	$365,212
Temporary Help Services	$0	$0	$203,603	$203,603	$203,603
Transportation	$0	$0	$4,183,154	$4,183,154	$4,183,154
Utilities	$0	$0	$867,903	$867,903	$867,903
Warehousing	$0	$0	$432,448	$432,448	$432,448
Non-Core	$0	$0	$25,384,577	$25,384,577	$25,384,577
Subtotal	$0	**$0**	**$76,716,909**	**$76,716,909**	**$76,716,909**
HIIPP Review and Update Involvement – Employee					
Agriculture, Forestry, and Fishing	$0	$0	$2,837,318	$2,837,318	$2,837,318
Building Materials and Equipment Suppliers	$0	$0	$641,563	$641,563	$641,563
Commercial Kitchens	$0	$0	$6,058,940	$6,058,940	$6,058,940
Construction	$0	$0	$32,778,482	$32,778,482	$32,778,482
Drycleaning and Commercial Laundries	$0	$0	$528,998	$528,998	$528,998

Table VIII.C.22. Total Costs – Heat Injury and Illness Prevention Plan (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Landscaping and Facilities Support	$0	$0	$1,921,123	$1,921,123	$1,921,123
Maintenance and Repair	$0	$0	$3,219,849	$3,219,849	$3,219,849
Manufacturing	$0	$0	$4,836,419	$4,836,419	$4,836,419
Oil and Gas	$0	$0	$1,016,130	$1,016,130	$1,016,130
Postal and Delivery Services	$0	$0	$1,251,217	$1,251,217	$1,251,217
Recreation and Amusement	$0	$0	$1,180,963	$1,180,963	$1,180,963
Sanitation and Waste Removal	$0	$0	$95,362	$95,362	$95,362
Telecommunications	$0	$0	$473,407	$473,407	$473,407
Temporary Help Services	$0	$0	$200,554	$200,554	$200,554
Transportation	$0	$0	$4,594,136	$4,594,136	$4,594,136
Utilities	$0	$0	$1,395,573	$1,395,573	$1,395,573
Warehousing	$0	$0	$474,934	$474,934	$474,934
Non-Core	$0	$0	$33,561,180	$33,561,180	$33,561,180
Subtotal	**$0**	**$0**	**$97,066,147**	**$97,066,147**	**$97,066,147**
Total					
Agriculture, Forestry, and Fishing	$3,438,511	$3,827,975	$5,475,331	$8,913,842	$9,303,306
Building Materials and Equipment Suppliers	$682,600	$759,915	$1,162,682	$1,845,282	$1,922,597
Commercial Kitchens	$5,826,193	$6,486,098	$10,289,129	$16,115,322	$16,775,228
Construction	$30,089,729	$33,497,850	$58,151,149	$88,240,878	$91,649,000
Drycleaning and Commercial Laundries	$527,352	$587,083	$948,600	$1,475,952	$1,535,683
Landscaping and Facilities Support	$2,086,886	$2,323,258	$3,634,843	$5,721,729	$5,958,101
Maintenance and Repair	$3,147,433	$3,503,928	$5,773,844	$8,921,277	$9,277,772
Manufacturing	$5,087,780	$5,664,048	$9,449,210	$14,536,989	$15,113,258
Oil and Gas	$1,144,922	$1,274,601	$1,918,846	$3,063,767	$3,193,447
Postal and Delivery Services	$1,555,149	$1,731,294	$2,390,502	$3,945,651	$4,121,796
Recreation and Amusement	$1,332,058	$1,482,934	$2,260,066	$3,592,124	$3,743,000
Sanitation and Waste Removal	$118,748	$132,198	$192,173	$310,921	$324,371
Telecommunications	$518,204	$576,898	$838,619	$1,356,823	$1,415,518
Temporary Help Services	$261,372	$290,976	$404,158	$665,530	$695,134
Transportation	$5,008,925	$5,576,262	$8,777,289	$13,786,214	$14,353,551
Utilities	$1,297,999	$1,445,017	$2,263,476	$3,561,475	$3,708,493
Warehousing	$581,002	$646,809	$907,382	$1,488,384	$1,554,191
Non-Core	$36,968,184	$41,155,395	$58,945,757	$95,913,940	$100,101,152

Table VIII.C.22. Total Costs – Heat Injury and Illness Prevention Plan (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Total	**$99,673,046**	**$110,962,542**	**$173,783,056**	**$273,456,102**	**$284,745,597**

Source: OSHA estimate.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

C. Identifying Heat Hazards.

Establishments would be expected to monitor environmental conditions in and around work areas under the proposed standard for both indoor and outdoor work sites. As outlined in section VIII.C.IV.C., establishments with outdoor work sites could track local forecasts to meet this requirement, while establishments with indoor work sites are assumed to use temperature and data loggers to monitor environmental conditions. For this analysis, OSHA assumes one work area per establishment. OSHA estimates the number of establishments with outdoor and indoor work areas by estimating the percentage of employees in each industry that are estimated as indoor and outdoor employees affected by the proposed standard. OSHA multiplies the total number of affected establishments by the percentages of indoor and outdoor employees to determine the number of indoor and outdoor establishments and then multiplies these counts of indoor and outdoor establishments by their respective unit costs for indoor and outdoor environmental monitoring (with the unit costs for outdoor establishments being lower than for indoor establishments).

Indoor establishments would also need to identify work areas that pose heat-related risks to employees. OSHA assumes that 20 percent of establishments will need to reevaluate work areas due to changes to work processes that may result in increased heat-related exposure for employees every year. OSHA therefore has estimated that this indoor work area evaluation would be incurred every five years at each establishment. Similar to the development and review of the HIIPP, the proposed standard would require employee involvement in these work-area evaluations. OSHA again assumes that four employees per establishment would make up a representative sample of employees that could provide input. Since these work-area evaluations are expected to occur every five years, OSHA assumed that the cost for these work-area evaluations would occur in the first and sixth years after the proposed standard's implementation. OSHA determined the

present value of these costs using a 2 percent discount rate. Once adjusted for compliance, OSHA annualized the present value of these costs for inclusion in the total annualized costs for this provision.

Table VIII.C.23. shows the annualized costs for each of these requirements by industry category, discounted (2 percent over a 10-year period) and undiscounted.

Table VIII.C.23. Total Costs – Identifying Heat Hazards (2023$)

Industry Category	One-Time Annualized		Periodic Costs Annualized		Annual	Total Annualized	
	0%	2%	0%	2%		0%	2%
Outdoor Environmental Monitoring							
Agriculture, Forestry, and Fishing	$0	$0	$0	$0	$1,375,617	$1,375,617	$1,375,617
Building Materials and Equipment Suppliers	$0	$0	$0	$0	$158,176	$158,176	$158,176
Commercial Kitchens	$0	$0	$0	$0	$281,211	$281,211	$281,211
Construction	$0	$0	$0	$0	$10,052,936	$10,052,936	$10,052,936
Drycleaning and Commercial Laundries	$0	$0	$0	$0	$80,978	$80,978	$80,978
Landscaping and Facilities Support	$0	$0	$0	$0	$1,064,766	$1,064,766	$1,064,766
Maintenance and Repair	$0	$0	$0	$0	$899,249	$899,249	$899,249
Manufacturing	$0	$0	$0	$0	$531,117	$531,117	$531,117
Oil and Gas	$0	$0	$0	$0	$496,105	$496,105	$496,105
Postal and Delivery Services	$0	$0	$0	$0	$437,122	$437,122	$437,122
Recreation and Amusement	$0	$0	$0	$0	$485,898	$485,898	$485,898
Sanitation and Waste Removal	$0	$0	$0	$0	$40,070	$40,070	$40,070
Telecommunications	$0	$0	$0	$0	$156,702	$156,702	$156,702
Temporary Help Services	$0	$0	$0	$0	$53,412	$53,412	$53,412
Transportation	$0	$0	$0	$0	$1,701,945	$1,701,945	$1,701,945
Utilities	$0	$0	$0	$0	$404,225	$404,225	$404,225
Warehousing	$0	$0	$0	$0	$99,663	$99,663	$99,663
Non-Core	$0	$0	$0	$0	$8,653,930	$8,653,930	$8,653,930
Subtotal	$0	**$0**	$0	**$0**	**$26,973,121**	**$26,973,121**	**$26,973,121**
Indoor Environmental Monitoring							
Agriculture, Forestry, and Fishing	$0	$0	$0	$0	$5,185,108	$5,185,108	$5,185,108
Building Materials and Equipment Suppliers	$0	$0	$0	$0	$2,683,488	$2,683,488	$2,683,488
Commercial Kitchens	$0	$0	$0	$0	$30,781,175	$30,781,175	$30,781,175
Construction	$0	$0	$0	$0	$22,515,231	$22,515,231	$22,515,231
Drycleaning and Commercial Laundries	$0	$0	$0	$0	$2,699,251	$2,699,251	$2,699,251
Landscaping and Facilities Support	$0	$0	$0	$0	$4,713,180	$4,713,180	$4,713,180
Maintenance and Repair	$0	$0	$0	$0	$11,923,927	$11,923,927	$11,923,927
Manufacturing	$0	$0	$0	$0	$10,319,923	$10,319,923	$10,319,923
Oil and Gas	$0	$0	$0	$0	$2,870,853	$2,870,853	$2,870,853
Postal and Delivery Services	$0	$0	$0	$0	$4,943,180	$4,943,180	$4,943,180
Recreation and Amusement	$0	$0	$0	$0	$3,895,764	$3,895,764	$3,895,764
Sanitation and Waste Removal	$0	$0	$0	$0	$386,155	$386,155	$386,155
Telecommunications	$0	$0	$0	$0	$1,423,714	$1,423,714	$1,423,714
Temporary Help Services	$0	$0	$0	$0	$1,134,702	$1,134,702	$1,134,702

Table VIII.C.23. Total Costs – Identifying Heat Hazards (2023$)

Industry Category	One-Time Annualized		Periodic Costs Annualized		Annual	Total Annualized	
	0%	2%	0%	2%		0%	2%
Transportation	$0	$0	$0	$0	$14,040,680	$14,040,680	$14,040,680
Utilities	$0	$0	$0	$0	$3,101,788	$3,101,788	$3,101,788
Warehousing	$0	$0	$0	$0	$2,565,146	$2,565,146	$2,565,146
Non-Core	$0	$0	$0	$0	$215,676,858	$215,676,858	$215,676,858
Subtotal	**$0**	**$0**	**$0**	**$0**	**$340,860,123**	**$340,860,123**	**$340,860,123**
Indoor Identification of Heat-Exposed Work Areas							
Agriculture, Forestry, and Fishing	$0	$0	$434,176	$451,540	$0	$434,176	$451,540
Building Materials and Equipment Suppliers	$0	$0	$196,825	$204,696	$0	$196,825	$204,696
Commercial Kitchens	$0	$0	$2,237,077	$2,326,542	$0	$2,237,077	$2,326,542
Construction	$0	$0	$969,517	$1,008,290	$0	$969,517	$1,008,290
Drycleaning and Commercial Laundries	$0	$0	$193,662	$201,407	$0	$193,662	$201,407
Landscaping and Facilities Support	$0	$0	$339,167	$352,731	$0	$339,167	$352,731
Maintenance and Repair	$0	$0	$873,563	$908,498	$0	$873,563	$908,498
Manufacturing	$0	$0	$352,835	$366,946	$0	$352,835	$366,946
Oil and Gas	$0	$0	$201,310	$209,361	$0	$201,310	$209,361
Postal and Delivery Services	$0	$0	$362,718	$377,224	$0	$362,718	$377,224
Recreation and Amusement	$0	$0	$288,093	$299,614	$0	$288,093	$299,614
Sanitation and Waste Removal	$0	$0	$28,493	$29,633	$0	$28,493	$29,633
Telecommunications	$0	$0	$104,314	$108,485	$0	$104,314	$108,485
Temporary Help Services	$0	$0	$83,063	$86,385	$0	$83,063	$86,385
Transportation	$0	$0	$1,134,479	$1,179,850	$0	$1,134,479	$1,179,850
Utilities	$0	$0	$167,121	$173,804	$0	$167,121	$173,804
Warehousing	$0	$0	$186,866	$194,339	$0	$186,866	$194,339
Non-Core	$0	$0	$15,801,702	$16,433,646	$0	$15,801,702	$16,433,646
Subtotal	**$0**	**$0**	**$23,954,982**	**$24,912,993**	**$0**	**$23,954,982**	**$24,912,993**
Work Area Evaluation – Employee							
Agriculture, Forestry, and Fishing	$0	$0	$116,745	$121,414	$0	$116,745	$121,414
Building Materials and Equipment Suppliers	$0	$0	$60,542	$62,963	$0	$60,542	$62,963
Commercial Kitchens	$0	$0	$834,492	$867,865	$0	$834,492	$867,865
Construction	$0	$0	$1,674,440	$1,741,404	$0	$1,674,440	$1,741,404
Drycleaning and Commercial Laundries	$0	$0	$61,038	$63,479	$0	$61,038	$63,479
Landscaping and Facilities Support	$0	$0	$95,514	$99,334	$0	$95,514	$99,334
Maintenance and Repair	$0	$0	$275,328	$286,338	$0	$275,328	$286,338
Manufacturing	$0	$0	$601,334	$625,383	$0	$601,334	$625,383
Oil and Gas	$0	$0	$56,627	$58,892	$0	$56,627	$58,892

Table VIII.C.23. Total Costs – Identifying Heat Hazards (2023$)

Industry Category	One-Time Annualized		Periodic Costs Annualized		Annual	Total Annualized	
	0%	2%	0%	2%		0%	2%
Postal and Delivery Services	$0	$0	$99,588	$103,571	$0	$99,588	$103,571
Recreation and Amusement	$0	$0	$78,775	$81,925	$0	$78,775	$81,925
Sanitation and Waste Removal	$0	$0	$7,017	$7,297	$0	$7,017	$7,297
Telecommunications	$0	$0	$33,804	$35,156	$0	$33,804	$35,156
Temporary Help Services	$0	$0	$20,455	$21,273	$0	$20,455	$21,273
Transportation	$0	$0	$311,485	$323,942	$0	$311,485	$323,942
Utilities	$0	$0	$90,893	$94,528	$0	$90,893	$94,528
Warehousing	$0	$0	$51,306	$53,358	$0	$51,306	$53,358
Non-Core	$0	$0	$2,926,926	$3,043,980	$0	$2,926,926	$3,043,980
Subtotal	**$0**	**$0**	**$7,396,309**	**$7,692,103**	**$0**	**$7,396,309**	**$7,692,103**
Monitoring Equipment – Indoor							
Agriculture, Forestry, and Fishing	$118,862	$132,325	$0	$0	$0	$118,862	$132,325
Building Materials and Equipment Suppliers	$57,453	$63,961	$0	$0	$0	$57,453	$63,961
Commercial Kitchens	$1,048,813	$1,167,608	$0	$0	$0	$1,048,813	$1,167,608
Construction	$362,081	$403,092	$0	$0	$0	$362,081	$403,092
Drycleaning and Commercial Laundries	$56,623	$63,037	$0	$0	$0	$56,623	$63,037
Landscaping and Facilities Support	$97,542	$108,590	$0	$0	$0	$97,542	$108,590
Maintenance and Repair	$250,133	$278,465	$0	$0	$0	$250,133	$278,465
Manufacturing	$168,477	$187,560	$0	$0	$0	$168,477	$187,560
Oil and Gas	$41,489	$46,189	$0	$0	$0	$41,489	$46,189
Postal and Delivery Services	$93,192	$103,747	$0	$0	$0	$93,192	$103,747
Recreation and Amusement	$96,716	$107,670	$0	$0	$0	$96,716	$107,670
Sanitation and Waste Removal	$7,882	$8,774	$0	$0	$0	$7,882	$8,774
Telecommunications	$18,319	$20,394	$0	$0	$0	$18,319	$20,394
Temporary Help Services	$23,160	$25,783	$0	$0	$0	$23,160	$25,783
Transportation	$264,703	$294,685	$0	$0	$0	$264,703	$294,685
Utilities	$37,716	$41,988	$0	$0	$0	$37,716	$41,988
Warehousing	$48,360	$53,837	$0	$0	$0	$48,360	$53,837
Non-Core	$4,048,215	$4,506,737	$0	$0	$0	$4,048,215	$4,506,737
Subtotal	**$6,839,737**	**$7,614,442**	**$0**	**$0**	**$0**	**$6,839,737**	**$7,614,442**
Review Monitoring Equipment User Manual – Indoor							
Agriculture, Forestry, and Fishing	$5,992	$6,671	$0	$0	$0	$5,992	$6,671
Building Materials and Equipment Suppliers	$3,096	$3,447	$0	$0	$0	$3,096	$3,447
Commercial Kitchens	$36,379	$40,499	$0	$0	$0	$36,379	$40,499
Construction	$60,102	$66,909	$0	$0	$0	$60,102	$66,909

Table VIII.C.23. Total Costs – Identifying Heat Hazards (2023$)

Industry Category	One-Time Annualized		Periodic Costs Annualized		Annual	Total Annualized	
	0%	2%	0%	2%		0%	2%
Drycleaning and Commercial Laundries	$3,115	$3,467	$0	$0	$0	$3,115	$3,467
Landscaping and Facilities Support	$5,921	$6,592	$0	$0	$0	$5,921	$6,592
Maintenance and Repair	$13,758	$15,317	$0	$0	$0	$13,758	$15,317
Manufacturing	$29,769	$33,141	$0	$0	$0	$29,769	$33,141
Oil and Gas	$3,383	$3,766	$0	$0	$0	$3,383	$3,766
Postal and Delivery Services	$5,704	$6,350	$0	$0	$0	$5,704	$6,350
Recreation and Amusement	$4,495	$5,004	$0	$0	$0	$4,495	$5,004
Sanitation and Waste Removal	$446	$496	$0	$0	$0	$446	$496
Telecommunications	$1,643	$1,829	$0	$0	$0	$1,643	$1,829
Temporary Help Services	$1,309	$1,458	$0	$0	$0	$1,309	$1,458
Transportation	$16,201	$18,036	$0	$0	$0	$16,201	$18,036
Utilities	$3,579	$3,984	$0	$0	$0	$3,579	$3,984
Warehousing	$2,960	$3,295	$0	$0	$0	$2,960	$3,295
Non-Core	$139,235	$155,005	$0	$0	$0	$139,235	$155,005
Subtotal	**$337,086**	**$375,266**	**$0**	**$0**	**$0**	**$337,086**	**$375,266**
Total							
Agriculture, Forestry, and Fishing	$124,854	$138,996	$550,921	$572,954	$6,560,724	$7,236,500	$7,272,674
Building Materials and Equipment Suppliers	$60,550	$67,408	$257,367	$267,659	$2,841,664	$3,159,581	$3,176,732
Commercial Kitchens	$1,085,192	$1,208,107	$3,071,569	$3,194,407	$31,062,385	$35,219,146	$35,464,900
Construction	$422,183	$470,002	$2,643,957	$2,749,695	$32,568,167	$35,634,308	$35,787,864
Drycleaning and Commercial Laundries	$59,738	$66,504	$254,700	$264,886	$2,780,229	$3,094,667	$3,111,620
Landscaping and Facilities Support	$103,463	$115,182	$434,682	$452,065	$5,777,946	$6,316,091	$6,345,193
Maintenance and Repair	$263,892	$293,782	$1,148,890	$1,194,837	$12,823,176	$14,235,958	$14,311,794
Manufacturing	$198,246	$220,701	$954,170	$992,329	$10,851,040	$12,003,456	$12,064,070
Oil and Gas	$44,873	$49,955	$257,938	$268,253	$3,366,958	$3,669,768	$3,685,166
Postal and Delivery Services	$98,895	$110,097	$462,306	$480,795	$5,380,302	$5,941,504	$5,971,194
Recreation and Amusement	$101,211	$112,674	$366,868	$381,540	$4,381,662	$4,849,741	$4,875,876
Sanitation and Waste Removal	$8,327	$9,270	$35,510	$36,930	$426,225	$470,062	$472,425
Telecommunications	$19,962	$22,223	$138,118	$143,641	$1,580,416	$1,738,495	$1,746,280
Temporary Help Services	$24,469	$27,241	$103,518	$107,658	$1,188,114	$1,316,102	$1,323,013
Transportation	$280,904	$312,721	$1,445,964	$1,503,791	$15,742,625	$17,469,493	$17,559,137
Utilities	$41,295	$45,972	$258,014	$268,332	$3,506,013	$3,805,322	$3,820,318
Warehousing	$51,319	$57,132	$238,172	$247,697	$2,664,809	$2,954,301	$2,969,638
Non-Core	$4,187,450	$4,661,742	$18,728,628	$19,477,626	$224,330,788	$247,246,865	$248,470,156
Total	**$7,176,823**	**$7,989,707**	**$31,351,291**	**$32,605,096**	**$367,833,244**	**$406,361,358**	**$408,428,047**

Table VIII.C.23. Total Costs – Identifying Heat Hazards (2023$)

Industry Category	One-Time Annualized		Periodic Costs Annualized		Annual	Total Annualized	
	0%	2%	0%	2%		0%	2%

Source: OSHA estimate.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

D. Requirements at or Above the Initial Heat Trigger.

I. Drinking Water.

All affected establishments would be required to provide sufficiently cool water to their affected employees. In order to meet this requirement, OSHA assumes that establishments would purchase one 40-quart cooler for every 40 employees. These establishments would also purchase reusable water bottles for each affected employee.

II. Break Area(s) at Outdoor Work Sites.

All affected establishments would also have to provide break areas for affected employees. At establishments with outdoor work sites, OSHA assumes that each establishment would purchase a twelve-by-twelve-foot tent as a means of providing artificial shade. OSHA assumes that establishments would incur this cost one time.

III. Break Area(s) and Work Area(s) at Indoor Work Sites.

Establishments with indoor work sites would purchase one industrial pedestal fan and one dehumidifier that provide sufficient air movement and humidity control in break areas for every 10 employees. Establishments with indoor work sites would also have to purchase these same control measures for work areas for every 10 employees. However, OSHA does not capture a cost for dehumidifiers for establishments with indoor work sites in the four least humid States in the U.S. (Arizona, Nevada, New Mexico, and Utah).

IV. Acclimatization.

Both new and returning employees would undergo acclimatization during their first week of work when the initial heat trigger is met or exceeded during that first week. To calculate acclimatization costs, OSHA multiplied the unit costs for acclimatization shown in section VIII.C.IV.D.IV., by the number of new employees and by the number of returning employees. OSHA calculates the number of new employees using BLS' Job Openings and Labor Turnover Survey (JOLTS) (BLS JOLTS, 2024). OSHA used the

JOLTS hire rates from June through August for 2023 by sector to represent the percentage of employees that are new and join their respective employers when the initial heat trigger is met or exceeded. OSHA lacks data that would allow further refinement of this estimate. Calculating the number of new employees based on those hired in June through August may not accurately represent the universe of employees who will need acclimatization. This assumption may underestimate the number of newly hired employees in areas where the heat season is longer but might overestimate the number in areas where the weather is cooler for more of the year. OSHA also heard from Small Entity Representatives during the SBAR Panel process that they purposefully avoid hiring new employees during times when temperatures are high in order to avoid the difficulties and costs of acclimatization. Therefore, again, using the JOLTS data for this timeframe may overstate the number of employees who will need acclimatization. OSHA also applies this assumption to employees working indoors in settings without adequate climate control but, as discussed above in section VIII.C.II.C., acknowledges that this assumption that outdoor heat translates to indoor heat may over- or understate the temperatures indoors. The agency welcomes comment on this estimate as well as data that would allow this parameter to be better estimated.

To calculate the number of returning employees, OSHA assumed that two percent of all employees not newly hired would qualify as returning employees (i.e., those returning to work from an absence of more than 14 days during a time when the initial or high heat trigger are met). OSHA welcomes comment on this estimate and information or data sources that might better allow the agency to identify employees returning from absences of more than 14 days. Next, OSHA multiplied the two percent by one minus the annual hire rate according to the JOLTS data by sector. OSHA then multiplied this product by the ratio of the summer hire rate to annual hire rate to arrive at the percentage

of employees returning to work when the initial heat trigger is met or exceeded during their first week back.

V. Rest Breaks if Needed.

To calculate the cost for if-needed rest breaks when the initial heat trigger is met or exceeded, OSHA first calculated the number of rest breaks that affected employees would be expected to take annually. OSHA used the number of work hours in a given State for each work shift type (daytime, evening, and overnight) that met or exceeded the initial heat trigger but did not meet or exceed the high heat trigger. The estimated number of hours was then normalized to 8-hour work shift equivalents by dividing the number of hours meeting or exceeding the initial heat trigger (but not meeting the high heat trigger) by eight.[78] OSHA then multiplied these 8-hour work shift equivalents, the number of affected employees, and the corresponding unit costs for rest breaks for indoor and outdoor employees as shown in section VIII.C.IV.D.V. to determine total costs for rest breaks at the initial heat trigger.

As discussed in section VIII.C.IV.D.V. and detailed further in appendix A at the end of this section, OSHA estimates that under the proposed standard, the reduction in time spent on pacing (i.e., the increase in worker efficiency) will partially offset the added cost of time spent on if-needed rest breaks when the initial heat trigger is met or exceeded for employees in Group 1 (i.e., currently noncompliant with if-needed rest breaks as well as scheduled rest breaks), by 20 percent and 23.33 percent for outdoor and indoor employees, respectively. Combining this estimated partial offset of the unit cost of if-needed rest breaks as required by the proposed standard with data on the industry-level

[78] By assuming full, 8-hour work shifts at or above the heat trigger(s), this methodology may overstate the number of breaks employers need to provide since there may be some days where the heat triggers are met or exceeded but for shorter periods of time. For example, if the high heat trigger is met or exceeded for less than two hours, the requirement to provide a scheduled rest break would not be triggered. Additionally, employees exposed to heat at or above the initial heat trigger for shorter periods of time are likely to need fewer if-needed rest breaks. A scheduled lunch break in the middle of the day may also be sufficient to satisfy the break requirement on days when the high heat trigger is met for only a portion of the day. OSHA welcomes comment on this methodology and recommendations on alternative approaches.

and/or State-level number of in-scope employees (discussed in Section VIII.B., Profile of Affected Industries), baseline non-compliance rates (discussed in section VIII.C.II.A.), and State-level exposure to heat at or above the initial heat trigger (discussed in section VIII.C.II.C.), OSHA estimates that approximately 21.78 percent of the total cost of compliance with if-needed rest breaks when the initial heat trigger is met or exceeded (approximately $0.0875 billion out of $0.402 billion) could be offset by avoided labor productivity losses due to pacing (i.e., avoided losses in worker efficiency).

VI. Effective Communication.

Employers would also be required to effectively communicate with affected employees when the initial heat trigger is met or exceeded. OSHA first calculated the number of times a designated person would have to perform this duty by estimating the number of hours annually that meet or exceed the initial heat trigger for each State. OSHA then normalized these estimates to reflect 8-hour work shift equivalents. These 8-hour work shift equivalents are then multiplied by the number of affected employees and the unit costs as shown in Section VIII.C.IV.D.VI., Effective Communication, of 15 seconds every two hours of both a designated person's and at-risk employee's time.

Table VIII.C.24. shows the annualized one-time, annual, and total annualized costs for each of these requirements by industry category and region, discounted (2 percent over a 10-year period) and undiscounted.

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Coolers with Spigot						
Agriculture, Forestry, and Fishing						
Alaskan	$15	$16	$0	$0	$15	$16
Central	$1,822	$2,028	$0	$0	$1,822	$2,028
Eastern	$1,294	$1,441	$0	$0	$1,294	$1,441
Pacific	$13	$15	$0	$0	$13	$15
Southern	$1,941	$2,161	$0	$0	$1,941	$2,161
Western	$447	$498	$0	$0	$447	$498
Subtotal	**$5,532**	**$6,158**	**$0**	**$0**	**$5,532**	**$6,158**
Building Materials and Equipment Suppliers						
Alaskan	$23	$25	$0	$0	$23	$25
Central	$2,115	$2,355	$0	$0	$2,115	$2,355
Eastern	$2,627	$2,925	$0	$0	$2,627	$2,925
Pacific	$41	$45	$0	$0	$41	$45
Southern	$2,456	$2,734	$0	$0	$2,456	$2,734
Western	$1,497	$1,667	$0	$0	$1,497	$1,667
Subtotal	**$8,759**	**$9,751**	**$0**	**$0**	**$8,759**	**$9,751**
Commercial Kitchens						
Alaskan	$125	$140	$0	$0	$125	$140
Central	$14,789	$16,465	$0	$0	$14,789	$16,465
Eastern	$22,011	$24,504	$0	$0	$22,011	$24,504
Pacific	$476	$530	$0	$0	$476	$530
Southern	$19,755	$21,993	$0	$0	$19,755	$21,993
Western	$12,343	$13,741	$0	$0	$12,343	$13,741
Subtotal	$0	**$77,372**	**$0**	**$0**	**$69,500**	**$77,372**
Construction						
Alaskan	$235	$262	$0	$0	$235	$262
Central	$17,355	$19,321	$0	$0	$17,355	$19,321
Eastern	$25,296	$28,161	$0	$0	$25,296	$28,161
Pacific	$499	$556	$0	$0	$499	$556
Southern	$65,874	$73,335	$0	$0	$65,874	$73,335
Western	$18,599	$20,706	$0	$0	$18,599	$20,706
Subtotal	**$127,859**	**$142,341**	**$0**	**$0**	**$127,859**	**$142,341**
Drycleaning and Commercial Laundries						
Alaskan	$2	$3	$0	$0	$2	$3
Central	$277	$309	$0	$0	$277	$309

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$508	$566	$0	$0	$508	$566
Pacific	$11	$12	$0	$0	$11	$12
Southern	$401	$446	$0	$0	$401	$446
Western	$249	$277	$0	$0	$249	$277
Subtotal	**$1,448**	**$1,612**	**$0**	**$0**	**$1,448**	**$1,612**
Landscaping and Facilities Support						
Alaskan	$87	$96	$0	$0	$87	$96
Central	$5,475	$6,095	$0	$0	$5,475	$6,095
Eastern	$8,862	$9,865	$0	$0	$8,862	$9,865
Pacific	$171	$191	$0	$0	$171	$191
Southern	$7,341	$8,173	$0	$0	$7,341	$8,173
Western	$20,404	$22,716	$0	$0	$20,404	$22,716
Subtotal	**$42,340**	**$47,136**	**$0**	**$0**	**$42,340**	**$47,136**
Maintenance and Repair						
Alaskan	$26	$29	$0	$0	$26	$29
Central	$2,866	$3,190	$0	$0	$2,866	$3,190
Eastern	$3,702	$4,121	$0	$0	$3,702	$4,121
Pacific	$45	$50	$0	$0	$45	$50
Southern	$3,449	$3,839	$0	$0	$3,449	$3,839
Western	$2,148	$2,391	$0	$0	$2,148	$2,391
Subtotal	**$12,235**	**$13,621**	**$0**	**$0**	**$12,235**	**$13,621**
Manufacturing						
Alaskan	$70	$78	$0	$0	$70	$78
Central	$22,988	$25,592	$0	$0	$22,988	$25,592
Eastern	$21,278	$23,688	$0	$0	$21,278	$23,688
Pacific	$65	$72	$0	$0	$65	$72
Southern	$17,040	$18,970	$0	$0	$17,040	$18,970
Western	$11,035	$12,284	$0	$0	$11,035	$12,284
Subtotal	**$72,475**	**$80,684**	**$0**	**$0**	**$72,475**	**$80,684**
Oil and Gas						
Alaskan	$76	$85	$0	$0	$76	$85
Central	$554	$617	$0	$0	$554	$617
Eastern	$362	$403	$0	$0	$362	$403
Southern	$3,468	$3,861	$0	$0	$3,468	$3,861
Western	$725	$807	$0	$0	$725	$807
Subtotal	**$5,185**	**$5,772**	**$0**	**$0**	**$5,185**	**$5,772**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Postal and Delivery Services						
Alaskan	$5	$6	$0	$0	$5	$6
Central	$974	$1,084	$0	$0	$974	$1,084
Eastern	$1,556	$1,732	$0	$0	$1,556	$1,732
Pacific	$16	$17	$0	$0	$16	$17
Southern	$1,104	$1,229	$0	$0	$1,104	$1,229
Western	$776	$864	$0	$0	$776	$864
Subtotal	**$4,431**	**$4,933**	**$0**	**$0**	**$4,431**	**$4,933**
Recreation and Amusement						
Alaskan	$23	$26	$0	$0	$23	$26
Central	$2,358	$2,625	$0	$0	$2,358	$2,625
Eastern	$3,928	$4,373	$0	$0	$3,928	$4,373
Pacific	$51	$57	$0	$0	$51	$57
Southern	$3,076	$3,425	$0	$0	$3,076	$3,425
Western	$2,314	$2,576	$0	$0	$2,314	$2,576
Subtotal	**$11,750**	**$13,081**	**$0**	**$0**	**$11,750**	**$13,081**
Sanitation and Waste Removal						
Alaskan	$14	$15	$0	$0	$14	$15
Central	$427	$476	$0	$0	$427	$476
Eastern	$723	$805	$0	$0	$723	$805
Pacific	$13	$14	$0	$0	$13	$14
Southern	$577	$642	$0	$0	$577	$642
Western	$347	$386	$0	$0	$347	$386
Subtotal	**$2,101**	**$2,339**	**$0**	**$0**	**$2,101**	**$2,339**
Telecommunications						
Alaskan	$12	$14	$0	$0	$12	$14
Central	$641	$713	$0	$0	$641	$713
Eastern	$973	$1,083	$0	$0	$973	$1,083
Pacific	$12	$13	$0	$0	$12	$13
Southern	$884	$984	$0	$0	$884	$984
Western	$453	$505	$0	$0	$453	$505
Subtotal	**$2,975**	**$3,312**	**$0**	**$0**	**$2,975**	**$3,312**
Temporary Help Services						
Alaskan	$7	$8	$0	$0	$7	$8
Central	$6,812	$7,583	$0	$0	$6,812	$7,583
Eastern	$8,706	$9,692	$0	$0	$8,706	$9,692

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$204	$228	$0	$0	$204	$228
Southern	$14,093	$15,689	$0	$0	$14,093	$15,689
Western	$7,054	$7,853	$0	$0	$7,054	$7,853
Subtotal	**$36,877**	**$41,053**	**$0**	**$0**	**$36,877**	**$41,053**
Transportation						
Alaskan	$99	$110	$0	$0	$99	$110
Central	$4,282	$4,768	$0	$0	$4,282	$4,768
Eastern	$4,364	$4,859	$0	$0	$4,364	$4,859
Pacific	$147	$163	$0	$0	$147	$163
Southern	$5,809	$6,467	$0	$0	$5,809	$6,467
Western	$1,895	$2,110	$0	$0	$1,895	$2,110
Subtotal	**$16,597**	**$18,477**	**$0**	**$0**	**$16,597**	**$18,477**
Utilities						
Alaskan	$16	$18	$0	$0	$16	$18
Central	$1,233	$1,373	$0	$0	$1,233	$1,373
Eastern	$1,725	$1,921	$0	$0	$1,725	$1,921
Pacific	$7	$7	$0	$0	$7	$7
Southern	$1,477	$1,644	$0	$0	$1,477	$1,644
Western	$683	$760	$0	$0	$683	$760
Subtotal	**$5,141**	**$5,723**	**$0**	**$0**	**$5,141**	**$5,723**
Warehousing						
Alaskan	$3	$3	$0	$0	$3	$3
Central	$1,489	$1,658	$0	$0	$1,489	$1,658
Eastern	$2,181	$2,428	$0	$0	$2,181	$2,428
Pacific	$9	$10	$0	$0	$9	$10
Southern	$1,846	$2,055	$0	$0	$1,846	$2,055
Western	$1,211	$1,348	$0	$0	$1,211	$1,348
Subtotal	**$6,738**	**$7,502**	**$0**	**$0**	**$6,738**	**$7,502**
Non-Core						
Alaskan	$837	$932	$0	$0	$837	$932
Central	$68,086	$75,798	$0	$0	$68,086	$75,798
Eastern	$112,634	$125,392	$0	$0	$112,634	$125,392
Pacific	$1,673	$1,862	$0	$0	$1,673	$1,862
Southern	$62,705	$69,807	$0	$0	$62,705	$69,807
Western	$61,070	$67,987	$0	$0	$61,070	$67,987
Subtotal	**$307,005**	**$341,778**	**$0**	**$0**	**$307,005**	**$341,778**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Total Costs for Coolers with Spigot						
Alaskan	$1,676	$1,866	$0	$0	$1,676	$1,866
Central	$154,543	$172,047	$0	$0	$154,543	$172,047
Eastern	$222,731	$247,959	$0	$0	$222,731	$247,959
Pacific	$3,453	$3,844	$0	$0	$3,453	$3,844
Southern	$213,294	$237,453	$0	$0	$213,294	$237,453
Western	$143,251	$159,476	$0	$0	$143,251	$159,476
Total	**$738,948**	**$822,646**	**$0**	**$0**	**$738,948**	**$822,646**
Reusable Water Bottle						
Agriculture, Forestry, and Fishing						
Alaskan	$4	$5	$0	$0	$4	$5
Central	$537	$598	$0	$0	$537	$598
Eastern	$382	$425	$0	$0	$382	$425
Pacific	$4	$4	$0	$0	$4	$4
Southern	$573	$637	$0	$0	$573	$637
Western	$132	$147	$0	$0	$132	$147
Subtotal	**$1,632**	**$1,817**	**$0**	**$0**	**$1,632**	**$1,817**
Building Materials and Equipment Suppliers						
Alaskan	$7	$7	$0	$0	$7	$7
Central	$624	$695	$0	$0	$624	$695
Eastern	$775	$863	$0	$0	$775	$863
Pacific	$12	$13	$0	$0	$12	$13
Southern	$725	$807	$0	$0	$725	$807
Western	$442	$492	$0	$0	$442	$492
Subtotal	**$2,584**	**$2,877**	**$0**	**$0**	**$2,584**	**$2,877**
Commercial Kitchens						
Alaskan	$37	$41	$0	$0	$37	$41
Central	$4,363	$4,858	$0	$0	$4,363	$4,858
Eastern	$6,494	$7,229	$0	$0	$6,494	$7,229
Pacific	$141	$156	$0	$0	$141	$156
Southern	$5,829	$6,489	$0	$0	$5,829	$6,489
Western	$3,642	$4,054	$0	$0	$3,642	$4,054
Subtotal	**$20,505**	**$22,828**	**$0**	**$0**	**$20,505**	**$22,828**
Construction						
Alaskan	$69	$77	$0	$0	$69	$77
Central	$5,120	$5,700	$0	$0	$5,120	$5,700

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$7,463	$8,309	$0	$0	$7,463	$8,309
Pacific	$147	$164	$0	$0	$147	$164
Southern	$19,435	$21,636	$0	$0	$19,435	$21,636
Western	$5,487	$6,109	$0	$0	$5,487	$6,109
Subtotal	**$37,723**	**$41,996**	**$0**	**$0**	**$37,723**	**$41,996**
Drycleaning and Commercial Laundries						
Alaskan	$1	$1	$0	$0	$1	$1
Central	$82	$91	$0	$0	$82	$91
Eastern	$150	$167	$0	$0	$150	$167
Pacific	$3	$4	$0	$0	$3	$4
Southern	$118	$132	$0	$0	$118	$132
Western	$73	$82	$0	$0	$73	$82
Subtotal	**$427**	**$476**	**$0**	**$0**	**$427**	**$476**
Landscaping and Facilities Support						
Alaskan	$26	$28	$0	$0	$26	$28
Central	$1,615	$1,798	$0	$0	$1,615	$1,798
Eastern	$2,615	$2,911	$0	$0	$2,615	$2,911
Pacific	$51	$56	$0	$0	$51	$56
Southern	$2,166	$2,411	$0	$0	$2,166	$2,411
Western	$6,020	$6,702	$0	$0	$6,020	$6,702
Subtotal	**$12,492**	**$13,907**	**$0**	**$0**	**$12,492**	**$13,907**
Maintenance and Repair						
Alaskan	$8	$8	$0	$0	$8	$8
Central	$846	$941	$0	$0	$846	$941
Eastern	$1,092	$1,216	$0	$0	$1,092	$1,216
Pacific	$13	$15	$0	$0	$13	$15
Southern	$1,017	$1,133	$0	$0	$1,017	$1,133
Western	$634	$705	$0	$0	$634	$705
Subtotal	**$3,610**	**$4,019**	**$0**	**$0**	**$3,610**	**$4,019**
Manufacturing						
Alaskan	$21	$23	$0	$0	$21	$23
Central	$6,782	$7,550	$0	$0	$6,782	$7,550
Eastern	$6,278	$6,989	$0	$0	$6,278	$6,989
Pacific	$19	$21	$0	$0	$19	$21
Southern	$5,027	$5,597	$0	$0	$5,027	$5,597
Western	$3,256	$3,624	$0	$0	$3,256	$3,624

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$21,383**	**$23,805**	**$0**	**$0**	**$21,383**	**$23,805**
Oil and Gas						
Alaskan	$22	$25	$0	$0	$22	$25
Central	$163	$182	$0	$0	$163	$182
Eastern	$107	$119	$0	$0	$107	$119
Southern	$1,023	$1,139	$0	$0	$1,023	$1,139
Western	$214	$238	$0	$0	$214	$238
Subtotal	**$1,530**	**$1,703**	**$0**	**$0**	**$1,530**	**$1,703**
Postal and Delivery Services						
Alaskan	$2	$2	$0	$0	$2	$2
Central	$287	$320	$0	$0	$287	$320
Eastern	$459	$511	$0	$0	$459	$511
Pacific	$5	$5	$0	$0	$5	$5
Southern	$326	$363	$0	$0	$326	$363
Western	$229	$255	$0	$0	$229	$255
Subtotal	**$1,307**	**$1,455**	**$0**	**$0**	**$1,307**	**$1,455**
Recreation and Amusement						
Alaskan	$7	$8	$0	$0	$7	$8
Central	$696	$774	$0	$0	$696	$774
Eastern	$1,159	$1,290	$0	$0	$1,159	$1,290
Pacific	$15	$17	$0	$0	$15	$17
Southern	$908	$1,010	$0	$0	$908	$1,010
Western	$683	$760	$0	$0	$683	$760
Subtotal	**$3,467**	**$3,859**	**$0**	**$0**	**$3,467**	**$3,859**
Sanitation and Waste Removal						
Alaskan	$4	$5	$0	$0	$4	$5
Central	$126	$140	$0	$0	$126	$140
Eastern	$213	$238	$0	$0	$213	$238
Pacific	$4	$4	$0	$0	$4	$4
Southern	$170	$189	$0	$0	$170	$189
Western	$102	$114	$0	$0	$102	$114
Subtotal	**$620**	**$690**	**$0**	**$0**	**$620**	**$690**
Telecommunications						
Alaskan	$4	$4	$0	$0	$4	$4
Central	$189	$210	$0	$0	$189	$210
Eastern	$287	$320	$0	$0	$287	$320

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$3	$4	$0	$0	$3	$4
Southern	$261	$290	$0	$0	$261	$290
Western	$134	$149	$0	$0	$134	$149
Subtotal	**$878**	**$977**	**$0**	**$0**	**$878**	**$977**
Temporary Help Services						
Alaskan	$2	$2	$0	$0	$2	$2
Central	$2,010	$2,237	$0	$0	$2,010	$2,237
Eastern	$2,568	$2,859	$0	$0	$2,568	$2,859
Pacific	$60	$67	$0	$0	$60	$67
Southern	$4,158	$4,629	$0	$0	$4,158	$4,629
Western	$2,081	$2,317	$0	$0	$2,081	$2,317
Subtotal	**$10,880**	**$12,112**	**$0**	**$0**	**$10,880**	**$12,112**
Transportation						
Alaskan	$29	$33	$0	$0	$29	$33
Central	$1,263	$1,407	$0	$0	$1,263	$1,407
Eastern	$1,288	$1,434	$0	$0	$1,288	$1,434
Pacific	$43	$48	$0	$0	$43	$48
Southern	$1,714	$1,908	$0	$0	$1,714	$1,908
Western	$559	$622	$0	$0	$559	$622
Subtotal	**$4,897**	**$5,451**	**$0**	**$0**	**$4,897**	**$5,451**
Utilities						
Alaskan	$5	$5	$0	$0	$5	$5
Central	$364	$405	$0	$0	$364	$405
Eastern	$509	$567	$0	$0	$509	$567
Pacific	$2	$2	$0	$0	$2	$2
Southern	$436	$485	$0	$0	$436	$485
Western	$202	$224	$0	$0	$202	$224
Subtotal	**$1,517**	**$1,689**	**$0**	**$0**	**$1,517**	**$1,689**
Warehousing						
Alaskan	$1	$1	$0	$0	$1	$1
Central	$439	$489	$0	$0	$439	$489
Eastern	$643	$716	$0	$0	$643	$716
Pacific	$3	$3	$0	$0	$3	$3
Southern	$545	$606	$0	$0	$545	$606
Western	$357	$398	$0	$0	$357	$398
Subtotal	**$1,988**	**$2,213**	**$0**	**$0**	**$1,988**	**$2,213**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Non-Core						
Alaskan	$247	$275	$0	$0	$247	$275
Central	$20,088	$22,363	$0	$0	$20,088	$22,363
Eastern	$33,231	$36,995	$0	$0	$33,231	$36,995
Pacific	$494	$549	$0	$0	$494	$549
Southern	$18,500	$20,596	$0	$0	$18,500	$20,596
Western	$18,018	$20,059	$0	$0	$18,018	$20,059
Subtotal	**$90,578**	**$100,837**	**$0**	**$0**	**$90,578**	**$100,837**
Total Costs for Reusable Water Bottle						
Alaskan	$494	$550	$0	$0	$494	$550
Central	$45,596	$50,760	$0	$0	$45,596	$50,760
Eastern	$65,714	$73,157	$0	$0	$65,714	$73,157
Pacific	$1,019	$1,134	$0	$0	$1,019	$1,134
Southern	$62,930	$70,057	$0	$0	$62,930	$70,057
Western	$42,264	$47,051	$0	$0	$42,264	$47,051
Total	**$218,017**	**$242,711**	**$0**	**$0**	**$218,017**	**$242,711**
Outdoor Break Area Engineering Control						
Agriculture, Forestry, and Fishing						
Alaskan	$2,139	$2,381	$0	$0	$2,139	$2,381
Central	$148,614	$165,447	$0	$0	$148,614	$165,447
Eastern	$82,148	$91,452	$0	$0	$82,148	$91,452
Pacific	$1,094	$1,218	$0	$0	$1,094	$1,218
Southern	$141,834	$157,899	$0	$0	$141,834	$157,899
Western	$34,464	$38,367	$0	$0	$34,464	$38,367
Subtotal	**$410,292**	**$456,764**	**$0**	**$0**	**$410,292**	**$456,764**
Building Materials and Equipment Suppliers						
Alaskan	$113	$126	$0	$0	$113	$126
Central	$8,748	$9,738	$0	$0	$8,748	$9,738
Eastern	$12,576	$14,001	$0	$0	$12,576	$14,001
Pacific	$209	$233	$0	$0	$209	$233
Southern	$11,796	$13,133	$0	$0	$11,796	$13,133
Western	$7,958	$8,859	$0	$0	$7,958	$8,859
Subtotal	**$41,401**	**$46,090**	**$0**	**$0**	**$41,401**	**$46,090**
Commercial Kitchens						
Alaskan	$319	$355	$0	$0	$319	$355
Central	$24,910	$27,731	$0	$0	$24,910	$27,731

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$39,778	$44,284	$0	$0	$39,778	$44,284
Pacific	$766	$853	$0	$0	$766	$853
Southern	$28,473	$31,698	$0	$0	$28,473	$31,698
Western	$22,781	$25,361	$0	$0	$22,781	$25,361
Subtotal	**$117,026**	**$130,281**	**$0**	**$0**	**$117,026**	**$130,281**
Construction						
Alaskan	$4,131	$4,599	$0	$0	$4,131	$4,599
Central	$265,524	$295,599	$0	$0	$265,524	$295,599
Eastern	$385,284	$428,923	$0	$0	$385,284	$428,923
Pacific	$5,698	$6,343	$0	$0	$5,698	$6,343
Southern	$278,496	$310,040	$0	$0	$278,496	$310,040
Western	$116,376	$129,557	$0	$0	$116,376	$129,557
Subtotal	**$1,055,509**	**$1,175,062**	**$0**	**$0**	**$1,055,509**	**$1,175,062**
Drycleaning and Commercial Laundries						
Alaskan	$28	$31	$0	$0	$28	$31
Central	$3,440	$3,830	$0	$0	$3,440	$3,830
Eastern	$8,838	$9,839	$0	$0	$8,838	$9,839
Pacific	$70	$77	$0	$0	$70	$77
Southern	$5,216	$5,806	$0	$0	$5,216	$5,806
Western	$3,579	$3,984	$0	$0	$3,579	$3,984
Subtotal	**$21,170**	**$23,567**	**$0**	**$0**	**$21,170**	**$23,567**
Landscaping and Facilities Support						
Alaskan	$500	$556	$0	$0	$500	$556
Central	$53,460	$59,515	$0	$0	$53,460	$59,515
Eastern	$86,844	$96,680	$0	$0	$86,844	$96,680
Pacific	$1,227	$1,366	$0	$0	$1,227	$1,366
Southern	$60,819	$67,707	$0	$0	$60,819	$67,707
Western	$49,560	$55,173	$0	$0	$49,560	$55,173
Subtotal	**$252,409**	**$280,998**	**$0**	**$0**	**$252,409**	**$280,998**
Maintenance and Repair						
Alaskan	$553	$616	$0	$0	$553	$616
Central	$56,502	$62,902	$0	$0	$56,502	$62,902
Eastern	$75,259	$83,783	$0	$0	$75,259	$83,783
Pacific	$903	$1,005	$0	$0	$903	$1,005
Southern	$60,866	$67,760	$0	$0	$60,866	$67,760
Western	$44,596	$49,647	$0	$0	$44,596	$49,647

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$238,677**	**$265,711**	**$0**	**$0**	**$238,677**	**$265,711**
Manufacturing						
Alaskan	$109	$121	$0	$0	$109	$121
Central	$13,706	$15,258	$0	$0	$13,706	$15,258
Eastern	$16,157	$17,987	$0	$0	$16,157	$17,987
Pacific	$138	$153	$0	$0	$138	$153
Southern	$12,473	$13,886	$0	$0	$12,473	$13,886
Western	$10,469	$11,655	$0	$0	$10,469	$11,655
Subtotal	**$53,053**	**$59,062**	**$0**	**$0**	**$53,053**	**$59,062**
Oil and Gas						
Alaskan	$371	$413	$0	$0	$371	$413
Central	$14,887	$16,573	$0	$0	$14,887	$16,573
Eastern	$7,969	$8,871	$0	$0	$7,969	$8,871
Southern	$54,268	$60,415	$0	$0	$54,268	$60,415
Western	$7,404	$8,243	$0	$0	$7,404	$8,243
Subtotal	**$84,899**	**$94,515**	**$0**	**$0**	**$84,899**	**$94,515**
Postal and Delivery Services						
Alaskan	$660	$735	$0	$0	$660	$735
Central	$28,109	$31,293	$0	$0	$28,109	$31,293
Eastern	$35,229	$39,219	$0	$0	$35,229	$39,219
Pacific	$367	$409	$0	$0	$367	$409
Southern	$25,444	$28,325	$0	$0	$25,444	$28,325
Western	$14,637	$16,294	$0	$0	$14,637	$16,294
Subtotal	**$104,446**	**$116,276**	**$0**	**$0**	**$104,446**	**$116,276**
Recreation and Amusement						
Alaskan	$911	$1,014	$0	$0	$911	$1,014
Central	$35,982	$40,057	$0	$0	$35,982	$40,057
Eastern	$53,826	$59,922	$0	$0	$53,826	$59,922
Pacific	$666	$741	$0	$0	$666	$741
Southern	$35,056	$39,027	$0	$0	$35,056	$39,027
Western	$27,649	$30,780	$0	$0	$27,649	$30,780
Subtotal	**$154,089**	**$171,542**	**$0**	**$0**	**$154,089**	**$171,542**
Sanitation and Waste Removal						
Alaskan	$75	$83	$0	$0	$75	$83
Central	$2,469	$2,749	$0	$0	$2,469	$2,749
Eastern	$3,594	$4,001	$0	$0	$3,594	$4,001

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$56	$62	$0	$0	$56	$62
Southern	$2,609	$2,905	$0	$0	$2,609	$2,905
Western	$1,605	$1,787	$0	$0	$1,605	$1,787
Subtotal	**$10,408**	**$11,587**	**$0**	**$0**	**$10,408**	**$11,587**
Telecommunications						
Alaskan	$96	$107	$0	$0	$96	$107
Central	$5,824	$6,483	$0	$0	$5,824	$6,483
Eastern	$7,971	$8,874	$0	$0	$7,971	$8,874
Pacific	$87	$97	$0	$0	$87	$97
Southern	$7,002	$7,795	$0	$0	$7,002	$7,795
Western	$4,503	$5,013	$0	$0	$4,503	$5,013
Subtotal	**$25,482**	**$28,368**	**$0**	**$0**	**$25,482**	**$28,368**
Temporary Help Services						
Alaskan	$16	$18	$0	$0	$16	$18
Central	$3,116	$3,469	$0	$0	$3,116	$3,469
Eastern	$4,390	$4,888	$0	$0	$4,390	$4,888
Pacific	$42	$47	$0	$0	$42	$47
Southern	$3,728	$4,150	$0	$0	$3,728	$4,150
Western	$2,499	$2,782	$0	$0	$2,499	$2,782
Subtotal	**$13,791**	**$15,353**	**$0**	**$0**	**$13,791**	**$15,353**
Transportation						
Alaskan	$2,163	$2,408	$0	$0	$2,163	$2,408
Central	$130,909	$145,737	$0	$0	$130,909	$145,737
Eastern	$116,569	$129,772	$0	$0	$116,569	$129,772
Pacific	$1,448	$1,612	$0	$0	$1,448	$1,612
Southern	$118,579	$132,010	$0	$0	$118,579	$132,010
Western	$40,067	$44,605	$0	$0	$40,067	$44,605
Subtotal	**$409,735**	**$456,144**	**$0**	**$0**	**$409,735**	**$456,144**
Utilities						
Alaskan	$333	$370	$0	$0	$333	$370
Central	$14,246	$15,860	$0	$0	$14,246	$15,860
Eastern	$17,850	$19,872	$0	$0	$17,850	$19,872
Pacific	$121	$135	$0	$0	$121	$135
Southern	$19,989	$22,253	$0	$0	$19,989	$22,253
Western	$9,235	$10,281	$0	$0	$9,235	$10,281
Subtotal	**$61,775**	**$68,772**	**$0**	**$0**	**$61,775**	**$68,772**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Warehousing						
Alaskan	$37	$41	$0	$0	$37	$41
Central	$5,364	$5,971	$0	$0	$5,364	$5,971
Eastern	$6,782	$7,550	$0	$0	$6,782	$7,550
Pacific	$86	$96	$0	$0	$86	$96
Southern	$6,658	$7,412	$0	$0	$6,658	$7,412
Western	$4,713	$5,247	$0	$0	$4,713	$5,247
Subtotal	**$23,639**	**$26,317**	**$0**	**$0**	**$23,639**	**$26,317**
Non-Core						
Alaskan	$10,666	$11,875	$0	$0	$10,666	$11,875
Central	$771,392	$858,764	$0	$0	$771,392	$858,764
Eastern	$1,203,522	$1,339,839	$0	$0	$1,203,522	$1,339,839
Pacific	$19,907	$22,161	$0	$0	$19,907	$22,161
Southern	$938,300	$1,044,577	$0	$0	$938,300	$1,044,577
Western	$697,582	$776,594	$0	$0	$697,582	$776,594
Subtotal	**$3,641,370**	**$4,053,811**	**$0**	**$0**	**$3,641,370**	**$4,053,811**
Total Costs for Outdoor Break Area Engineering Control						
Alaskan	$23,219	$25,849	$0	$0	$23,219	$25,849
Central	$1,587,201	$1,766,975	$0	$0	$1,587,201	$1,766,975
Eastern	$2,164,586	$2,409,758	$0	$0	$2,164,586	$2,409,758
Pacific	$32,884	$36,608	$0	$0	$32,884	$36,608
Southern	$1,811,607	$2,016,799	$0	$0	$1,811,607	$2,016,799
Western	$1,099,676	$1,224,231	$0	$0	$1,099,676	$1,224,231
Total	**$6,719,171**	**$7,480,220**	**$0**	**$0**	**$6,719,171**	**$7,480,220**
Air Movement						
Agriculture, Forestry, and Fishing						
Alaskan	$329	$366	$0	$0	$329	$366
Central	$108,158	$120,408	$0	$0	$108,158	$120,408
Eastern	$60,978	$67,885	$0	$0	$60,978	$67,885
Pacific	$639	$711	$0	$0	$639	$711
Southern	$90,405	$100,644	$0	$0	$90,405	$100,644
Western	$154,877	$172,419	$0	$0	$154,877	$172,419
Subtotal	**$415,385**	**$462,433**	**$0**	**$0**	**$415,385**	**$462,433**
Building Materials and Equipment Suppliers						
Alaskan	$1,021	$1,137	$0	$0	$1,021	$1,137
Central	$95,087	$105,857	$0	$0	$95,087	$105,857

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$117,705	$131,037	$0	$0	$117,705	$131,037
Pacific	$1,817	$2,022	$0	$0	$1,817	$2,022
Southern	$108,302	$120,569	$0	$0	$108,302	$120,569
Western	$76,760	$85,455	$0	$0	$76,760	$85,455
Subtotal	**$400,693**	**$446,078**	**$0**	**$0**	**$400,693**	**$446,078**
Commercial Kitchens						
Alaskan	$7,767	$8,647	$0	$0	$7,767	$8,647
Central	$920,349	$1,024,593	$0	$0	$920,349	$1,024,593
Eastern	$1,369,741	$1,524,885	$0	$0	$1,369,741	$1,524,885
Pacific	$29,672	$33,033	$0	$0	$29,672	$33,033
Southern	$1,231,959	$1,371,497	$0	$0	$1,231,959	$1,371,497
Western	$855,252	$952,122	$0	$0	$855,252	$952,122
Subtotal	**$4,414,740**	**$4,914,777**	**$0**	**$0**	**$4,414,740**	**$4,914,777**
Construction						
Alaskan	$6,033	$6,716	$0	$0	$6,033	$6,716
Central	$434,847	$484,100	$0	$0	$434,847	$484,100
Eastern	$636,158	$708,213	$0	$0	$636,158	$708,213
Pacific	$12,280	$13,670	$0	$0	$12,280	$13,670
Southern	$613,504	$682,993	$0	$0	$613,504	$682,993
Western	$440,836	$490,768	$0	$0	$440,836	$490,768
Subtotal	**$2,143,659**	**$2,386,461**	**$0**	**$0**	**$2,143,659**	**$2,386,461**
Drycleaning and Commercial Laundries						
Alaskan	$120	$133	$0	$0	$120	$133
Central	$14,557	$16,206	$0	$0	$14,557	$16,206
Eastern	$26,699	$29,723	$0	$0	$26,699	$29,723
Pacific	$581	$647	$0	$0	$581	$647
Southern	$21,042	$23,425	$0	$0	$21,042	$23,425
Western	$14,307	$15,927	$0	$0	$14,307	$15,927
Subtotal	**$77,306**	**$86,062**	**$0**	**$0**	**$77,306**	**$86,062**
Landscaping and Facilities Support						
Alaskan	$2,383	$2,653	$0	$0	$2,383	$2,653
Central	$125,165	$139,342	$0	$0	$125,165	$139,342
Eastern	$202,660	$225,615	$0	$0	$202,660	$225,615
Pacific	$3,766	$4,193	$0	$0	$3,766	$4,193
Southern	$168,079	$187,117	$0	$0	$168,079	$187,117
Western	$113,917	$126,820	$0	$0	$113,917	$126,820

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$615,970**	**$685,738**	**$0**	**$0**	**$615,970**	**$685,738**
Maintenance and Repair						
Alaskan	$1,009	$1,124	$0	$0	$1,009	$1,124
Central	$112,682	$125,445	$0	$0	$112,682	$125,445
Eastern	$145,140	$161,579	$0	$0	$145,140	$161,579
Pacific	$1,762	$1,961	$0	$0	$1,762	$1,961
Southern	$136,568	$152,036	$0	$0	$136,568	$152,036
Western	$94,222	$104,894	$0	$0	$94,222	$104,894
Subtotal	**$491,382**	**$547,039**	**$0**	**$0**	**$491,382**	**$547,039**
Manufacturing						
Alaskan	$3,604	$4,012	$0	$0	$3,604	$4,012
Central	$1,299,063	$1,446,201	$0	$0	$1,299,063	$1,446,201
Eastern	$1,193,136	$1,328,277	$0	$0	$1,193,136	$1,328,277
Pacific	$3,459	$3,851	$0	$0	$3,459	$3,851
Southern	$941,420	$1,048,050	$0	$0	$941,420	$1,048,050
Western	$556,173	$619,168	$0	$0	$556,173	$619,168
Subtotal	**$3,996,855**	**$4,449,560**	**$0**	**$0**	**$3,996,855**	**$4,449,560**
Oil and Gas						
Alaskan	$1,954	$2,175	$0	$0	$1,954	$2,175
Central	$14,641	$16,299	$0	$0	$14,641	$16,299
Eastern	$9,558	$10,641	$0	$0	$9,558	$10,641
Southern	$90,159	$100,371	$0	$0	$90,159	$100,371
Western	$9,362	$10,422	$0	$0	$9,362	$10,422
Subtotal	**$125,674**	**$139,908**	**$0**	**$0**	**$125,674**	**$139,908**
Postal and Delivery Services						
Alaskan	$195	$217	$0	$0	$195	$217
Central	$38,356	$42,701	$0	$0	$38,356	$42,701
Eastern	$61,466	$68,428	$0	$0	$61,466	$68,428
Pacific	$601	$670	$0	$0	$601	$670
Southern	$43,628	$48,570	$0	$0	$43,628	$48,570
Western	$34,742	$38,677	$0	$0	$34,742	$38,677
Subtotal	**$178,989**	**$199,262**	**$0**	**$0**	**$178,989**	**$199,262**
Recreation and Amusement						
Alaskan	$711	$792	$0	$0	$711	$792
Central	$72,605	$80,828	$0	$0	$72,605	$80,828
Eastern	$120,964	$134,665	$0	$0	$120,964	$134,665

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$1,579	$1,757	$0	$0	$1,579	$1,757
Southern	$94,989	$105,748	$0	$0	$94,989	$105,748
Western	$80,440	$89,551	$0	$0	$80,440	$89,551
Subtotal	**$371,287**	**$413,341**	**$0**	**$0**	**$371,287**	**$413,341**
Sanitation and Waste Removal						
Alaskan	$402	$448	$0	$0	$402	$448
Central	$14,210	$15,819	$0	$0	$14,210	$15,819
Eastern	$23,287	$25,925	$0	$0	$23,287	$25,925
Pacific	$405	$451	$0	$0	$405	$451
Southern	$18,720	$20,840	$0	$0	$18,720	$20,840
Western	$13,505	$15,035	$0	$0	$13,505	$15,035
Subtotal	**$70,529**	**$78,518**	**$0**	**$0**	**$70,529**	**$78,518**
Telecommunications						
Alaskan	$484	$539	$0	$0	$484	$539
Central	$25,066	$27,905	$0	$0	$25,066	$27,905
Eastern	$38,069	$42,381	$0	$0	$38,069	$42,381
Pacific	$454	$505	$0	$0	$454	$505
Southern	$34,579	$38,496	$0	$0	$34,579	$38,496
Western	$21,013	$23,393	$0	$0	$21,013	$23,393
Subtotal	**$119,665**	**$133,218**	**$0**	**$0**	**$119,665**	**$133,218**
Temporary Help Services						
Alaskan	$339	$377	$0	$0	$339	$377
Central	$318,045	$354,068	$0	$0	$318,045	$354,068
Eastern	$406,486	$452,527	$0	$0	$406,486	$452,527
Pacific	$9,548	$10,629	$0	$0	$9,548	$10,629
Southern	$658,041	$732,574	$0	$0	$658,041	$732,574
Western	$343,674	$382,600	$0	$0	$343,674	$382,600
Subtotal	**$1,736,132**	**$1,932,776**	**$0**	**$0**	**$1,736,132**	**$1,932,776**
Transportation						
Alaskan	$2,987	$3,325	$0	$0	$2,987	$3,325
Central	$134,943	$150,227	$0	$0	$134,943	$150,227
Eastern	$138,796	$154,516	$0	$0	$138,796	$154,516
Pacific	$4,572	$5,089	$0	$0	$4,572	$5,089
Southern	$183,350	$204,117	$0	$0	$183,350	$204,117
Western	$101,601	$113,109	$0	$0	$101,601	$113,109
Subtotal	**$566,248**	**$630,384**	**$0**	**$0**	**$566,248**	**$630,384**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Utilities						
Alaskan	$499	$556	$0	$0	$499	$556
Central	$37,661	$41,927	$0	$0	$37,661	$41,927
Eastern	$52,688	$58,655	$0	$0	$52,688	$58,655
Pacific	$206	$229	$0	$0	$206	$229
Southern	$45,122	$50,233	$0	$0	$45,122	$50,233
Western	$22,843	$25,430	$0	$0	$22,843	$25,430
Subtotal	**$159,019**	**$177,031**	**$0**	**$0**	**$159,019**	**$177,031**
Warehousing						
Alaskan	$125	$139	$0	$0	$125	$139
Central	$73,616	$81,954	$0	$0	$73,616	$81,954
Eastern	$107,817	$120,029	$0	$0	$107,817	$120,029
Pacific	$446	$497	$0	$0	$446	$497
Southern	$91,232	$101,565	$0	$0	$91,232	$101,565
Western	$65,675	$73,114	$0	$0	$65,675	$73,114
Subtotal	**$338,911**	**$377,297**	**$0**	**$0**	**$338,911**	**$377,297**
Non-Core						
Alaskan	$53,752	$59,840	$0	$0	$53,752	$59,840
Central	$4,747,729	$5,285,482	$0	$0	$4,747,729	$5,285,482
Eastern	$7,725,828	$8,600,896	$0	$0	$7,725,828	$8,600,896
Pacific	$112,841	$125,622	$0	$0	$112,841	$125,622
Southern	$4,614,342	$5,136,987	$0	$0	$4,614,342	$5,136,987
Western	$4,639,061	$5,164,506	$0	$0	$4,639,061	$5,164,506
Subtotal	**$21,893,554**	**$24,373,334**	**$0**	**$0**	**$21,893,554**	**$24,373,334**
Total Costs for Air Movement						
Alaskan	$83,713	$93,195	$0	$0	$83,713	$93,195
Central	$8,586,779	$9,559,363	$0	$0	$8,586,779	$9,559,363
Eastern	$12,437,176	$13,845,877	$0	$0	$12,437,176	$13,845,877
Pacific	$184,628	$205,540	$0	$0	$184,628	$205,540
Southern	$9,185,441	$10,225,833	$0	$0	$9,185,441	$10,225,833
Western	$7,638,260	$8,503,410	$0	$0	$7,638,260	$8,503,410
Total	**$38,115,998**	**$42,433,217**	**$0**	**$0**	**$38,115,998**	**$42,433,217**
Humidity Control						
Agriculture, Forestry, and Fishing						
Alaskan	$95	$106	$0	$0	$95	$106
Central	$31,400	$34,957	$0	$0	$31,400	$34,957

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$17,703	$19,708	$0	$0	$17,703	$19,708
Pacific	$185	$206	$0	$0	$185	$206
Southern	$25,671	$28,578	$0	$0	$25,671	$28,578
Western	$42,556	$47,376	$0	$0	$42,556	$47,376
Subtotal	**$117,611**	**$130,932**	**$0**	**$0**	**$117,611**	**$130,932**
Building Materials and Equipment Suppliers						
Alaskan	$297	$330	$0	$0	$297	$330
Central	$27,606	$30,732	$0	$0	$27,606	$30,732
Eastern	$34,172	$38,042	$0	$0	$34,172	$38,042
Pacific	$527	$587	$0	$0	$527	$587
Southern	$30,778	$34,264	$0	$0	$30,778	$34,264
Western	$18,585	$20,690	$0	$0	$18,585	$20,690
Subtotal	**$111,964**	**$124,646**	**$0**	**$0**	**$111,964**	**$124,646**
Commercial Kitchens						
Alaskan	$2,255	$2,510	$0	$0	$2,255	$2,510
Central	$267,194	$297,458	$0	$0	$267,194	$297,458
Eastern	$397,660	$442,701	$0	$0	$397,660	$442,701
Pacific	$8,614	$9,590	$0	$0	$8,614	$9,590
Southern	$349,840	$389,465	$0	$0	$349,840	$389,465
Western	$198,024	$220,453	$0	$0	$198,024	$220,453
Subtotal	**$1,223,587**	**$1,362,177**	**$0**	**$0**	**$1,223,587**	**$1,362,177**
Construction						
Alaskan	$1,751	$1,950	$0	$0	$1,751	$1,950
Central	$126,244	$140,543	$0	$0	$126,244	$140,543
Eastern	$184,688	$205,607	$0	$0	$184,688	$205,607
Pacific	$3,565	$3,969	$0	$0	$3,565	$3,969
Southern	$174,434	$194,191	$0	$0	$174,434	$194,191
Western	$99,311	$110,559	$0	$0	$99,311	$110,559
Subtotal	**$589,993**	**$656,819**	**$0**	**$0**	**$589,993**	**$656,819**
Drycleaning and Commercial Laundries						
Alaskan	$35	$39	$0	$0	$35	$39
Central	$4,226	$4,705	$0	$0	$4,226	$4,705
Eastern	$7,751	$8,629	$0	$0	$7,751	$8,629
Pacific	$169	$188	$0	$0	$169	$188
Southern	$5,975	$6,651	$0	$0	$5,975	$6,651
Western	$3,210	$3,573	$0	$0	$3,210	$3,573

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$21,365**	**$23,785**	**$0**	**$0**	**$21,365**	**$23,785**
Landscaping and Facilities Support						
Alaskan	$692	$770	$0	$0	$692	$770
Central	$36,338	$40,453	$0	$0	$36,338	$40,453
Eastern	$58,836	$65,500	$0	$0	$58,836	$65,500
Pacific	$1,093	$1,217	$0	$0	$1,093	$1,217
Southern	$48,013	$53,451	$0	$0	$48,013	$53,451
Western	$25,082	$27,923	$0	$0	$25,082	$27,923
Subtotal	**$170,054**	**$189,315**	**$0**	**$0**	**$170,054**	**$189,315**
Maintenance and Repair						
Alaskan	$293	$326	$0	$0	$293	$326
Central	$32,714	$36,419	$0	$0	$32,714	$36,419
Eastern	$42,137	$46,909	$0	$0	$42,137	$46,909
Pacific	$511	$569	$0	$0	$511	$569
Southern	$38,727	$43,113	$0	$0	$38,727	$43,113
Western	$21,788	$24,255	$0	$0	$21,788	$24,255
Subtotal	**$136,169**	**$151,592**	**$0**	**$0**	**$136,169**	**$151,592**
Manufacturing						
Alaskan	$1,046	$1,165	$0	$0	$1,046	$1,165
Central	$377,141	$419,858	$0	$0	$377,141	$419,858
Eastern	$346,389	$385,622	$0	$0	$346,389	$385,622
Pacific	$1,004	$1,118	$0	$0	$1,004	$1,118
Southern	$271,764	$302,545	$0	$0	$271,764	$302,545
Western	$136,507	$151,968	$0	$0	$136,507	$151,968
Subtotal	**$1,133,851**	**$1,262,277**	**$0**	**$0**	**$1,133,851**	**$1,262,277**
Oil and Gas						
Alaskan	$567	$631	$0	$0	$567	$631
Central	$4,250	$4,732	$0	$0	$4,250	$4,732
Eastern	$2,775	$3,089	$0	$0	$2,775	$3,089
Southern	$24,984	$27,813	$0	$0	$24,984	$27,813
Western	$2,148	$2,392	$0	$0	$2,148	$2,392
Subtotal	**$34,724**	**$38,657**	**$0**	**$0**	**$34,724**	**$38,657**
Postal and Delivery Services						
Alaskan	$56	$63	$0	$0	$56	$63
Central	$11,136	$12,397	$0	$0	$11,136	$12,397
Eastern	$17,845	$19,866	$0	$0	$17,845	$19,866

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$175	$194	$0	$0	$175	$194
Southern	$12,429	$13,836	$0	$0	$12,429	$13,836
Western	$8,172	$9,097	$0	$0	$8,172	$9,097
Subtotal	**$49,812**	**$55,453**	**$0**	**$0**	**$49,812**	**$55,453**
Recreation and Amusement						
Alaskan	$207	$230	$0	$0	$207	$230
Central	$21,078	$23,466	$0	$0	$21,078	$23,466
Eastern	$35,118	$39,096	$0	$0	$35,118	$39,096
Pacific	$458	$510	$0	$0	$458	$510
Southern	$27,043	$30,106	$0	$0	$27,043	$30,106
Western	$19,011	$21,164	$0	$0	$19,011	$21,164
Subtotal	**$102,915**	**$114,572**	**$0**	**$0**	**$102,915**	**$114,572**
Sanitation and Waste Removal						
Alaskan	$117	$130	$0	$0	$117	$130
Central	$4,125	$4,593	$0	$0	$4,125	$4,593
Eastern	$6,761	$7,527	$0	$0	$6,761	$7,527
Pacific	$118	$131	$0	$0	$118	$131
Southern	$5,329	$5,933	$0	$0	$5,329	$5,933
Western	$3,191	$3,553	$0	$0	$3,191	$3,553
Subtotal	**$19,641**	**$21,866**	**$0**	**$0**	**$19,641**	**$21,866**
Telecommunications						
Alaskan	$141	$157	$0	$0	$141	$157
Central	$7,277	$8,101	$0	$0	$7,277	$8,101
Eastern	$11,052	$12,304	$0	$0	$11,052	$12,304
Pacific	$132	$147	$0	$0	$132	$147
Southern	$9,825	$10,938	$0	$0	$9,825	$10,938
Western	$4,802	$5,346	$0	$0	$4,802	$5,346
Subtotal	**$33,228**	**$36,991**	**$0**	**$0**	**$33,228**	**$36,991**
Temporary Help Services						
Alaskan	$98	$110	$0	$0	$98	$110
Central	$92,334	$102,792	$0	$0	$92,334	$102,792
Eastern	$118,010	$131,377	$0	$0	$118,010	$131,377
Pacific	$2,772	$3,086	$0	$0	$2,772	$3,086
Southern	$190,450	$212,021	$0	$0	$190,450	$212,021
Western	$78,264	$87,129	$0	$0	$78,264	$87,129
Subtotal	**$481,928**	**$536,514**	**$0**	**$0**	**$481,928**	**$536,514**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Transportation						
Alaskan	$867	$965	$0	$0	$867	$965
Central	$39,176	$43,614	$0	$0	$39,176	$43,614
Eastern	$40,295	$44,859	$0	$0	$40,295	$44,859
Pacific	$1,327	$1,478	$0	$0	$1,327	$1,478
Southern	$52,599	$58,556	$0	$0	$52,599	$58,556
Western	$22,771	$25,350	$0	$0	$22,771	$25,350
Subtotal	**$157,035**	**$174,822**	**$0**	**$0**	**$157,035**	**$174,822**
Utilities						
Alaskan	$145	$161	$0	$0	$145	$161
Central	$10,934	$12,172	$0	$0	$10,934	$12,172
Eastern	$15,296	$17,029	$0	$0	$15,296	$17,029
Pacific	$60	$67	$0	$0	$60	$67
Southern	$12,788	$14,236	$0	$0	$12,788	$14,236
Western	$5,328	$5,931	$0	$0	$5,328	$5,931
Subtotal	**$44,550**	**$49,596**	**$0**	**$0**	**$44,550**	**$49,596**
Warehousing						
Alaskan	$36	$40	$0	$0	$36	$40
Central	$21,372	$23,793	$0	$0	$21,372	$23,793
Eastern	$31,301	$34,846	$0	$0	$31,301	$34,846
Pacific	$130	$144	$0	$0	$130	$144
Southern	$26,358	$29,343	$0	$0	$26,358	$29,343
Western	$15,033	$16,735	$0	$0	$15,033	$16,735
Subtotal	**$94,230**	**$104,902**	**$0**	**$0**	**$94,230**	**$104,902**
Non-Core						
Alaskan	$15,605	$17,373	$0	$0	$15,605	$17,373
Central	$1,378,350	$1,534,470	$0	$0	$1,378,350	$1,534,470
Eastern	$2,242,945	$2,496,993	$0	$0	$2,242,945	$2,496,993
Pacific	$32,760	$36,470	$0	$0	$32,760	$36,470
Southern	$1,298,373	$1,445,433	$0	$0	$1,298,373	$1,445,433
Western	$1,074,393	$1,196,084	$0	$0	$1,074,393	$1,196,084
Subtotal	**$6,042,426**	**$6,726,823**	**$0**	**$0**	**$6,042,426**	**$6,726,823**
Total Costs for Humidity Control						
Alaskan	$24,304	$27,056	$0	$0	$24,304	$27,056
Central	$2,492,895	$2,775,253	$0	$0	$2,492,895	$2,775,253
Eastern	$3,610,734	$4,019,704	$0	$0	$3,610,734	$4,019,704

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$53,601	$59,672	$0	$0	$53,601	$59,672
Southern	$2,605,377	$2,900,476	$0	$0	$2,605,377	$2,900,476
Western	$1,778,174	$1,979,579	$0	$0	$1,778,174	$1,979,579
Total	**$10,565,084**	**$11,761,741**	**$0**	**$0**	**$10,565,084**	**$11,761,741**
New Employee Acclimatization – Designated Person						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$22,683	$0	$22,683	$22,683
Eastern	$0	$0	$14,046	$0	$14,046	$14,046
Pacific	$0	$0	$658	$0	$658	$658
Southern	$0	$0	$34,594	$0	$34,594	$34,594
Western	$0	$0	$10,637	$0	$10,637	$10,637
Subtotal	**$0**	**$0**	**$82,618**	**$0**	**$82,618**	**$82,618**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$8,839	$0	$8,839	$8,839
Eastern	$0	$0	$10,086	$0	$10,086	$10,086
Pacific	$0	$0	$756	$0	$756	$756
Southern	$0	$0	$17,336	$0	$17,336	$17,336
Western	$0	$0	$7,440	$0	$7,440	$7,440
Subtotal	**$0**	**$0**	**$44,458**	**$0**	**$44,458**	**$44,458**
Commercial Kitchens						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$66,528	$0	$66,528	$66,528
Eastern	$0	$0	$93,907	$0	$93,907	$93,907
Pacific	$0	$0	$9,308	$0	$9,308	$9,308
Southern	$0	$0	$159,557	$0	$159,557	$159,557
Western	$0	$0	$66,267	$0	$66,267	$66,267
Subtotal	**$0**	**$0**	**$395,566**	**$0**	**$395,566**	**$395,566**
Construction						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$129,541	$0	$129,541	$129,541
Eastern	$0	$0	$177,518	$0	$177,518	$177,518
Pacific	$0	$0	$16,312	$0	$16,312	$16,312
Southern	$0	$0	$294,027	$0	$294,027	$294,027
Western	$0	$0	$66,918	$0	$66,918	$66,918

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$684,317**	**$0**	**$684,317**	**$684,317**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,288	$0	$1,288	$1,288
Eastern	$0	$0	$2,184	$0	$2,184	$2,184
Pacific	$0	$0	$228	$0	$228	$228
Southern	$0	$0	$3,057	$0	$3,057	$3,057
Western	$0	$0	$1,351	$0	$1,351	$1,351
Subtotal	**$0**	**$0**	**$8,108**	**$0**	**$8,108**	**$8,108**
Landscaping and Facilities Support						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$23,521	$0	$23,521	$23,521
Eastern	$0	$0	$35,839	$0	$35,839	$35,839
Pacific	$0	$0	$3,250	$0	$3,250	$3,250
Southern	$0	$0	$52,232	$0	$52,232	$52,232
Western	$0	$0	$28,306	$0	$28,306	$28,306
Subtotal	**$0**	**$0**	**$143,148**	**$0**	**$143,148**	**$143,148**
Maintenance and Repair						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$13,304	$0	$13,304	$13,304
Eastern	$0	$0	$16,305	$0	$16,305	$16,305
Pacific	$0	$0	$931	$0	$931	$931
Southern	$0	$0	$26,401	$0	$26,401	$26,401
Western	$0	$0	$11,705	$0	$11,705	$11,705
Subtotal	**$0**	**$0**	**$68,645**	**$0**	**$68,645**	**$68,645**
Manufacturing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$96,792	$0	$96,792	$96,792
Eastern	$0	$0	$91,190	$0	$91,190	$91,190
Pacific	$0	$0	$1,258	$0	$1,258	$1,258
Southern	$0	$0	$117,159	$0	$117,159	$117,159
Western	$0	$0	$44,603	$0	$44,603	$44,603
Subtotal	**$0**	**$0**	**$351,003**	**$0**	**$351,003**	**$351,003**
Oil and Gas						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$4,390	$0	$4,390	$4,390

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$2,615	$0	$2,615	$2,615
Southern	$0	$0	$40,324	$0	$40,324	$40,324
Western	$0	$0	$2,640	$0	$2,640	$2,640
Subtotal	**$0**	**$0**	**$49,968**	**$0**	**$49,968**	**$49,968**
Postal and Delivery Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$5,530	$0	$5,530	$5,530
Eastern	$0	$0	$8,245	$0	$8,245	$8,245
Pacific	$0	$0	$390	$0	$390	$390
Southern	$0	$0	$10,789	$0	$10,789	$10,789
Western	$0	$0	$5,187	$0	$5,187	$5,187
Subtotal	**$0**	**$0**	**$30,140**	**$0**	**$30,140**	**$30,140**
Recreation and Amusement						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$15,389	$0	$15,389	$15,389
Eastern	$0	$0	$24,238	$0	$24,238	$24,238
Pacific	$0	$0	$1,474	$0	$1,474	$1,474
Southern	$0	$0	$39,175	$0	$39,175	$39,175
Western	$0	$0	$18,246	$0	$18,246	$18,246
Subtotal	**$0**	**$0**	**$98,522**	**$0**	**$98,522**	**$98,522**
Sanitation and Waste Removal						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,782	$0	$1,782	$1,782
Eastern	$0	$0	$2,781	$0	$2,781	$2,781
Pacific	$0	$0	$237	$0	$237	$237
Southern	$0	$0	$3,921	$0	$3,921	$3,921
Western	$0	$0	$1,742	$0	$1,742	$1,742
Subtotal	**$0**	**$0**	**$10,462**	**$0**	**$10,462**	**$10,462**
Telecommunications						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$3,528	$0	$3,528	$3,528
Eastern	$0	$0	$4,889	$0	$4,889	$4,889
Pacific	$0	$0	$274	$0	$274	$274
Southern	$0	$0	$7,485	$0	$7,485	$7,485
Western	$0	$0	$2,908	$0	$2,908	$2,908
Subtotal	**$0**	**$0**	**$19,083**	**$0**	**$19,083**	**$19,083**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Temporary Help Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$28,772	$0	$28,772	$28,772
Eastern	$0	$0	$35,627	$0	$35,627	$35,627
Pacific	$0	$0	$3,810	$0	$3,810	$3,810
Southern	$0	$0	$107,950	$0	$107,950	$107,950
Western	$0	$0	$33,490	$0	$33,490	$33,490
Subtotal	**$0**	**$0**	**$209,649**	**$0**	**$209,649**	**$209,649**
Transportation						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$24,480	$0	$24,480	$24,480
Eastern	$0	$0	$23,617	$0	$23,617	$23,617
Pacific	$0	$0	$3,687	$0	$3,687	$3,687
Southern	$0	$0	$55,722	$0	$55,722	$55,722
Western	$0	$0	$13,832	$0	$13,832	$13,832
Subtotal	**$0**	**$0**	**$121,339**	**$0**	**$121,339**	**$121,339**
Utilities						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$9,201	$0	$9,201	$9,201
Eastern	$0	$0	$12,379	$0	$12,379	$12,379
Pacific	$0	$0	$229	$0	$229	$229
Southern	$0	$0	$18,581	$0	$18,581	$18,581
Western	$0	$0	$6,092	$0	$6,092	$6,092
Subtotal	**$0**	**$0**	**$46,483**	**$0**	**$46,483**	**$46,483**
Warehousing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$8,709	$0	$8,709	$8,709
Eastern	$0	$0	$12,191	$0	$12,191	$12,191
Pacific	$0	$0	$227	$0	$227	$227
Southern	$0	$0	$16,982	$0	$16,982	$16,982
Western	$0	$0	$8,107	$0	$8,107	$8,107
Subtotal	**$0**	**$0**	**$46,217**	**$0**	**$46,217**	**$46,217**
Non-Core						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$525,443	$0	$525,443	$525,443
Eastern	$0	$0	$818,290	$0	$818,290	$818,290

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$56,311	$0	$56,311	$56,311
Southern	$0	$0	$902,582	$0	$902,582	$902,582
Western	$0	$0	$549,837	$0	$549,837	$549,837
Subtotal	**$0**	**$0**	**$2,852,465**	**$0**	**$2,852,465**	**$2,852,465**
Total Costs for New Employee Acclimatization – Designated Person						
Alaskan	$0	$0	$3	$0	$3	$3
Central	$0	$0	$989,721	$0	$989,721	$989,721
Eastern	$0	$0	$1,385,945	$0	$1,385,945	$1,385,945
Pacific	$0	$0	$99,338	$0	$99,338	$99,338
Southern	$0	$0	$1,907,875	$0	$1,907,875	$1,907,875
Western	$0	$0	$879,308	$0	$879,308	$879,308
Total	**$0**	**$0**	**$5,262,190**	**$0**	**$5,262,190**	**$5,262,190**
Returning Employee Acclimatization – Designated Person						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$550	$0	$550	$550
Eastern	$0	$0	$341	$0	$341	$341
Pacific	$0	$0	$16	$0	$16	$16
Southern	$0	$0	$839	$0	$839	$839
Western	$0	$0	$258	$0	$258	$258
Subtotal	**$0**	**$0**	**$2,003**	**$0**	**$2,003**	**$2,003**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$252	$0	$252	$252
Eastern	$0	$0	$308	$0	$308	$308
Pacific	$0	$0	$21	$0	$21	$21
Southern	$0	$0	$523	$0	$523	$523
Western	$0	$0	$226	$0	$226	$226
Subtotal	**$0**	**$0**	**$1,329**	**$0**	**$1,329**	**$1,329**
Commercial Kitchens						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$429	$0	$429	$429
Eastern	$0	$0	$606	$0	$606	$606
Pacific	$0	$0	$63	$0	$63	$63
Southern	$0	$0	$996	$0	$996	$996
Western	$0	$0	$429	$0	$429	$429

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$2,524**	**$0**	**$2,524**	**$2,524**
Construction						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$2,049	$0	$2,049	$2,049
Eastern	$0	$0	$2,806	$0	$2,806	$2,806
Pacific	$0	$0	$258	$0	$258	$258
Southern	$0	$0	$4,652	$0	$4,652	$4,652
Western	$0	$0	$1,053	$0	$1,053	$1,053
Subtotal	**$0**	**$0**	**$10,819**	**$0**	**$10,819**	**$10,819**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$33	$0	$33	$33
Eastern	$0	$0	$56	$0	$56	$56
Pacific	$0	$0	$6	$0	$6	$6
Southern	$0	$0	$79	$0	$79	$79
Western	$0	$0	$35	$0	$35	$35
Subtotal	**$0**	**$0**	**$209**	**$0**	**$209**	**$209**
Landscaping and Facilities Support						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$779	$0	$779	$779
Eastern	$0	$0	$1,186	$0	$1,186	$1,186
Pacific	$0	$0	$107	$0	$107	$107
Southern	$0	$0	$1,731	$0	$1,731	$1,731
Western	$0	$0	$946	$0	$946	$946
Subtotal	**$0**	**$0**	**$4,748**	**$0**	**$4,748**	**$4,748**
Maintenance and Repair						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$343	$0	$343	$343
Eastern	$0	$0	$420	$0	$420	$420
Pacific	$0	$0	$24	$0	$24	$24
Southern	$0	$0	$680	$0	$680	$680
Western	$0	$0	$302	$0	$302	$302
Subtotal	**$0**	**$0**	**$1,769**	**$0**	**$1,769**	**$1,769**
Manufacturing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$3,339	$0	$3,339	$3,339

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$3,146	$0	$3,146	$3,146
Pacific	$0	$0	$43	$0	$43	$43
Southern	$0	$0	$4,042	$0	$4,042	$4,042
Western	$0	$0	$1,539	$0	$1,539	$1,539
Subtotal	**$0**	**$0**	**$12,108**	**$0**	**$12,108**	**$12,108**
Oil and Gas						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$103	$0	$103	$103
Eastern	$0	$0	$61	$0	$61	$61
Southern	$0	$0	$958	$0	$958	$958
Western	$0	$0	$62	$0	$62	$62
Subtotal	**$0**	**$0**	**$1,184**	**$0**	**$1,184**	**$1,184**
Postal and Delivery Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$102	$0	$102	$102
Eastern	$0	$0	$152	$0	$152	$152
Pacific	$0	$0	$7	$0	$7	$7
Southern	$0	$0	$199	$0	$199	$199
Western	$0	$0	$96	$0	$96	$96
Subtotal	**$0**	**$0**	**$556**	**$0**	**$556**	**$556**
Recreation and Amusement						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$68	$0	$68	$68
Eastern	$0	$0	$108	$0	$108	$108
Pacific	$0	$0	$7	$0	$7	$7
Southern	$0	$0	$174	$0	$174	$174
Western	$0	$0	$81	$0	$81	$81
Subtotal	**$0**	**$0**	**$437**	**$0**	**$437**	**$437**
Sanitation and Waste Removal						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$61	$0	$61	$61
Eastern	$0	$0	$96	$0	$96	$96
Pacific	$0	$0	$8	$0	$8	$8
Southern	$0	$0	$135	$0	$135	$135
Western	$0	$0	$60	$0	$60	$60
Subtotal	**$0**	**$0**	**$359**	**$0**	**$359**	**$359**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Telecommunications						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$167	$0	$167	$167
Eastern	$0	$0	$231	$0	$231	$231
Pacific	$0	$0	$13	$0	$13	$13
Southern	$0	$0	$354	$0	$354	$354
Western	$0	$0	$138	$0	$138	$138
Subtotal	**$0**	**$0**	**$903**	**$0**	**$903**	**$903**
Temporary Help Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$988	$0	$988	$988
Eastern	$0	$0	$1,224	$0	$1,224	$1,224
Pacific	$0	$0	$131	$0	$131	$131
Southern	$0	$0	$3,708	$0	$3,708	$3,708
Western	$0	$0	$1,150	$0	$1,150	$1,150
Subtotal	**$0**	**$0**	**$7,201**	**$0**	**$7,201**	**$7,201**
Transportation						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$452	$0	$452	$452
Eastern	$0	$0	$436	$0	$436	$436
Pacific	$0	$0	$68	$0	$68	$68
Southern	$0	$0	$1,029	$0	$1,029	$1,029
Western	$0	$0	$255	$0	$255	$255
Subtotal	**$0**	**$0**	**$2,240**	**$0**	**$2,240**	**$2,240**
Utilities						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$221	$0	$221	$221
Eastern	$0	$0	$298	$0	$298	$298
Pacific	$0	$0	$6	$0	$6	$6
Southern	$0	$0	$447	$0	$447	$447
Western	$0	$0	$147	$0	$147	$147
Subtotal	**$0**	**$0**	**$1,118**	**$0**	**$1,118**	**$1,118**
Warehousing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$161	$0	$161	$161
Eastern	$0	$0	$225	$0	$225	$225

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$4	$0	$4	$4
Southern	$0	$0	$314	$0	$314	$314
Western	$0	$0	$150	$0	$150	$150
Subtotal	**$0**	**$0**	**$853**	**$0**	**$853**	**$853**
Non-Core						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$18,283	$0	$18,283	$18,283
Eastern	$0	$0	$28,957	$0	$28,957	$28,957
Pacific	$0	$0	$1,869	$0	$1,869	$1,869
Southern	$0	$0	$25,241	$0	$25,241	$25,241
Western	$0	$0	$20,730	$0	$20,730	$20,730
Subtotal	**$0**	**$0**	**$95,080**	**$0**	**$95,080**	**$95,080**
Total Costs for Returning Employee Acclimatization – Designated Person						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$28,381	$0	$28,381	$28,381
Eastern	$0	$0	$40,657	$0	$40,657	$40,657
Pacific	$0	$0	$2,651	$0	$2,651	$2,651
Southern	$0	$0	$46,100	$0	$46,100	$46,100
Western	$0	$0	$27,656	$0	$27,656	$27,656
Total	**$0**	**$0**	**$145,444**	**$0**	**$145,444**	**$145,444**
New Indoor Employee Acclimatization						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$193,345	$0	$193,345	$193,345
Eastern	$0	$0	$118,157	$0	$118,157	$118,157
Pacific	$0	$0	$5,594	$0	$5,594	$5,594
Southern	$0	$0	$292,499	$0	$292,499	$292,499
Western	$0	$0	$90,313	$0	$90,313	$90,313
Subtotal	**$0**	**$0**	**$699,909**	**$0**	**$699,909**	**$699,909**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$200,995	$0	$200,995	$200,995
Eastern	$0	$0	$228,631	$0	$228,631	$228,631
Pacific	$0	$0	$17,117	$0	$17,117	$17,117
Southern	$0	$0	$387,695	$0	$387,695	$387,695
Western	$0	$0	$167,006	$0	$167,006	$167,006

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$1,001,445**	**$0**	**$1,001,445**	**$1,001,445**
Commercial Kitchens						
Alaskan	$0	$0	$6	$0	$6	$6
Central	$0	$0	$2,459,217	$0	$2,459,217	$2,459,217
Eastern	$0	$0	$3,471,889	$0	$3,471,889	$3,471,889
Pacific	$0	$0	$343,188	$0	$343,188	$343,188
Southern	$0	$0	$5,921,221	$0	$5,921,221	$5,921,221
Western	$0	$0	$2,451,199	$0	$2,451,199	$2,451,199
Subtotal	**$0**	**$0**	**$14,646,720**	**$0**	**$14,646,720**	**$14,646,720**
Construction						
Alaskan	$0	$0	$7	$0	$7	$7
Central	$0	$0	$1,828,198	$0	$1,828,198	$1,828,198
Eastern	$0	$0	$2,533,833	$0	$2,533,833	$2,533,833
Pacific	$0	$0	$222,954	$0	$222,954	$222,954
Southern	$0	$0	$4,123,445	$0	$4,123,445	$4,123,445
Western	$0	$0	$1,027,254	$0	$1,027,254	$1,027,254
Subtotal	**$0**	**$0**	**$9,735,691**	**$0**	**$9,735,691**	**$9,735,691**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$35,160	$0	$35,160	$35,160
Eastern	$0	$0	$59,609	$0	$59,609	$59,609
Pacific	$0	$0	$6,222	$0	$6,222	$6,222
Southern	$0	$0	$83,456	$0	$83,456	$83,456
Western	$0	$0	$36,894	$0	$36,894	$36,894
Subtotal	**$0**	**$0**	**$221,342**	**$0**	**$221,342**	**$221,342**
Landscaping and Facilities Support						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$227,016	$0	$227,016	$227,016
Eastern	$0	$0	$346,329	$0	$346,329	$346,329
Pacific	$0	$0	$30,706	$0	$30,706	$30,706
Southern	$0	$0	$504,064	$0	$504,064	$504,064
Western	$0	$0	$266,057	$0	$266,057	$266,057
Subtotal	**$0**	**$0**	**$1,374,173**	**$0**	**$1,374,173**	**$1,374,173**
Maintenance and Repair						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$271,890	$0	$271,890	$271,890

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$332,610	$0	$332,610	$332,610
Pacific	$0	$0	$18,859	$0	$18,859	$18,859
Southern	$0	$0	$542,961	$0	$542,961	$542,961
Western	$0	$0	$237,715	$0	$237,715	$237,715
Subtotal	**$0**	**$0**	**$1,404,036**	**$0**	**$1,404,036**	**$1,404,036**
Manufacturing						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$2,361,334	$0	$2,361,334	$2,361,334
Eastern	$0	$0	$2,209,292	$0	$2,209,292	$2,209,292
Pacific	$0	$0	$29,010	$0	$29,010	$29,010
Southern	$0	$0	$2,797,246	$0	$2,797,246	$2,797,246
Western	$0	$0	$1,073,345	$0	$1,073,345	$1,073,345
Subtotal	**$0**	**$0**	**$8,470,228**	**$0**	**$8,470,228**	**$8,470,228**
Oil and Gas						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$53,570	$0	$53,570	$53,570
Eastern	$0	$0	$31,858	$0	$31,858	$31,858
Southern	$0	$0	$486,559	$0	$486,559	$486,559
Western	$0	$0	$31,794	$0	$31,794	$31,794
Subtotal	**$0**	**$0**	**$603,784**	**$0**	**$603,784**	**$603,784**
Postal and Delivery Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$98,673	$0	$98,673	$98,673
Eastern	$0	$0	$147,574	$0	$147,574	$147,574
Pacific	$0	$0	$6,848	$0	$6,848	$6,848
Southern	$0	$0	$193,367	$0	$193,367	$193,367
Western	$0	$0	$94,004	$0	$94,004	$94,004
Subtotal	**$0**	**$0**	**$540,465**	**$0**	**$540,465**	**$540,465**
Recreation and Amusement						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$211,899	$0	$211,899	$211,899
Eastern	$0	$0	$333,853	$0	$333,853	$333,853
Pacific	$0	$0	$20,233	$0	$20,233	$20,233
Southern	$0	$0	$540,964	$0	$540,964	$540,964
Western	$0	$0	$252,184	$0	$252,184	$252,184
Subtotal	**$0**	**$0**	**$1,359,134**	**$0**	**$1,359,134**	**$1,359,134**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Sanitation and Waste Removal						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$24,083	$0	$24,083	$24,083
Eastern	$0	$0	$36,457	$0	$36,457	$36,457
Pacific	$0	$0	$3,068	$0	$3,068	$3,068
Southern	$0	$0	$51,809	$0	$51,809	$51,809
Western	$0	$0	$23,188	$0	$23,188	$23,188
Subtotal	**$0**	**$0**	**$138,605**	**$0**	**$138,605**	**$138,605**
Telecommunications						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$73,774	$0	$73,774	$73,774
Eastern	$0	$0	$102,236	$0	$102,236	$102,236
Pacific	$0	$0	$5,728	$0	$5,728	$5,728
Southern	$0	$0	$156,530	$0	$156,530	$156,530
Western	$0	$0	$60,813	$0	$60,813	$60,813
Subtotal	**$0**	**$0**	**$399,081**	**$0**	**$399,081**	**$399,081**
Temporary Help Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$545,638	$0	$545,638	$545,638
Eastern	$0	$0	$675,623	$0	$675,623	$675,623
Pacific	$0	$0	$72,247	$0	$72,247	$72,247
Southern	$0	$0	$2,047,160	$0	$2,047,160	$2,047,160
Western	$0	$0	$635,109	$0	$635,109	$635,109
Subtotal	**$0**	**$0**	**$3,975,776**	**$0**	**$3,975,776**	**$3,975,776**
Transportation						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$349,275	$0	$349,275	$349,275
Eastern	$0	$0	$340,221	$0	$340,221	$340,221
Pacific	$0	$0	$52,048	$0	$52,048	$52,048
Southern	$0	$0	$797,648	$0	$797,648	$797,648
Western	$0	$0	$198,447	$0	$198,447	$198,447
Subtotal	**$0**	**$0**	**$1,737,639**	**$0**	**$1,737,639**	**$1,737,639**
Utilities						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$186,352	$0	$186,352	$186,352
Eastern	$0	$0	$250,671	$0	$250,671	$250,671

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$4,646	$0	$4,646	$4,646
Southern	$0	$0	$376,360	$0	$376,360	$376,360
Western	$0	$0	$123,487	$0	$123,487	$123,487
Subtotal	**$0**	**$0**	**$941,515**	**$0**	**$941,515**	**$941,515**
Warehousing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$194,963	$0	$194,963	$194,963
Eastern	$0	$0	$272,889	$0	$272,889	$272,889
Pacific	$0	$0	$5,083	$0	$5,083	$5,083
Southern	$0	$0	$380,156	$0	$380,156	$380,156
Western	$0	$0	$181,486	$0	$181,486	$181,486
Subtotal	**$0**	**$0**	**$1,034,577**	**$0**	**$1,034,577**	**$1,034,577**
Non-Core						
Alaskan	$0	$0	$32	$0	$32	$32
Central	$0	$0	$11,211,606	$0	$11,211,606	$11,211,606
Eastern	$0	$0	$17,218,995	$0	$17,218,995	$17,218,995
Pacific	$0	$0	$1,136,938	$0	$1,136,938	$1,136,938
Southern	$0	$0	$19,641,718	$0	$19,641,718	$19,641,718
Western	$0	$0	$11,524,405	$0	$11,524,405	$11,524,405
Subtotal	**$0**	**$0**	**$60,733,695**	**$0**	**$60,733,695**	**$60,733,695**
Total Costs for New Indoor Employee Acclimatization						
Alaskan	$0	$0	$56	$0	$56	$56
Central	$0	$0	$20,526,989	$0	$20,526,989	$20,526,989
Eastern	$0	$0	$28,710,726	$0	$28,710,726	$28,710,726
Pacific	$0	$0	$1,980,487	$0	$1,980,487	$1,980,487
Southern	$0	$0	$39,324,858	$0	$39,324,858	$39,324,858
Western	$0	$0	$18,474,699	$0	$18,474,699	$18,474,699
Total	**$0**	**$0**	**$109,017,815**	**$0**	**$109,017,815**	**$109,017,815**
New Outdoor Employee Acclimatization						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$555,498	$0	$555,498	$555,498
Eastern	$0	$0	$345,783	$0	$345,783	$345,783
Pacific	$0	$0	$16,128	$0	$16,128	$16,128
Southern	$0	$0	$849,910	$0	$849,910	$849,910
Western	$0	$0	$260,886	$0	$260,886	$260,886

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$2,028,206**	**$0**	**$2,028,206**	**$2,028,206**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$116,270	$0	$116,270	$116,270
Eastern	$0	$0	$133,667	$0	$133,667	$133,667
Pacific	$0	$0	$10,037	$0	$10,037	$10,037
Southern	$0	$0	$236,477	$0	$236,477	$236,477
Western	$0	$0	$100,700	$0	$100,700	$100,700
Subtotal	**$0**	**$0**	**$597,153**	**$0**	**$597,153**	**$597,153**
Commercial Kitchens						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$237,085	$0	$237,085	$237,085
Eastern	$0	$0	$333,855	$0	$333,855	$333,855
Pacific	$0	$0	$32,738	$0	$32,738	$32,738
Southern	$0	$0	$556,756	$0	$556,756	$556,756
Western	$0	$0	$233,410	$0	$233,410	$233,410
Subtotal	**$0**	**$0**	**$1,393,844**	**$0**	**$1,393,844**	**$1,393,844**
Construction						
Alaskan	$0	$0	$12	$0	$12	$12
Central	$0	$0	$3,377,743	$0	$3,377,743	$3,377,743
Eastern	$0	$0	$4,623,309	$0	$4,623,309	$4,623,309
Pacific	$0	$0	$427,668	$0	$427,668	$427,668
Southern	$0	$0	$7,682,911	$0	$7,682,911	$7,682,911
Western	$0	$0	$1,736,798	$0	$1,736,798	$1,736,798
Subtotal	**$0**	**$0**	**$17,848,441**	**$0**	**$17,848,441**	**$17,848,441**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$11,476	$0	$11,476	$11,476
Eastern	$0	$0	$19,456	$0	$19,456	$19,456
Pacific	$0	$0	$2,031	$0	$2,031	$2,031
Southern	$0	$0	$27,240	$0	$27,240	$27,240
Western	$0	$0	$12,042	$0	$12,042	$12,042
Subtotal	**$0**	**$0**	**$72,246**	**$0**	**$72,246**	**$72,246**
Landscaping and Facilities Support						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$507,726	$0	$507,726	$507,726

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$773,553	$0	$773,553	$773,553
Pacific	$0	$0	$71,873	$0	$71,873	$71,873
Southern	$0	$0	$1,125,493	$0	$1,125,493	$1,125,493
Western	$0	$0	$610,538	$0	$610,538	$610,538
Subtotal	**$0**	**$0**	**$3,089,185**	**$0**	**$3,089,185**	**$3,089,185**
Maintenance and Repair						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$222,942	$0	$222,942	$222,942
Eastern	$0	$0	$273,945	$0	$273,945	$273,945
Pacific	$0	$0	$15,795	$0	$15,795	$15,795
Southern	$0	$0	$438,537	$0	$438,537	$438,537
Western	$0	$0	$197,862	$0	$197,862	$197,862
Subtotal	**$0**	**$0**	**$1,149,081**	**$0**	**$1,149,081**	**$1,149,081**
Manufacturing						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$529,914	$0	$529,914	$529,914
Eastern	$0	$0	$516,810	$0	$516,810	$516,810
Pacific	$0	$0	$8,812	$0	$8,812	$8,812
Southern	$0	$0	$711,140	$0	$711,140	$711,140
Western	$0	$0	$261,112	$0	$261,112	$261,112
Subtotal	**$0**	**$0**	**$2,027,789**	**$0**	**$2,027,789**	**$2,027,789**
Oil and Gas						
Alaskan	$0	$0	$4	$0	$4	$4
Central	$0	$0	$95,998	$0	$95,998	$95,998
Eastern	$0	$0	$57,257	$0	$57,257	$57,257
Southern	$0	$0	$890,293	$0	$890,293	$890,293
Western	$0	$0	$58,298	$0	$58,298	$58,298
Subtotal	**$0**	**$0**	**$1,101,849**	**$0**	**$1,101,849**	**$1,101,849**
Postal and Delivery Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$80,470	$0	$80,470	$80,470
Eastern	$0	$0	$119,456	$0	$119,456	$119,456
Pacific	$0	$0	$5,817	$0	$5,817	$5,817
Southern	$0	$0	$156,028	$0	$156,028	$156,028
Western	$0	$0	$73,827	$0	$73,827	$73,827
Subtotal	**$0**	**$0**	**$435,598**	**$0**	**$435,598**	**$435,598**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Recreation and Amusement						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$288,790	$0	$288,790	$288,790
Eastern	$0	$0	$455,142	$0	$455,142	$455,142
Pacific	$0	$0	$27,480	$0	$27,480	$27,480
Southern	$0	$0	$733,313	$0	$733,313	$733,313
Western	$0	$0	$342,375	$0	$342,375	$342,375
Subtotal	**$0**	**$0**	**$1,847,101**	**$0**	**$1,847,101**	**$1,847,101**
Sanitation and Waste Removal						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$28,326	$0	$28,326	$28,326
Eastern	$0	$0	$45,492	$0	$45,492	$45,492
Pacific	$0	$0	$3,910	$0	$3,910	$3,910
Southern	$0	$0	$63,700	$0	$63,700	$63,700
Western	$0	$0	$28,103	$0	$28,103	$28,103
Subtotal	**$0**	**$0**	**$169,531**	**$0**	**$169,531**	**$169,531**
Telecommunications						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$61,192	$0	$61,192	$61,192
Eastern	$0	$0	$84,800	$0	$84,800	$84,800
Pacific	$0	$0	$4,751	$0	$4,751	$4,751
Southern	$0	$0	$129,833	$0	$129,833	$129,833
Western	$0	$0	$50,442	$0	$50,442	$50,442
Subtotal	**$0**	**$0**	**$331,018**	**$0**	**$331,018**	**$331,018**
Temporary Help Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$278,149	$0	$278,149	$278,149
Eastern	$0	$0	$344,411	$0	$344,411	$344,411
Pacific	$0	$0	$36,829	$0	$36,829	$36,829
Southern	$0	$0	$1,043,577	$0	$1,043,577	$1,043,577
Western	$0	$0	$323,758	$0	$323,758	$323,758
Subtotal	**$0**	**$0**	**$2,026,725**	**$0**	**$2,026,725**	**$2,026,725**
Transportation						
Alaskan	$0	$0	$3	$0	$3	$3
Central	$0	$0	$456,381	$0	$456,381	$456,381
Eastern	$0	$0	$436,573	$0	$436,573	$436,573

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$69,357	$0	$69,357	$69,357
Southern	$0	$0	$1,035,820	$0	$1,035,820	$1,035,820
Western	$0	$0	$256,606	$0	$256,606	$256,606
Subtotal	**$0**	**$0**	**$2,254,740**	**$0**	**$2,254,740**	**$2,254,740**
Utilities						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$257,850	$0	$257,850	$257,850
Eastern	$0	$0	$346,941	$0	$346,941	$346,941
Pacific	$0	$0	$6,406	$0	$6,406	$6,406
Southern	$0	$0	$520,692	$0	$520,692	$520,692
Western	$0	$0	$170,610	$0	$170,610	$170,610
Subtotal	**$0**	**$0**	**$1,302,500**	**$0**	**$1,302,500**	**$1,302,500**
Warehousing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$81,507	$0	$81,507	$81,507
Eastern	$0	$0	$114,085	$0	$114,085	$114,085
Pacific	$0	$0	$2,125	$0	$2,125	$2,125
Southern	$0	$0	$158,929	$0	$158,929	$158,929
Western	$0	$0	$75,873	$0	$75,873	$75,873
Subtotal	**$0**	**$0**	**$432,519**	**$0**	**$432,519**	**$432,519**
Non-Core						
Alaskan	$0	$0	$30	$0	$30	$30
Central	$0	$0	$8,624,746	$0	$8,624,746	$8,624,746
Eastern	$0	$0	$13,666,774	$0	$13,666,774	$13,666,774
Pacific	$0	$0	$981,519	$0	$981,519	$981,519
Southern	$0	$0	$13,733,045	$0	$13,733,045	$13,733,045
Western	$0	$0	$9,513,647	$0	$9,513,647	$9,513,647
Subtotal	**$0**	**$0**	**$46,519,760**	**$0**	**$46,519,760**	**$46,519,760**
Total Costs for New Outdoor Employee Acclimatization						
Alaskan	$0	$0	$56	$0	$56	$56
Central	$0	$0	$15,812,062	$0	$15,812,062	$15,812,062
Eastern	$0	$0	$22,691,309	$0	$22,691,309	$22,691,309
Pacific	$0	$0	$1,723,276	$0	$1,723,276	$1,723,276
Southern	$0	$0	$30,093,696	$0	$30,093,696	$30,093,696
Western	$0	$0	$14,306,888	$0	$14,306,888	$14,306,888
Total	**$0**	**$0**	**$84,627,286**	**$0**	**$84,627,286**	**$84,627,286**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Returning Indoor Employee Acclimatization						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$4,688	$0	$4,688	$4,688
Eastern	$0	$0	$2,865	$0	$2,865	$2,865
Pacific	$0	$0	$136	$0	$136	$136
Southern	$0	$0	$7,092	$0	$7,092	$7,092
Western	$0	$0	$6,503	$0	$6,503	$6,503
Subtotal	**$0**	**$0**	**$21,284**	**$0**	**$21,284**	**$21,284**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$5,665	$0	$5,665	$5,665
Eastern	$0	$0	$6,911	$0	$6,911	$6,911
Pacific	$0	$0	$461	$0	$461	$461
Southern	$0	$0	$11,569	$0	$11,569	$11,569
Western	$0	$0	$5,026	$0	$5,026	$5,026
Subtotal	**$0**	**$0**	**$29,632**	**$0**	**$29,632**	**$29,632**
Commercial Kitchens						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$16,124	$0	$16,124	$16,124
Eastern	$0	$0	$22,774	$0	$22,774	$22,774
Pacific	$0	$0	$2,386	$0	$2,386	$2,386
Southern	$0	$0	$37,431	$0	$37,431	$37,431
Western	$0	$0	$16,151	$0	$16,151	$16,151
Subtotal	**$0**	**$0**	**$94,866**	**$0**	**$94,866**	**$94,866**
Construction						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$40,091	$0	$40,091	$40,091
Eastern	$0	$0	$55,085	$0	$55,085	$55,085
Pacific	$0	$0	$4,992	$0	$4,992	$4,992
Southern	$0	$0	$90,641	$0	$90,641	$90,641
Western	$0	$0	$41,364	$0	$41,364	$41,364
Subtotal	**$0**	**$0**	**$232,173**	**$0**	**$232,173**	**$232,173**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$906	$0	$906	$906

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$1,536	$0	$1,536	$1,536
Pacific	$0	$0	$160	$0	$160	$160
Southern	$0	$0	$2,150	$0	$2,150	$2,150
Western	$0	$0	$951	$0	$951	$951
Subtotal	**$0**	**$0**	**$5,703**	**$0**	**$5,703**	**$5,703**
Landscaping and Facilities Support						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$7,457	$0	$7,457	$7,457
Eastern	$0	$0	$11,364	$0	$11,364	$11,364
Pacific	$0	$0	$990	$0	$990	$990
Southern	$0	$0	$16,560	$0	$16,560	$16,560
Western	$0	$0	$7,104	$0	$7,104	$7,104
Subtotal	**$0**	**$0**	**$43,475**	**$0**	**$43,475**	**$43,475**
Maintenance and Repair						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$7,006	$0	$7,006	$7,006
Eastern	$0	$0	$8,570	$0	$8,570	$8,570
Pacific	$0	$0	$486	$0	$486	$486
Southern	$0	$0	$13,990	$0	$13,990	$13,990
Western	$0	$0	$6,125	$0	$6,125	$6,125
Subtotal	**$0**	**$0**	**$36,177**	**$0**	**$36,177**	**$36,177**
Manufacturing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$122,175	$0	$122,175	$122,175
Eastern	$0	$0	$114,309	$0	$114,309	$114,309
Pacific	$0	$0	$1,501	$0	$1,501	$1,501
Southern	$0	$0	$144,730	$0	$144,730	$144,730
Western	$0	$0	$55,535	$0	$55,535	$55,535
Subtotal	**$0**	**$0**	**$438,250**	**$0**	**$438,250**	**$438,250**
Oil and Gas						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,123	$0	$1,123	$1,123
Eastern	$0	$0	$674	$0	$674	$674
Southern	$0	$0	$10,578	$0	$10,578	$10,578
Western	$0	$0	$781	$0	$781	$781
Subtotal	**$0**	**$0**	**$13,157**	**$0**	**$13,157**	**$13,157**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Postal and Delivery Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,822	$0	$1,822	$1,822
Eastern	$0	$0	$2,724	$0	$2,724	$2,724
Pacific	$0	$0	$126	$0	$126	$126
Southern	$0	$0	$3,570	$0	$3,570	$3,570
Western	$0	$0	$1,735	$0	$1,735	$1,735
Subtotal	**$0**	**$0**	**$9,978**	**$0**	**$9,978**	**$9,978**
Recreation and Amusement						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$942	$0	$942	$942
Eastern	$0	$0	$1,484	$0	$1,484	$1,484
Pacific	$0	$0	$89	$0	$89	$89
Southern	$0	$0	$2,404	$0	$2,404	$2,404
Western	$0	$0	$1,122	$0	$1,122	$1,122
Subtotal	**$0**	**$0**	**$6,041**	**$0**	**$6,041**	**$6,041**
Sanitation and Waste Removal						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$827	$0	$827	$827
Eastern	$0	$0	$1,252	$0	$1,252	$1,252
Pacific	$0	$0	$105	$0	$105	$105
Southern	$0	$0	$1,780	$0	$1,780	$1,780
Western	$0	$0	$796	$0	$796	$796
Subtotal	**$0**	**$0**	**$4,761**	**$0**	**$4,761**	**$4,761**
Telecommunications						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$3,492	$0	$3,492	$3,492
Eastern	$0	$0	$4,840	$0	$4,840	$4,840
Pacific	$0	$0	$271	$0	$271	$271
Southern	$0	$0	$7,410	$0	$7,410	$7,410
Western	$0	$0	$2,879	$0	$2,879	$2,879
Subtotal	**$0**	**$0**	**$18,893**	**$0**	**$18,893**	**$18,893**
Temporary Help Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$18,741	$0	$18,741	$18,741
Eastern	$0	$0	$23,206	$0	$23,206	$23,206

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$2,482	$0	$2,482	$2,482
Southern	$0	$0	$70,315	$0	$70,315	$70,315
Western	$0	$0	$21,815	$0	$21,815	$21,815
Subtotal	**$0**	**$0**	**$136,559**	**$0**	**$136,559**	**$136,559**
Transportation						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$6,448	$0	$6,448	$6,448
Eastern	$0	$0	$6,281	$0	$6,281	$6,281
Pacific	$0	$0	$961	$0	$961	$961
Southern	$0	$0	$14,726	$0	$14,726	$14,726
Western	$0	$0	$5,045	$0	$5,045	$5,045
Subtotal	**$0**	**$0**	**$33,461**	**$0**	**$33,461**	**$33,461**
Utilities						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$4,482	$0	$4,482	$4,482
Eastern	$0	$0	$6,029	$0	$6,029	$6,029
Pacific	$0	$0	$112	$0	$112	$112
Southern	$0	$0	$9,053	$0	$9,053	$9,053
Western	$0	$0	$2,970	$0	$2,970	$2,970
Subtotal	**$0**	**$0**	**$22,646**	**$0**	**$22,646**	**$22,646**
Warehousing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$3,599	$0	$3,599	$3,599
Eastern	$0	$0	$5,038	$0	$5,038	$5,038
Pacific	$0	$0	$94	$0	$94	$94
Southern	$0	$0	$7,018	$0	$7,018	$7,018
Western	$0	$0	$3,351	$0	$3,351	$3,351
Subtotal	**$0**	**$0**	**$19,100**	**$0**	**$19,100**	**$19,100**
Non-Core						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$374,077	$0	$374,077	$374,077
Eastern	$0	$0	$578,128	$0	$578,128	$578,128
Pacific	$0	$0	$35,713	$0	$35,713	$35,713
Southern	$0	$0	$545,004	$0	$545,004	$545,004
Western	$0	$0	$407,593	$0	$407,593	$407,593
Subtotal	**$0**	**$0**	**$1,940,516**	**$0**	**$1,940,516**	**$1,940,516**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Total Costs for Returning Indoor Employee Acclimatization						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$619,667	$0	$619,667	$619,667
Eastern	$0	$0	$853,071	$0	$853,071	$853,071
Pacific	$0	$0	$51,065	$0	$51,065	$51,065
Southern	$0	$0	$996,021	$0	$996,021	$996,021
Western	$0	$0	$586,847	$0	$586,847	$586,847
Total	**$0**	**$0**	**$3,106,673**	**$0**	**$3,106,673**	**$3,106,673**
Returning Outdoor Employee Acclimatization						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$13,470	$0	$13,470	$13,470
Eastern	$0	$0	$8,384	$0	$8,384	$8,384
Pacific	$0	$0	$391	$0	$391	$391
Southern	$0	$0	$20,608	$0	$20,608	$20,608
Western	$0	$0	$18,563	$0	$18,563	$18,563
Subtotal	**$0**	**$0**	**$61,417**	**$0**	**$61,417**	**$61,417**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$3,401	$0	$3,401	$3,401
Eastern	$0	$0	$4,165	$0	$4,165	$4,165
Pacific	$0	$0	$282	$0	$282	$282
Southern	$0	$0	$7,291	$0	$7,291	$7,291
Western	$0	$0	$3,127	$0	$3,127	$3,127
Subtotal	**$0**	**$0**	**$18,266**	**$0**	**$18,266**	**$18,266**
Commercial Kitchens						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,652	$0	$1,652	$1,652
Eastern	$0	$0	$2,329	$0	$2,329	$2,329
Pacific	$0	$0	$247	$0	$247	$247
Southern	$0	$0	$3,706	$0	$3,706	$3,706
Western	$0	$0	$1,641	$0	$1,641	$1,641
Subtotal	**$0**	**$0**	**$9,576**	**$0**	**$9,576**	**$9,576**
Construction						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$76,776	$0	$76,776	$76,776

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$104,503	$0	$104,503	$104,503
Pacific	$0	$0	$9,850	$0	$9,850	$9,850
Southern	$0	$0	$174,940	$0	$174,940	$174,940
Western	$0	$0	$80,015	$0	$80,015	$80,015
Subtotal	**$0**	**$0**	**$446,085**	**$0**	**$446,085**	**$446,085**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$296	$0	$296	$296
Eastern	$0	$0	$501	$0	$501	$501
Pacific	$0	$0	$52	$0	$52	$52
Southern	$0	$0	$702	$0	$702	$702
Western	$0	$0	$310	$0	$310	$310
Subtotal	**$0**	**$0**	**$1,862**	**$0**	**$1,862**	**$1,862**
Landscaping and Facilities Support						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$16,658	$0	$16,658	$16,658
Eastern	$0	$0	$25,377	$0	$25,377	$25,377
Pacific	$0	$0	$2,343	$0	$2,343	$2,343
Southern	$0	$0	$37,002	$0	$37,002	$37,002
Western	$0	$0	$15,747	$0	$15,747	$15,747
Subtotal	**$0**	**$0**	**$97,128**	**$0**	**$97,128**	**$97,128**
Maintenance and Repair						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$5,744	$0	$5,744	$5,744
Eastern	$0	$0	$7,059	$0	$7,059	$7,059
Pacific	$0	$0	$407	$0	$407	$407
Southern	$0	$0	$11,300	$0	$11,300	$11,300
Western	$0	$0	$5,098	$0	$5,098	$5,098
Subtotal	**$0**	**$0**	**$29,608**	**$0**	**$29,608**	**$29,608**
Manufacturing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$27,418	$0	$27,418	$27,418
Eastern	$0	$0	$26,740	$0	$26,740	$26,740
Pacific	$0	$0	$456	$0	$456	$456
Southern	$0	$0	$36,794	$0	$36,794	$36,794
Western	$0	$0	$13,510	$0	$13,510	$13,510

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$104,918**	**$0**	**$104,918**	**$104,918**
Oil and Gas						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$2,029	$0	$2,029	$2,029
Eastern	$0	$0	$1,221	$0	$1,221	$1,221
Southern	$0	$0	$19,469	$0	$19,469	$19,469
Western	$0	$0	$1,434	$0	$1,434	$1,434
Subtotal	**$0**	**$0**	**$24,153**	**$0**	**$24,153**	**$24,153**
Postal and Delivery Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,486	$0	$1,486	$1,486
Eastern	$0	$0	$2,205	$0	$2,205	$2,205
Pacific	$0	$0	$107	$0	$107	$107
Southern	$0	$0	$2,881	$0	$2,881	$2,881
Western	$0	$0	$1,363	$0	$1,363	$1,363
Subtotal	**$0**	**$0**	**$8,042**	**$0**	**$8,042**	**$8,042**
Recreation and Amusement						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,284	$0	$1,284	$1,284
Eastern	$0	$0	$2,024	$0	$2,024	$2,024
Pacific	$0	$0	$121	$0	$121	$121
Southern	$0	$0	$3,259	$0	$3,259	$3,259
Western	$0	$0	$1,524	$0	$1,524	$1,524
Subtotal	**$0**	**$0**	**$8,213**	**$0**	**$8,213**	**$8,213**
Sanitation and Waste Removal						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$973	$0	$973	$973
Eastern	$0	$0	$1,563	$0	$1,563	$1,563
Pacific	$0	$0	$134	$0	$134	$134
Southern	$0	$0	$2,188	$0	$2,188	$2,188
Western	$0	$0	$965	$0	$965	$965
Subtotal	**$0**	**$0**	**$5,823**	**$0**	**$5,823**	**$5,823**
Telecommunications						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$2,897	$0	$2,897	$2,897
Eastern	$0	$0	$4,014	$0	$4,014	$4,014

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$225	$0	$225	$225
Southern	$0	$0	$6,146	$0	$6,146	$6,146
Western	$0	$0	$2,388	$0	$2,388	$2,388
Subtotal	**$0**	**$0**	**$15,670**	**$0**	**$15,670**	**$15,670**
Temporary Help Services						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$9,554	$0	$9,554	$9,554
Eastern	$0	$0	$11,830	$0	$11,830	$11,830
Pacific	$0	$0	$1,265	$0	$1,265	$1,265
Southern	$0	$0	$35,845	$0	$35,845	$35,845
Western	$0	$0	$11,120	$0	$11,120	$11,120
Subtotal	**$0**	**$0**	**$69,614**	**$0**	**$69,614**	**$69,614**
Transportation						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$8,425	$0	$8,425	$8,425
Eastern	$0	$0	$8,060	$0	$8,060	$8,060
Pacific	$0	$0	$1,280	$0	$1,280	$1,280
Southern	$0	$0	$19,123	$0	$19,123	$19,123
Western	$0	$0	$6,496	$0	$6,496	$6,496
Subtotal	**$0**	**$0**	**$43,384**	**$0**	**$43,384**	**$43,384**
Utilities						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$6,202	$0	$6,202	$6,202
Eastern	$0	$0	$8,345	$0	$8,345	$8,345
Pacific	$0	$0	$154	$0	$154	$154
Southern	$0	$0	$12,524	$0	$12,524	$12,524
Western	$0	$0	$4,104	$0	$4,104	$4,104
Subtotal	**$0**	**$0**	**$31,329**	**$0**	**$31,329**	**$31,329**
Warehousing						
Alaskan	$0	$0	$0	$0	$0	$0
Central	$0	$0	$1,505	$0	$1,505	$1,505
Eastern	$0	$0	$2,106	$0	$2,106	$2,106
Pacific	$0	$0	$39	$0	$39	$39
Southern	$0	$0	$2,934	$0	$2,934	$2,934
Western	$0	$0	$1,401	$0	$1,401	$1,401
Subtotal	**$0**	**$0**	**$7,985**	**$0**	**$7,985**	**$7,985**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Non-Core						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$333,854	$0	$333,854	$333,854
Eastern	$0	$0	$542,408	$0	$542,408	$542,408
Pacific	$0	$0	$35,984	$0	$35,984	$35,984
Southern	$0	$0	$394,771	$0	$394,771	$394,771
Western	$0	$0	$406,653	$0	$406,653	$406,653
Subtotal	**$0**	**$0**	**$1,713,672**	**$0**	**$1,713,672**	**$1,713,672**
Total Costs for Returning Outdoor Employee Acclimatization						
Alaskan	$0	$0	$2	$0	$2	$2
Central	$0	$0	$513,623	$0	$513,623	$513,623
Eastern	$0	$0	$762,835	$0	$762,835	$762,835
Pacific	$0	$0	$53,340	$0	$53,340	$53,340
Southern	$0	$0	$791,484	$0	$791,484	$791,484
Western	$0	$0	$575,460	$0	$575,460	$575,460
Total	**$0**	**$0**	**$2,696,744**	**$0**	**$2,696,744**	**$2,696,744**
Rest Breaks at Initial Heat Trigger – Indoor						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$8	$2	$6	$6
Central	$0	$0	$494,281	$115,332	$378,949	$378,949
Eastern	$0	$0	$285,957	$66,723	$219,234	$219,234
Pacific	$0	$0	$15,605	$3,641	$11,964	$11,964
Southern	$0	$0	$795,586	$185,637	$609,949	$609,949
Western	$0	$0	$661,911	$154,446	$507,465	$507,465
Subtotal	**$0**	**$0**	**$2,253,348**	**$525,781**	**$1,727,567**	**$1,727,567**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$30	$7	$23	$23
Central	$0	$0	$542,090	$126,488	$415,602	$415,602
Eastern	$0	$0	$654,987	$152,830	$502,157	$502,157
Pacific	$0	$0	$48,716	$11,367	$37,349	$37,349
Southern	$0	$0	$1,259,531	$293,891	$965,641	$965,641
Western	$0	$0	$489,137	$114,132	$375,005	$375,005
Subtotal	**$0**	**$0**	**$2,994,491**	**$698,714**	**$2,295,776**	**$2,295,776**
Commercial Kitchens						
Alaskan	$0	$0	$73	$17	$56	$56
Central	$0	$0	$1,857,283	$433,366	$1,423,917	$1,423,917

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$2,613,642	$609,850	$2,003,792	$2,003,792
Pacific	$0	$0	$436,216	$101,784	$334,433	$334,433
Southern	$0	$0	$5,793,449	$1,351,805	$4,441,644	$4,441,644
Western	$0	$0	$1,917,574	$447,434	$1,470,140	$1,470,140
Subtotal	**$0**	**$0**	**$12,618,237**	**$2,944,255**	**$9,673,982**	**$9,673,982**
Construction						
Alaskan	$0	$0	$246	$57	$189	$189
Central	$0	$0	$3,219,194	$751,145	$2,468,049	$2,468,049
Eastern	$0	$0	$4,443,035	$1,036,708	$3,406,327	$3,406,327
Pacific	$0	$0	$502,541	$117,260	$385,282	$385,282
Southern	$0	$0	$8,615,101	$2,010,190	$6,604,911	$6,604,911
Western	$0	$0	$3,402,628	$793,947	$2,608,682	$2,608,682
Subtotal	**$0**	**$0**	**$20,182,745**	**$4,709,307**	**$15,473,438**	**$15,473,438**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$4	$1	$3	$3
Central	$0	$0	$87,222	$20,352	$66,870	$66,870
Eastern	$0	$0	$147,275	$34,364	$112,911	$112,911
Pacific	$0	$0	$17,020	$3,971	$13,048	$13,048
Southern	$0	$0	$239,057	$55,780	$183,277	$183,277
Western	$0	$0	$92,951	$21,689	$71,263	$71,263
Subtotal	**$0**	**$0**	**$583,529**	**$136,157**	**$447,372**	**$447,372**
Landscaping and Facilities Support						
Alaskan	$0	$0	$75	$17	$57	$57
Central	$0	$0	$705,904	$164,711	$541,193	$541,193
Eastern	$0	$0	$1,087,767	$253,812	$833,955	$833,955
Pacific	$0	$0	$99,076	$23,118	$75,959	$75,959
Southern	$0	$0	$1,798,521	$419,655	$1,378,866	$1,378,866
Western	$0	$0	$685,161	$159,871	$525,290	$525,290
Subtotal	**$0**	**$0**	**$4,376,505**	**$1,021,184**	**$3,355,320**	**$3,355,320**
Maintenance and Repair						
Alaskan	$0	$0	$34	$8	$26	$26
Central	$0	$0	$675,747	$157,674	$518,072	$518,072
Eastern	$0	$0	$834,797	$194,786	$640,011	$640,011
Pacific	$0	$0	$52,772	$12,313	$40,458	$40,458
Southern	$0	$0	$1,556,716	$363,234	$1,193,482	$1,193,482
Western	$0	$0	$608,916	$142,080	$466,836	$466,836

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$3,728,982**	**$870,096**	**$2,858,886**	**$2,858,886**
Manufacturing						
Alaskan	$0	$0	$143	$33	$110	$110
Central	$0	$0	$8,513,706	$1,986,531	$6,527,175	$6,527,175
Eastern	$0	$0	$8,181,403	$1,908,994	$6,272,409	$6,272,409
Pacific	$0	$0	$107,956	$25,190	$82,766	$82,766
Southern	$0	$0	$11,413,732	$2,663,204	$8,750,528	$8,750,528
Western	$0	$0	$4,062,091	$947,821	$3,114,270	$3,114,270
Subtotal	**$0**	**$0**	**$32,279,030**	**$7,531,774**	**$24,747,257**	**$24,747,257**
Oil and Gas						
Alaskan	$0	$0	$86	$20	$66	$66
Central	$0	$0	$113,630	$26,514	$87,116	$87,116
Eastern	$0	$0	$64,273	$14,997	$49,276	$49,276
Southern	$0	$0	$1,170,506	$273,118	$897,388	$897,388
Western	$0	$0	$77,990	$18,198	$59,792	$59,792
Subtotal	**$0**	**$0**	**$1,426,485**	**$332,846**	**$1,093,638**	**$1,093,638**
Postal and Delivery Services						
Alaskan	$0	$0	$5	$1	$4	$4
Central	$0	$0	$181,573	$42,367	$139,206	$139,206
Eastern	$0	$0	$269,273	$62,830	$206,442	$206,442
Pacific	$0	$0	$14,502	$3,384	$11,118	$11,118
Southern	$0	$0	$418,102	$97,557	$320,545	$320,545
Western	$0	$0	$177,024	$41,306	$135,719	$135,719
Subtotal	**$0**	**$0**	**$1,060,480**	**$247,445**	**$813,034**	**$813,034**
Recreation and Amusement						
Alaskan	$0	$0	$6	$1	$4	$4
Central	$0	$0	$125,999	$29,400	$96,599	$96,599
Eastern	$0	$0	$194,885	$45,473	$149,412	$149,412
Pacific	$0	$0	$22,307	$5,205	$17,102	$17,102
Southern	$0	$0	$456,939	$106,619	$350,320	$350,320
Western	$0	$0	$153,737	$35,872	$117,865	$117,865
Subtotal	**$0**	**$0**	**$953,872**	**$222,570**	**$731,302**	**$731,302**
Sanitation and Waste Removal						
Alaskan	$0	$0	$13	$3	$10	$10
Central	$0	$0	$78,193	$18,245	$59,948	$59,948
Eastern	$0	$0	$117,476	$27,411	$90,065	$90,065

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$10,513	$2,453	$8,060	$8,060
Southern	$0	$0	$191,472	$44,677	$146,795	$146,795
Western	$0	$0	$77,662	$18,121	$59,541	$59,541
Subtotal	**$0**	**$0**	**$475,329**	**$110,910**	**$364,419**	**$364,419**
Telecommunications						
Alaskan	$0	$0	$35	$8	$27	$27
Central	$0	$0	$326,875	$76,271	$250,604	$250,604
Eastern	$0	$0	$451,879	$105,439	$346,441	$346,441
Pacific	$0	$0	$24,069	$5,616	$18,453	$18,453
Southern	$0	$0	$773,027	$180,373	$592,654	$592,654
Western	$0	$0	$274,288	$64,001	$210,288	$210,288
Subtotal	**$0**	**$0**	**$1,850,175**	**$431,707**	**$1,418,467**	**$1,418,467**
Temporary Help Services						
Alaskan	$0	$0	$11	$2	$8	$8
Central	$0	$0	$1,764,509	$411,719	$1,352,790	$1,352,790
Eastern	$0	$0	$2,223,951	$518,922	$1,705,029	$1,705,029
Pacific	$0	$0	$237,694	$55,462	$182,232	$182,232
Southern	$0	$0	$7,717,829	$1,800,827	$5,917,003	$5,917,003
Western	$0	$0	$2,078,922	$485,082	$1,593,840	$1,593,840
Subtotal	**$0**	**$0**	**$14,022,916**	**$3,272,014**	**$10,750,903**	**$10,750,903**
Transportation						
Alaskan	$0	$0	$78	$18	$60	$60
Central	$0	$0	$644,184	$150,310	$493,874	$493,874
Eastern	$0	$0	$626,041	$146,076	$479,965	$479,965
Pacific	$0	$0	$114,259	$26,660	$87,598	$87,598
Southern	$0	$0	$1,718,290	$400,934	$1,317,356	$1,317,356
Western	$0	$0	$519,628	$121,246	$398,381	$398,381
Subtotal	**$0**	**$0**	**$3,622,479**	**$845,245**	**$2,777,234**	**$2,777,234**
Utilities						
Alaskan	$0	$0	$34	$8	$26	$26
Central	$0	$0	$433,621	$101,178	$332,443	$332,443
Eastern	$0	$0	$581,993	$135,798	$446,195	$446,195
Pacific	$0	$0	$13,832	$3,228	$10,605	$10,605
Southern	$0	$0	$1,004,639	$234,416	$770,223	$770,223
Western	$0	$0	$303,370	$70,786	$232,584	$232,584
Subtotal	**$0**	**$0**	**$2,337,489**	**$545,414**	**$1,792,075**	**$1,792,075**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Warehousing						
Alaskan	$0	$0	$3	$1	$2	$2
Central	$0	$0	$359,090	$83,788	$275,302	$275,302
Eastern	$0	$0	$508,162	$118,571	$389,591	$389,591
Pacific	$0	$0	$11,186	$2,610	$8,576	$8,576
Southern	$0	$0	$810,689	$189,161	$621,528	$621,528
Western	$0	$0	$338,273	$78,930	$259,343	$259,343
Subtotal	**$0**	**$0**	**$2,027,404**	**$473,061**	**$1,554,343**	**$1,554,343**
Non-Core						
Alaskan	$0	$0	$1,385	$323	$1,062	$1,062
Central	$0	$0	$19,589,073	$4,570,784	$15,018,289	$15,018,289
Eastern	$0	$0	$30,377,960	$7,088,191	$23,289,770	$23,289,770
Pacific	$0	$0	$1,959,466	$457,209	$1,502,257	$1,502,257
Southern	$0	$0	$33,508,390	$7,818,624	$25,689,765	$25,689,765
Western	$0	$0	$21,969,623	$5,126,245	$16,843,378	$16,843,378
Subtotal	**$0**	**$0**	**$107,405,896**	**$25,061,376**	**$82,344,521**	**$82,344,521**
Total Costs for Rest Breaks at Initial Heat Trigger – Indoor						
Alaskan	$0	$0	$2,268	$529	$1,739	$1,739
Central	$0	$0	$39,712,173	$9,266,174	$30,445,999	$30,445,999
Eastern	$0	$0	$53,664,756	$12,521,777	$41,142,980	$41,142,980
Pacific	$0	$0	$3,687,730	$860,470	$2,827,260	$2,827,260
Southern	$0	$0	$79,241,576	$18,489,701	$60,751,875	$60,751,875
Western	$0	$0	$37,890,887	$8,841,207	$29,049,680	$29,049,680
Total	**$0**	**$0**	**$214,199,392**	**$49,979,858**	**$164,219,534**	**$164,219,534**
Rest Breaks at Initial Heat Trigger – Outdoor						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$26	$5	$21	$21
Central	$0	$0	$1,447,844	$289,569	$1,158,275	$1,158,275
Eastern	$0	$0	$854,788	$170,958	$683,830	$683,830
Pacific	$0	$0	$45,903	$9,181	$36,722	$36,722
Southern	$0	$0	$2,356,557	$471,311	$1,885,246	$1,885,246
Western	$0	$0	$1,932,124	$386,425	$1,545,700	$1,545,700
Subtotal	**$0**	**$0**	**$6,637,243**	**$1,327,449**	**$5,309,794**	**$5,309,794**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$19	$4	$15	$15
Central	$0	$0	$331,125	$66,225	$264,900	$264,900

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$402,033	$80,407	$321,626	$321,626
Pacific	$0	$0	$30,235	$6,047	$24,188	$24,188
Southern	$0	$0	$807,047	$161,409	$645,638	$645,638
Western	$0	$0	$309,009	$61,802	$247,207	$247,207
Subtotal	**$0**	**$0**	**$1,879,467**	**$375,893**	**$1,503,574**	**$1,503,574**
Commercial Kitchens						
Alaskan	$0	$0	$8	$2	$6	$6
Central	$0	$0	$188,883	$37,777	$151,106	$151,106
Eastern	$0	$0	$264,517	$52,903	$211,613	$211,613
Pacific	$0	$0	$43,628	$8,726	$34,903	$34,903
Southern	$0	$0	$568,982	$113,796	$455,186	$455,186
Western	$0	$0	$193,195	$38,639	$154,556	$154,556
Subtotal	**$0**	**$0**	**$1,259,213**	**$251,843**	**$1,007,371**	**$1,007,371**
Construction						
Alaskan	$0	$0	$441	$88	$353	$353
Central	$0	$0	$6,152,988	$1,230,598	$4,922,390	$4,922,390
Eastern	$0	$0	$8,382,560	$1,676,512	$6,706,048	$6,706,048
Pacific	$0	$0	$995,358	$199,072	$796,286	$796,286
Southern	$0	$0	$16,580,548	$3,316,110	$13,264,438	$13,264,438
Western	$0	$0	$6,576,720	$1,315,344	$5,261,376	$5,261,376
Subtotal	**$0**	**$0**	**$38,688,614**	**$7,737,723**	**$30,950,891**	**$30,950,891**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$29,041	$5,808	$23,232	$23,232
Eastern	$0	$0	$49,035	$9,807	$39,228	$39,228
Pacific	$0	$0	$5,667	$1,133	$4,533	$4,533
Southern	$0	$0	$79,594	$15,919	$63,675	$63,675
Western	$0	$0	$30,948	$6,190	$24,759	$24,759
Subtotal	**$0**	**$0**	**$194,286**	**$38,857**	**$155,429**	**$155,429**
Landscaping and Facilities Support						
Alaskan	$0	$0	$127	$25	$102	$102
Central	$0	$0	$1,609,058	$321,812	$1,287,246	$1,287,246
Eastern	$0	$0	$2,479,858	$495,972	$1,983,886	$1,983,886
Pacific	$0	$0	$239,411	$47,882	$191,529	$191,529
Southern	$0	$0	$4,100,068	$820,014	$3,280,054	$3,280,054
Western	$0	$0	$1,553,009	$310,602	$1,242,407	$1,242,407

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$9,981,530**	**$1,996,306**	**$7,985,224**	**$7,985,224**
Maintenance and Repair						
Alaskan	$0	$0	$29	$6	$23	$23
Central	$0	$0	$565,344	$113,069	$452,275	$452,275
Eastern	$0	$0	$700,860	$140,172	$560,688	$560,688
Pacific	$0	$0	$45,008	$9,002	$36,006	$36,006
Southern	$0	$0	$1,283,101	$256,620	$1,026,481	$1,026,481
Western	$0	$0	$516,573	$103,315	$413,258	$413,258
Subtotal	**$0**	**$0**	**$3,110,915**	**$622,183**	**$2,488,732**	**$2,488,732**
Manufacturing						
Alaskan	$0	$0	$51	$10	$41	$41
Central	$0	$0	$1,954,406	$390,881	$1,563,525	$1,563,525
Eastern	$0	$0	$1,956,554	$391,311	$1,565,244	$1,565,244
Pacific	$0	$0	$33,381	$6,676	$26,705	$26,705
Southern	$0	$0	$2,961,164	$592,233	$2,368,931	$2,368,931
Western	$0	$0	$1,008,707	$201,741	$806,965	$806,965
Subtotal	**$0**	**$0**	**$7,914,264**	**$1,582,853**	**$6,331,411**	**$6,331,411**
Oil and Gas						
Alaskan	$0	$0	$164	$33	$131	$131
Central	$0	$0	$209,271	$41,854	$167,417	$167,417
Eastern	$0	$0	$118,661	$23,732	$94,929	$94,929
Southern	$0	$0	$2,196,724	$439,345	$1,757,379	$1,757,379
Western	$0	$0	$145,839	$29,168	$116,671	$116,671
Subtotal	**$0**	**$0**	**$2,670,659**	**$534,132**	**$2,136,527**	**$2,136,527**
Postal and Delivery Services						
Alaskan	$0	$0	$5	$1	$4	$4
Central	$0	$0	$150,995	$30,199	$120,796	$120,796
Eastern	$0	$0	$222,509	$44,502	$178,007	$178,007
Pacific	$0	$0	$12,567	$2,513	$10,053	$10,053
Southern	$0	$0	$343,861	$68,772	$275,089	$275,089
Western	$0	$0	$141,847	$28,369	$113,478	$113,478
Subtotal	**$0**	**$0**	**$871,785**	**$174,357**	**$697,428**	**$697,428**
Recreation and Amusement						
Alaskan	$0	$0	$8	$2	$6	$6
Central	$0	$0	$175,190	$35,038	$140,152	$140,152
Eastern	$0	$0	$271,067	$54,213	$216,853	$216,853

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$30,901	$6,180	$24,721	$24,721
Southern	$0	$0	$631,736	$126,347	$505,389	$505,389
Western	$0	$0	$213,035	$42,607	$170,428	$170,428
Subtotal	**$0**	**$0**	**$1,321,937**	**$264,387**	**$1,057,550**	**$1,057,550**
Sanitation and Waste Removal						
Alaskan	$0	$0	$19	$4	$15	$15
Central	$0	$0	$93,862	$18,772	$75,090	$75,090
Eastern	$0	$0	$149,142	$29,828	$119,314	$119,314
Pacific	$0	$0	$13,534	$2,707	$10,827	$10,827
Southern	$0	$0	$239,950	$47,990	$191,960	$191,960
Western	$0	$0	$95,962	$19,192	$76,770	$76,770
Subtotal	**$0**	**$0**	**$592,470**	**$118,494**	**$473,976**	**$473,976**
Telecommunications						
Alaskan	$0	$0	$30	$6	$24	$24
Central	$0	$0	$276,569	$55,314	$221,255	$221,255
Eastern	$0	$0	$382,333	$76,467	$305,867	$305,867
Pacific	$0	$0	$20,365	$4,073	$16,292	$16,292
Southern	$0	$0	$654,055	$130,811	$523,244	$523,244
Western	$0	$0	$232,075	$46,415	$185,660	$185,660
Subtotal	**$0**	**$0**	**$1,565,427**	**$313,085**	**$1,252,342**	**$1,252,342**
Temporary Help Services						
Alaskan	$0	$0	$6	$1	$4	$4
Central	$0	$0	$917,544	$183,509	$734,035	$734,035
Eastern	$0	$0	$1,156,453	$231,291	$925,162	$925,162
Pacific	$0	$0	$123,601	$24,720	$98,881	$98,881
Southern	$0	$0	$4,013,267	$802,653	$3,210,613	$3,210,613
Western	$0	$0	$1,081,038	$216,208	$864,831	$864,831
Subtotal	**$0**	**$0**	**$7,291,908**	**$1,458,382**	**$5,833,527**	**$5,833,527**
Transportation						
Alaskan	$0	$0	$112	$22	$90	$90
Central	$0	$0	$858,719	$171,744	$686,975	$686,975
Eastern	$0	$0	$818,869	$163,774	$655,096	$655,096
Pacific	$0	$0	$154,829	$30,966	$123,863	$123,863
Southern	$0	$0	$2,274,433	$454,887	$1,819,546	$1,819,546
Western	$0	$0	$683,172	$136,634	$546,538	$546,538
Subtotal	**$0**	**$0**	**$4,790,135**	**$958,027**	**$3,832,108**	**$3,832,108**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Utilities						
Alaskan	$0	$0	$47	$9	$38	$38
Central	$0	$0	$612,027	$122,405	$489,621	$489,621
Eastern	$0	$0	$821,643	$164,329	$657,315	$657,315
Pacific	$0	$0	$19,465	$3,893	$15,572	$15,572
Southern	$0	$0	$1,417,789	$283,558	$1,134,231	$1,134,231
Western	$0	$0	$427,591	$85,518	$342,073	$342,073
Subtotal	**$0**	**$0**	**$3,298,562**	**$659,712**	**$2,638,849**	**$2,638,849**
Warehousing						
Alaskan	$0	$0	$1	$0	$1	$1
Central	$0	$0	$153,135	$30,627	$122,508	$122,508
Eastern	$0	$0	$216,708	$43,342	$173,366	$173,366
Pacific	$0	$0	$4,770	$954	$3,816	$3,816
Southern	$0	$0	$345,721	$69,144	$276,577	$276,577
Western	$0	$0	$144,258	$28,852	$115,406	$115,406
Subtotal	**$0**	**$0**	**$864,594**	**$172,919**	**$691,675**	**$691,675**
Non-Core						
Alaskan	$0	$0	$1,602	$320	$1,282	$1,282
Central	$0	$0	$17,577,924	$3,515,585	$14,062,339	$14,062,339
Eastern	$0	$0	$28,801,093	$5,760,219	$23,040,875	$23,040,875
Pacific	$0	$0	$1,933,219	$386,644	$1,546,575	$1,546,575
Southern	$0	$0	$24,553,870	$4,910,774	$19,643,096	$19,643,096
Western	$0	$0	$22,012,012	$4,402,402	$17,609,610	$17,609,610
Subtotal	**$0**	**$0**	**$94,879,721**	**$18,975,944**	**$75,903,777**	**$75,903,777**
Total Costs for Rest Breaks at Initial Heat Trigger – Outdoor						
Alaskan	$0	$0	$2,698	$540	$2,158	$2,158
Central	$0	$0	$33,303,923	$6,660,785	$26,643,138	$26,643,138
Eastern	$0	$0	$48,048,684	$9,609,737	$38,438,947	$38,438,947
Pacific	$0	$0	$3,751,841	$750,368	$3,001,473	$3,001,473
Southern	$0	$0	$65,408,469	$13,081,694	$52,326,776	$52,326,776
Western	$0	$0	$37,297,115	$7,459,423	$29,837,692	$29,837,692
Total	**$0**	**$0**	**$187,812,730**	**$37,562,546**	**$150,250,184**	**$150,250,184**
Effective Communication – Supervisor						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$28	$0	$28	$28
Central	$0	$0	$1,964,364	$0	$1,964,364	$1,964,364

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$1,215,238	$0	$1,215,238	$1,215,238
Pacific	$0	$0	$44,631	$0	$44,631	$44,631
Southern	$0	$0	$4,074,345	$0	$4,074,345	$4,074,345
Western	$0	$0	$2,888,709	$0	$2,888,709	$2,888,709
Subtotal	**$0**	**$0**	**$10,187,315**	**$0**	**$10,187,315**	**$10,187,315**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$36	$0	$36	$36
Central	$0	$0	$765,503	$0	$765,503	$765,503
Eastern	$0	$0	$961,428	$0	$961,428	$961,428
Pacific	$0	$0	$54,471	$0	$54,471	$54,471
Southern	$0	$0	$2,264,317	$0	$2,264,317	$2,264,317
Western	$0	$0	$764,695	$0	$764,695	$764,695
Subtotal	**$0**	**$0**	**$4,810,451**	**$0**	**$4,810,451**	**$4,810,451**
Commercial Kitchens						
Alaskan	$0	$0	$131	$0	$131	$131
Central	$0	$0	$3,143,911	$0	$3,143,911	$3,143,911
Eastern	$0	$0	$4,732,451	$0	$4,732,451	$4,732,451
Pacific	$0	$0	$380,104	$0	$380,104	$380,104
Southern	$0	$0	$10,585,830	$0	$10,585,830	$10,585,830
Western	$0	$0	$3,623,278	$0	$3,623,278	$3,623,278
Subtotal	**$0**	**$0**	**$22,465,706**	**$0**	**$22,465,706**	**$22,465,706**
Construction						
Alaskan	$0	$0	$559	$0	$559	$559
Central	$0	$0	$9,137,347	$0	$9,137,347	$9,137,347
Eastern	$0	$0	$13,712,035	$0	$13,712,035	$13,712,035
Pacific	$0	$0	$992,545	$0	$992,545	$992,545
Southern	$0	$0	$31,427,215	$0	$31,427,215	$31,427,215
Western	$0	$0	$10,961,509	$0	$10,961,509	$10,961,509
Subtotal	**$0**	**$0**	**$66,231,210**	**$0**	**$66,231,210**	**$66,231,210**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$4	$0	$4	$4
Central	$0	$0	$105,390	$0	$105,390	$105,390
Eastern	$0	$0	$192,692	$0	$192,692	$192,692
Pacific	$0	$0	$15,964	$0	$15,964	$15,964
Southern	$0	$0	$369,774	$0	$369,774	$369,774
Western	$0	$0	$127,300	$0	$127,300	$127,300

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$811,123**	**$0**	**$811,123**	**$811,123**
Landscaping and Facilities Support						
Alaskan	$0	$0	$156	$0	$156	$156
Central	$0	$0	$2,235,263	$0	$2,235,263	$2,235,263
Eastern	$0	$0	$3,759,687	$0	$3,759,687	$3,759,687
Pacific	$0	$0	$263,459	$0	$263,459	$263,459
Southern	$0	$0	$7,391,500	$0	$7,391,500	$7,391,500
Western	$0	$0	$2,457,942	$0	$2,457,942	$2,457,942
Subtotal	**$0**	**$0**	**$16,108,008**	**$0**	**$16,108,008**	**$16,108,008**
Maintenance and Repair						
Alaskan	$0	$0	$45	$0	$45	$45
Central	$0	$0	$1,088,876	$0	$1,088,876	$1,088,876
Eastern	$0	$0	$1,448,306	$0	$1,448,306	$1,448,306
Pacific	$0	$0	$65,204	$0	$65,204	$65,204
Southern	$0	$0	$3,198,265	$0	$3,198,265	$3,198,265
Western	$0	$0	$1,106,431	$0	$1,106,431	$1,106,431
Subtotal	**$0**	**$0**	**$6,907,125**	**$0**	**$6,907,125**	**$6,907,125**
Manufacturing						
Alaskan	$0	$0	$151	$0	$151	$151
Central	$0	$0	$10,477,364	$0	$10,477,364	$10,477,364
Eastern	$0	$0	$10,527,247	$0	$10,527,247	$10,527,247
Pacific	$0	$0	$116,915	$0	$116,915	$116,915
Southern	$0	$0	$18,442,859	$0	$18,442,859	$18,442,859
Western	$0	$0	$5,656,280	$0	$5,656,280	$5,656,280
Subtotal	**$0**	**$0**	**$45,220,816**	**$0**	**$45,220,816**	**$45,220,816**
Oil and Gas						
Alaskan	$0	$0	$197	$0	$197	$197
Central	$0	$0	$294,598	$0	$294,598	$294,598
Eastern	$0	$0	$178,004	$0	$178,004	$178,004
Southern	$0	$0	$4,394,986	$0	$4,394,986	$4,394,986
Western	$0	$0	$213,864	$0	$213,864	$213,864
Subtotal	**$0**	**$0**	**$5,081,648**	**$0**	**$5,081,648**	**$5,081,648**
Postal and Delivery Services						
Alaskan	$0	$0	$10	$0	$10	$10
Central	$0	$0	$380,967	$0	$380,967	$380,967
Eastern	$0	$0	$605,787	$0	$605,787	$605,787

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$22,894	$0	$22,894	$22,894
Southern	$0	$0	$1,074,645	$0	$1,074,645	$1,074,645
Western	$0	$0	$409,080	$0	$409,080	$409,080
Subtotal	**$0**	**$0**	**$2,493,383**	**$0**	**$2,493,383**	**$2,493,383**
Recreation and Amusement						
Alaskan	$0	$0	$33	$0	$33	$33
Central	$0	$0	$660,935	$0	$660,935	$660,935
Eastern	$0	$0	$1,121,133	$0	$1,121,133	$1,121,133
Pacific	$0	$0	$54,251	$0	$54,251	$54,251
Southern	$0	$0	$2,414,130	$0	$2,414,130	$2,414,130
Western	$0	$0	$906,381	$0	$906,381	$906,381
Subtotal	**$0**	**$0**	**$5,156,864**	**$0**	**$5,156,864**	**$5,156,864**
Sanitation and Waste Removal						
Alaskan	$0	$0	$25	$0	$25	$25
Central	$0	$0	$171,785	$0	$171,785	$171,785
Eastern	$0	$0	$288,897	$0	$288,897	$288,897
Pacific	$0	$0	$19,746	$0	$19,746	$19,746
Southern	$0	$0	$573,019	$0	$573,019	$573,019
Western	$0	$0	$196,550	$0	$196,550	$196,550
Subtotal	**$0**	**$0**	**$1,250,023**	**$0**	**$1,250,023**	**$1,250,023**
Telecommunications						
Alaskan	$0	$0	$36	$0	$36	$36
Central	$0	$0	$425,813	$0	$425,813	$425,813
Eastern	$0	$0	$643,399	$0	$643,399	$643,399
Pacific	$0	$0	$28,284	$0	$28,284	$28,284
Southern	$0	$0	$1,330,181	$0	$1,330,181	$1,330,181
Western	$0	$0	$403,641	$0	$403,641	$403,641
Subtotal	**$0**	**$0**	**$2,831,354**	**$0**	**$2,831,354**	**$2,831,354**
Temporary Help Services						
Alaskan	$0	$0	$13	$0	$13	$13
Central	$0	$0	$2,758,017	$0	$2,758,017	$2,758,017
Eastern	$0	$0	$3,814,255	$0	$3,814,255	$3,814,255
Pacific	$0	$0	$317,980	$0	$317,980	$317,980
Southern	$0	$0	$15,855,219	$0	$15,855,219	$15,855,219
Western	$0	$0	$3,754,041	$0	$3,754,041	$3,754,041
Subtotal	**$0**	**$0**	**$26,499,525**	**$0**	**$26,499,525**	**$26,499,525**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Transportation						
Alaskan	$0	$0	$176	$0	$176	$176
Central	$0	$0	$1,693,569	$0	$1,693,569	$1,693,569
Eastern	$0	$0	$1,739,047	$0	$1,739,047	$1,739,047
Pacific	$0	$0	$216,193	$0	$216,193	$216,193
Southern	$0	$0	$5,538,578	$0	$5,538,578	$5,538,578
Western	$0	$0	$1,501,275	$0	$1,501,275	$1,501,275
Subtotal	**$0**	**$0**	**$10,688,839**	**$0**	**$10,688,839**	**$10,688,839**
Utilities						
Alaskan	$0	$0	$45	$0	$45	$45
Central	$0	$0	$721,516	$0	$721,516	$721,516
Eastern	$0	$0	$1,032,539	$0	$1,032,539	$1,032,539
Pacific	$0	$0	$15,379	$0	$15,379	$15,379
Southern	$0	$0	$2,119,922	$0	$2,119,922	$2,119,922
Western	$0	$0	$557,975	$0	$557,975	$557,975
Subtotal	**$0**	**$0**	**$4,447,375**	**$0**	**$4,447,375**	**$4,447,375**
Warehousing						
Alaskan	$0	$0	$4	$0	$4	$4
Central	$0	$0	$611,486	$0	$611,486	$611,486
Eastern	$0	$0	$901,301	$0	$901,301	$901,301
Pacific	$0	$0	$13,316	$0	$13,316	$13,316
Southern	$0	$0	$1,668,522	$0	$1,668,522	$1,668,522
Western	$0	$0	$636,547	$0	$636,547	$636,547
Subtotal	**$0**	**$0**	**$3,831,178**	**$0**	**$3,831,178**	**$3,831,178**
Non-Core						
Alaskan	$0	$0	$1,664	$0	$1,664	$1,664
Central	$0	$0	$28,533,033	$0	$28,533,033	$28,533,033
Eastern	$0	$0	$49,053,020	$0	$49,053,020	$49,053,020
Pacific	$0	$0	$2,542,930	$0	$2,542,930	$2,542,930
Southern	$0	$0	$62,702,524	$0	$62,702,524	$62,702,524
Western	$0	$0	$36,703,176	$0	$36,703,176	$36,703,176
Subtotal	**$0**	**$0**	**$179,536,346**	**$0**	**$179,536,346**	**$179,536,346**
Total Costs for Effective Communication – Supervisor						
Alaskan	$0	$0	$3,312	$0	$3,312	$3,312
Central	$0	$0	$65,169,736	$0	$65,169,736	$65,169,736
Eastern	$0	$0	$95,926,466	$0	$95,926,466	$95,926,466

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$5,164,266	$0	$5,164,266	$5,164,266
Southern	$0	$0	$175,425,832	$0	$175,425,832	$175,425,832
Western	$0	$0	$72,868,675	$0	$72,868,675	$72,868,675
Total	**$0**	**$0**	**$414,558,288**	**$0**	**$414,558,288**	**$414,558,288**
Effective Communication – Employee						
Agriculture, Forestry, and Fishing						
Alaskan	$0	$0	$30	$0	$30	$30
Central	$0	$0	$2,112,774	$0	$2,112,774	$2,112,774
Eastern	$0	$0	$1,307,050	$0	$1,307,050	$1,307,050
Pacific	$0	$0	$48,003	$0	$48,003	$48,003
Southern	$0	$0	$4,382,165	$0	$4,382,165	$4,382,165
Western	$0	$0	$3,106,954	$0	$3,106,954	$3,106,954
Subtotal	**$0**	**$0**	**$10,956,976**	**$0**	**$10,956,976**	**$10,956,976**
Building Materials and Equipment Suppliers						
Alaskan	$0	$0	$44	$0	$44	$44
Central	$0	$0	$942,412	$0	$942,412	$942,412
Eastern	$0	$0	$1,184,054	$0	$1,184,054	$1,184,054
Pacific	$0	$0	$67,085	$0	$67,085	$67,085
Southern	$0	$0	$2,791,746	$0	$2,791,746	$2,791,746
Western	$0	$0	$942,394	$0	$942,394	$942,394
Subtotal	**$0**	**$0**	**$5,927,736**	**$0**	**$5,927,736**	**$5,927,736**
Commercial Kitchens						
Alaskan	$0	$0	$189	$0	$189	$189
Central	$0	$0	$4,479,892	$0	$4,479,892	$4,479,892
Eastern	$0	$0	$6,743,062	$0	$6,743,062	$6,743,062
Pacific	$0	$0	$537,452	$0	$537,452	$537,452
Southern	$0	$0	$15,142,940	$0	$15,142,940	$15,142,940
Western	$0	$0	$5,158,261	$0	$5,158,261	$5,158,261
Subtotal	**$0**	**$0**	**$32,061,796**	**$0**	**$32,061,796**	**$32,061,796**
Construction						
Alaskan	$0	$0	$757	$0	$757	$757
Central	$0	$0	$12,067,609	$0	$12,067,609	$12,067,609
Eastern	$0	$0	$18,192,171	$0	$18,192,171	$18,192,171
Pacific	$0	$0	$1,301,390	$0	$1,301,390	$1,301,390
Southern	$0	$0	$41,487,043	$0	$41,487,043	$41,487,043
Western	$0	$0	$14,467,580	$0	$14,467,580	$14,467,580

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$87,516,549**	**$0**	**$87,516,549**	**$87,516,549**
Drycleaning and Commercial Laundries						
Alaskan	$0	$0	$5	$0	$5	$5
Central	$0	$0	$132,867	$0	$132,867	$132,867
Eastern	$0	$0	$242,929	$0	$242,929	$242,929
Pacific	$0	$0	$20,126	$0	$20,126	$20,126
Southern	$0	$0	$466,178	$0	$466,178	$466,178
Western	$0	$0	$160,489	$0	$160,489	$160,489
Subtotal	**$0**	**$0**	**$1,022,592**	**$0**	**$1,022,592**	**$1,022,592**
Landscaping and Facilities Support						
Alaskan	$0	$0	$156	$0	$156	$156
Central	$0	$0	$2,278,317	$0	$2,278,317	$2,278,317
Eastern	$0	$0	$3,829,915	$0	$3,829,915	$3,829,915
Pacific	$0	$0	$270,710	$0	$270,710	$270,710
Southern	$0	$0	$7,523,810	$0	$7,523,810	$7,523,810
Western	$0	$0	$2,501,833	$0	$2,501,833	$2,501,833
Subtotal	**$0**	**$0**	**$16,404,742**	**$0**	**$16,404,742**	**$16,404,742**
Maintenance and Repair						
Alaskan	$0	$0	$56	$0	$56	$56
Central	$0	$0	$1,372,758	$0	$1,372,758	$1,372,758
Eastern	$0	$0	$1,825,895	$0	$1,825,895	$1,825,895
Pacific	$0	$0	$82,203	$0	$82,203	$82,203
Southern	$0	$0	$4,032,088	$0	$4,032,088	$4,032,088
Western	$0	$0	$1,394,890	$0	$1,394,890	$1,394,890
Subtotal	**$0**	**$0**	**$8,707,890**	**$0**	**$8,707,890**	**$8,707,890**
Manufacturing						
Alaskan	$0	$0	$158	$0	$158	$158
Central	$0	$0	$10,985,306	$0	$10,985,306	$10,985,306
Eastern	$0	$0	$11,037,608	$0	$11,037,608	$11,037,608
Pacific	$0	$0	$122,583	$0	$122,583	$122,583
Southern	$0	$0	$19,336,968	$0	$19,336,968	$19,336,968
Western	$0	$0	$5,930,496	$0	$5,930,496	$5,930,496
Subtotal	**$0**	**$0**	**$47,413,118**	**$0**	**$47,413,118**	**$47,413,118**
Oil and Gas						
Alaskan	$0	$0	$222	$0	$222	$222
Central	$0	$0	$331,463	$0	$331,463	$331,463

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$200,341	$0	$200,341	$200,341
Southern	$0	$0	$4,954,004	$0	$4,954,004	$4,954,004
Western	$0	$0	$240,985	$0	$240,985	$240,985
Subtotal	**$0**	**$0**	**$5,727,015**	**$0**	**$5,727,015**	**$5,727,015**
Postal and Delivery Services						
Alaskan	$0	$0	$11	$0	$11	$11
Central	$0	$0	$418,395	$0	$418,395	$418,395
Eastern	$0	$0	$665,304	$0	$665,304	$665,304
Pacific	$0	$0	$25,144	$0	$25,144	$25,144
Southern	$0	$0	$1,180,225	$0	$1,180,225	$1,180,225
Western	$0	$0	$449,271	$0	$449,271	$449,271
Subtotal	**$0**	**$0**	**$2,738,350**	**$0**	**$2,738,350**	**$2,738,350**
Recreation and Amusement						
Alaskan	$0	$0	$36	$0	$36	$36
Central	$0	$0	$716,707	$0	$716,707	$716,707
Eastern	$0	$0	$1,216,575	$0	$1,216,575	$1,216,575
Pacific	$0	$0	$58,528	$0	$58,528	$58,528
Southern	$0	$0	$2,617,835	$0	$2,617,835	$2,617,835
Western	$0	$0	$984,819	$0	$984,819	$984,819
Subtotal	**$0**	**$0**	**$5,594,500**	**$0**	**$5,594,500**	**$5,594,500**
Sanitation and Waste Removal						
Alaskan	$0	$0	$25	$0	$25	$25
Central	$0	$0	$169,213	$0	$169,213	$169,213
Eastern	$0	$0	$284,571	$0	$284,571	$284,571
Pacific	$0	$0	$19,451	$0	$19,451	$19,451
Southern	$0	$0	$564,437	$0	$564,437	$564,437
Western	$0	$0	$193,607	$0	$193,607	$193,607
Subtotal	**$0**	**$0**	**$1,231,303**	**$0**	**$1,231,303**	**$1,231,303**
Telecommunications						
Alaskan	$0	$0	$46	$0	$46	$46
Central	$0	$0	$551,961	$0	$551,961	$551,961
Eastern	$0	$0	$834,009	$0	$834,009	$834,009
Pacific	$0	$0	$36,663	$0	$36,663	$36,663
Southern	$0	$0	$1,724,252	$0	$1,724,252	$1,724,252
Western	$0	$0	$523,221	$0	$523,221	$523,221
Subtotal	**$0**	**$0**	**$3,670,153**	**$0**	**$3,670,153**	**$3,670,153**

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Temporary Help Services						
Alaskan	$0	$0	$13	$0	$13	$13
Central	$0	$0	$2,716,714	$0	$2,716,714	$2,716,714
Eastern	$0	$0	$3,757,134	$0	$3,757,134	$3,757,134
Pacific	$0	$0	$313,218	$0	$313,218	$313,218
Southern	$0	$0	$15,617,778	$0	$15,617,778	$15,617,778
Western	$0	$0	$3,697,822	$0	$3,697,822	$3,697,822
Subtotal	**$0**	**$0**	**$26,102,678**	**$0**	**$26,102,678**	**$26,102,678**
Transportation						
Alaskan	$0	$0	$194	$0	$194	$194
Central	$0	$0	$1,859,957	$0	$1,859,957	$1,859,957
Eastern	$0	$0	$1,909,903	$0	$1,909,903	$1,909,903
Pacific	$0	$0	$237,434	$0	$237,434	$237,434
Southern	$0	$0	$6,082,726	$0	$6,082,726	$6,082,726
Western	$0	$0	$1,648,771	$0	$1,648,771	$1,648,771
Subtotal	**$0**	**$0**	**$11,738,984**	**$0**	**$11,738,984**	**$11,738,984**
Utilities						
Alaskan	$0	$0	$73	$0	$73	$73
Central	$0	$0	$1,160,185	$0	$1,160,185	$1,160,185
Eastern	$0	$0	$1,660,306	$0	$1,660,306	$1,660,306
Pacific	$0	$0	$24,729	$0	$24,729	$24,729
Southern	$0	$0	$3,408,801	$0	$3,408,801	$3,408,801
Western	$0	$0	$897,215	$0	$897,215	$897,215
Subtotal	**$0**	**$0**	**$7,151,308**	**$0**	**$7,151,308**	**$7,151,308**
Warehousing						
Alaskan	$0	$0	$5	$0	$5	$5
Central	$0	$0	$671,562	$0	$671,562	$671,562
Eastern	$0	$0	$989,851	$0	$989,851	$989,851
Pacific	$0	$0	$14,625	$0	$14,625	$14,625
Southern	$0	$0	$1,832,450	$0	$1,832,450	$1,832,450
Western	$0	$0	$699,086	$0	$699,086	$699,086
Subtotal	**$0**	**$0**	**$4,207,579**	**$0**	**$4,207,579**	**$4,207,579**
Non-Core						
Alaskan	$0	$0	$2,181	$0	$2,181	$2,181
Central	$0	$0	$36,970,389	$0	$36,970,389	$36,970,389
Eastern	$0	$0	$63,618,726	$0	$63,618,726	$63,618,726

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$3,266,173	$0	$3,266,173	$3,266,173
Southern	$0	$0	$78,991,981	$0	$78,991,981	$78,991,981
Western	$0	$0	$48,034,871	$0	$48,034,871	$48,034,871
Subtotal	**$0**	**$0**	**$230,884,322**	**$0**	**$230,884,322**	**$230,884,322**
Total Costs for Effective Communication – Employee						
Alaskan	$0	$0	$4,201	$0	$4,201	$4,201
Central	$0	$0	$79,938,482	$0	$79,938,482	$79,938,482
Eastern	$0	$0	$119,499,404	$0	$119,499,404	$119,499,404
Pacific	$0	$0	$6,445,514	$0	$6,445,514	$6,445,514
Southern	$0	$0	$212,137,427	$0	$212,137,427	$212,137,427
Western	$0	$0	$91,032,564	$0	$91,032,564	$91,032,564
Total	**$0**	**$0**	**$509,057,592**	**$0**	**$509,057,592**	**$509,057,592**
Total Costs for Requirements at or above the Initial Heat Trigger						
Agriculture, Forestry, and Fishing						
Alaskan	$2,582	$2,874	$94	$7	$2,668	$2,961
Central	$290,531	$323,438	$6,809,497	$404,901	$6,695,127	$6,728,034
Eastern	$162,505	$180,911	$4,152,610	$237,681	$4,077,434	$4,095,840
Pacific	$1,935	$2,155	$177,064	$12,822	$166,177	$166,397
Southern	$260,422	$289,919	$12,814,196	$656,948	$12,417,670	$12,447,167
Western	$232,476	$258,807	$8,976,858	$540,871	$8,668,463	$8,694,794
Subtotal	**$950,451**	**$1,058,104**	**$32,930,319**	**$1,853,230**	**$32,027,540**	**$32,135,193**
Building Materials and Equipment Suppliers						
Alaskan	$1,461	$1,626	$130	$11	$1,580	$1,745
Central	$134,180	$149,378	$2,916,552	$192,713	$2,858,020	$2,873,218
Eastern	$167,855	$186,868	$3,586,270	$233,237	$3,520,888	$3,539,901
Pacific	$2,606	$2,901	$229,181	$17,414	$214,373	$214,668
Southern	$154,057	$171,507	$7,783,534	$455,300	$7,482,291	$7,499,741
Western	$105,242	$117,162	$2,788,761	$175,934	$2,718,069	$2,729,990
Subtotal	**$565,401**	**$629,442**	**$17,304,428**	**$1,074,608**	**$16,795,222**	**$16,859,262**
Commercial Kitchens						
Alaskan	$10,503	$11,693	$408	$19	$10,892	$12,082
Central	$1,231,606	$1,371,104	$12,451,003	$471,143	$13,211,467	$13,350,965
Eastern	$1,835,684	$2,043,603	$18,279,032	$662,753	$19,451,963	$19,659,882
Pacific	$39,669	$44,162	$1,785,332	$110,509	$1,714,492	$1,718,985
Southern	$1,635,856	$1,821,141	$38,770,869	$1,465,601	$38,941,123	$39,126,409
Western	$1,092,042	$1,215,732	$13,661,407	$486,073	$14,267,375	$14,391,066

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$5,845,359**	**$6,507,436**	**$84,948,051**	**$3,196,098**	**$87,597,312**	**$88,259,388**
Construction						
Alaskan	$12,220	$13,604	$2,022	$146	$14,097	$15,481
Central	$849,091	$945,263	$36,031,537	$1,981,743	$34,898,885	$34,995,057
Eastern	$1,238,890	$1,379,213	$52,226,855	$2,713,220	$50,752,525	$50,892,848
Pacific	$22,189	$24,702	$4,473,869	$316,331	$4,179,726	$4,182,239
Southern	$1,151,743	$1,282,196	$110,480,523	$5,326,300	$106,305,966	$106,436,419
Western	$680,610	$757,700	$38,361,839	$2,109,291	$36,933,159	$37,010,248
Subtotal	**$3,954,742**	**$4,402,677**	**$241,576,645**	**$12,447,030**	**$233,084,357**	**$233,532,292**
Drycleaning and Commercial Laundries						
Alaskan	$185	$206	$14	$1	$198	$219
Central	$22,582	$25,140	$403,678	$26,160	$400,100	$402,658
Eastern	$43,947	$48,924	$715,273	$44,171	$715,048	$720,026
Pacific	$834	$928	$67,476	$5,105	$63,205	$63,299
Southern	$32,751	$36,461	$1,271,287	$71,699	$1,232,339	$1,236,049
Western	$21,418	$23,843	$463,272	$27,878	$456,811	$459,237
Subtotal	**$121,717**	**$135,503**	**$2,921,000**	**$175,014**	**$2,867,703**	**$2,881,489**
Landscaping and Facilities Support						
Alaskan	$3,686	$4,104	$517	$43	$4,161	$4,578
Central	$222,053	$247,204	$7,611,700	$486,523	$7,347,230	$7,372,381
Eastern	$359,816	$400,571	$12,350,876	$749,784	$11,960,908	$12,001,663
Pacific	$6,309	$7,023	$981,924	$71,000	$917,233	$917,948
Southern	$286,418	$318,859	$22,550,982	$1,239,668	$21,597,731	$21,630,172
Western	$214,983	$239,333	$8,126,642	$470,473	$7,871,153	$7,895,503
Subtotal	**$1,093,265**	**$1,217,094**	**$51,622,642**	**$3,017,490**	**$49,698,416**	**$49,822,245**
Maintenance and Repair						
Alaskan	$1,889	$2,103	$166	$14	$2,041	$2,255
Central	$205,609	$228,897	$4,223,953	$270,743	$4,158,818	$4,182,107
Eastern	$267,329	$297,609	$5,448,766	$334,958	$5,381,138	$5,411,417
Pacific	$3,235	$3,601	$281,687	$21,315	$263,607	$263,973
Southern	$240,626	$267,880	$11,104,039	$619,854	$10,724,811	$10,752,066
Western	$163,386	$181,892	$4,085,617	$245,395	$4,003,608	$4,022,114
Subtotal	**$882,074**	**$981,982**	**$25,144,229**	**$1,492,279**	**$24,534,023**	**$24,633,932**
Manufacturing						
Alaskan	$4,850	$5,399	$505	$44	$5,311	$5,861
Central	$1,719,680	$1,914,460	$35,071,755	$2,377,413	$34,414,022	$34,608,802

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$1,583,237	$1,762,563	$34,664,298	$2,300,305	$33,947,231	$34,126,557
Pacific	$4,686	$5,216	$421,914	$31,866	$394,734	$395,264
Southern	$1,247,724	$1,389,048	$55,965,834	$3,255,437	$53,958,122	$54,099,446
Western	$717,440	$798,701	$18,107,217	$1,149,563	$17,675,095	$17,756,356
Subtotal	**$5,277,616**	**$5,875,387**	**$144,231,525**	**$9,114,627**	**$140,394,515**	**$140,992,285**
Oil and Gas						
Alaskan	$2,991	$3,329	$675	$53	$3,612	$3,951
Central	$34,495	$38,402	$1,106,175	$68,368	$1,072,303	$1,076,210
Eastern	$20,770	$23,123	$654,966	$38,729	$637,008	$639,360
Southern	$173,902	$193,599	$14,164,399	$712,463	$13,625,838	$13,645,535
Western	$19,853	$22,102	$773,687	$47,365	$746,174	$748,423
Subtotal	**$252,011**	**$280,555**	**$16,699,902**	**$866,978**	**$16,084,935**	**$16,113,480**
Postal and Delivery Services						
Alaskan	$918	$1,022	$31	$2	$947	$1,051
Central	$78,862	$87,795	$1,320,012	$72,566	$1,326,308	$1,335,240
Eastern	$116,555	$129,757	$2,043,229	$107,332	$2,052,452	$2,065,653
Pacific	$1,164	$1,295	$88,403	$5,897	$83,669	$83,801
Southern	$82,930	$92,323	$3,383,667	$166,330	$3,300,268	$3,309,661
Western	$58,555	$65,188	$1,353,434	$69,675	$1,342,314	$1,348,946
Subtotal	**$338,985**	**$377,380**	**$8,188,776**	**$421,802**	**$8,105,958**	**$8,144,354**
Recreation and Amusement						
Alaskan	$1,859	$2,069	$84	$3	$1,940	$2,150
Central	$132,718	$147,751	$2,197,203	$64,438	$2,265,483	$2,280,515
Eastern	$214,995	$239,347	$3,620,509	$99,687	$3,735,818	$3,760,169
Pacific	$2,769	$3,082	$215,391	$11,385	$206,774	$207,088
Southern	$161,072	$179,315	$7,439,929	$232,966	$7,368,035	$7,386,279
Western	$130,096	$144,831	$2,873,505	$78,479	$2,925,122	$2,939,857
Subtotal	**$643,508**	**$716,396**	**$16,346,621**	**$486,958**	**$16,503,172**	**$16,576,059**
Sanitation and Waste Removal						
Alaskan	$611	$680	$82	$7	$686	$756
Central	$21,357	$23,776	$569,105	$37,017	$553,445	$555,864
Eastern	$34,579	$38,496	$927,727	$57,240	$905,066	$908,983
Pacific	$595	$663	$70,706	$5,160	$66,142	$66,209
Southern	$27,406	$30,510	$1,692,411	$92,667	$1,627,150	$1,630,254
Western	$18,751	$20,874	$618,635	$37,314	$600,072	$602,196

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$103,299**	**$115,000**	**$3,878,665**	**$229,404**	**$3,752,560**	**$3,764,261**
Telecommunications						
Alaskan	$737	$820	$148	$14	$871	$954
Central	$38,996	$43,413	$1,726,267	$131,585	$1,633,679	$1,638,096
Eastern	$58,352	$64,961	$2,512,631	$181,905	$2,389,078	$2,395,687
Pacific	$687	$765	$120,644	$9,689	$111,641	$111,719
Southern	$52,550	$58,502	$4,789,275	$311,184	$4,530,641	$4,536,593
Western	$30,905	$34,405	$1,552,793	$110,416	$1,473,282	$1,476,783
Subtotal	**$182,227**	**$202,867**	**$10,701,758**	**$744,793**	**$10,139,192**	**$10,159,832**
Temporary Help Services						
Alaskan	$463	$516	$42	$4	$502	$555
Central	$422,316	$470,150	$9,038,626	$595,228	$8,865,714	$8,913,548
Eastern	$540,161	$601,342	$12,043,713	$750,212	$11,833,661	$11,894,842
Pacific	$12,627	$14,057	$1,109,256	$80,182	$1,041,701	$1,043,131
Southern	$870,470	$969,064	$46,512,648	$2,603,480	$44,779,638	$44,878,232
Western	$433,572	$482,681	$11,638,266	$701,290	$11,370,549	$11,419,658
Subtotal	**$2,279,609**	**$2,537,809**	**$80,342,552**	**$4,730,396**	**$77,891,765**	**$78,149,965**
Transportation						
Alaskan	$6,145	$6,841	$566	$41	$6,670	$7,366
Central	$310,575	$345,752	$5,901,892	$322,053	$5,890,413	$5,925,590
Eastern	$301,312	$335,440	$5,909,047	$309,850	$5,900,509	$5,934,637
Pacific	$7,536	$8,390	$850,115	$57,626	$800,025	$800,879
Southern	$362,051	$403,059	$17,538,094	$855,821	$17,044,323	$17,085,331
Western	$166,893	$185,797	$4,833,527	$257,881	$4,742,540	$4,761,443
Subtotal	**$1,154,512**	**$1,285,278**	**$35,033,240**	**$1,803,272**	**$34,384,480**	**$34,515,247**
Utilities						
Alaskan	$998	$1,111	$200	$17	$1,181	$1,294
Central	$64,438	$71,736	$3,391,657	$223,584	$3,232,511	$3,239,809
Eastern	$88,068	$98,044	$4,721,144	$300,127	$4,509,085	$4,519,060
Pacific	$396	$441	$84,957	$7,120	$78,232	$78,277
Southern	$79,812	$88,852	$8,888,807	$517,973	$8,450,646	$8,459,686
Western	$38,290	$42,627	$2,493,560	$156,305	$2,375,546	$2,379,883
Subtotal	**$272,003**	**$302,811**	**$19,580,325**	**$1,205,126**	**$18,647,201**	**$18,678,009**
Warehousing						
Alaskan	$201	$224	$14	$1	$214	$237
Central	$102,280	$113,864	$2,085,718	$114,415	$2,073,583	$2,085,167

Table VIII.C.24. Total Costs – Requirements at or above the Initial Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$148,725	$165,570	$3,022,555	$161,913	$3,009,367	$3,026,212
Pacific	$674	$750	$51,470	$3,564	$48,580	$48,656
Southern	$126,638	$140,981	$5,223,716	$258,305	$5,092,049	$5,106,393
Western	$86,989	$96,842	$2,088,531	$107,782	$2,067,739	$2,077,591
Subtotal	**$465,506**	**$518,232**	**$12,472,005**	**$645,980**	**$12,291,531**	**$12,344,257**
Non-Core						
Alaskan	$81,107	$90,294	$6,898	$644	$87,362	$96,548
Central	$6,985,646	$7,776,877	$123,758,429	$8,086,368	$122,657,706	$123,448,937
Eastern	$11,318,161	$12,600,116	$204,704,352	$12,848,409	$203,174,104	$204,456,059
Pacific	$167,674	$186,666	$11,950,120	$843,852	$11,273,942	$11,292,933
Southern	$6,932,221	$7,717,400	$234,999,127	$12,729,398	$229,201,949	$229,987,129
Western	$6,490,124	$7,225,230	$151,142,547	$9,528,648	$148,104,024	$148,839,129
Subtotal	**$31,974,933**	**$35,596,583**	**$726,561,474**	**$44,037,320**	**$714,499,087**	**$718,120,736**
Total						
Alaskan	$133,406	$148,516	$12,598	$1,069	$144,935	$160,045
Central	$12,867,014	$14,324,399	$256,614,758	$15,926,958	$253,554,813	$255,012,199
Eastern	$18,500,941	$20,596,455	$371,583,854	$22,131,513	$367,953,282	$370,048,796
Pacific	$275,584	$306,798	$22,959,508	$1,610,839	$21,624,253	$21,655,467
Southern	$13,878,649	$15,450,618	$605,373,338	$31,571,395	$587,680,592	$589,252,561
Western	$10,701,625	$11,913,748	$273,940,099	$16,300,630	$268,341,094	$269,553,217
Total	**$56,357,219**	**$62,740,535**	**$1,530,484,155**	**$87,542,404**	**$1,499,298,970**	**$1,505,682,286**

Source: OSHA estimate.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

E. Requirements at or Above the High Heat Trigger.

I. Rest Breaks.

All affected establishments would need to provide affected employees with rest breaks when the high heat trigger is met or exceeded. These rest breaks are different from those at the initial heat trigger in that they are scheduled, reoccurring at least every two hours. Employees would still be allowed rest breaks if needed as outlined under the initial heat trigger requirements, although OSHA estimates that these if-needed rest breaks would be shorter when the high heat trigger is met or exceeded because affected employees would also receive scheduled rest breaks (refer to section VIII.C.IV.E.I. for more details on the time estimated for high heat trigger rest breaks).

Similar to the initial heat trigger rest breaks, OSHA calculated total high heat trigger rest break costs by estimating the number of hours by work shift type (daytime, evening, and overnight) in a given State that meets or exceeds the high heat trigger and normalizing these estimates to 8-hour work shift equivalents. These 8-hour work shift equivalents are then multiplied by the number of affected employees and the unit costs for both indoor and outdoor work conditions.

As discussed in section VIII.C.IV.E.I., and detailed further in appendix A at the end of this section, OSHA estimates that under the proposed standard, the reduction in time spent on pacing (i.e., the increase in worker efficiency) will partially offset the added cost of time spent on if-needed rest breaks as well as scheduled rest breaks when the high heat trigger is met or exceeded for employees in Group 1 (i.e., currently noncompliant with if-needed rest breaks as well as scheduled rest breaks). OSHA also estimates that reduced pacing (i.e., increase in worker efficiency) will partially offset the added cost of scheduled rest breaks when the high heat trigger is met or exceeded for employees in Group 2 (i.e., that are currently noncompliant with only scheduled rest breaks and currently compliant with if-needed rest breaks). Combining this estimated

partial offset of the unit costs of rest breaks required when the high heat trigger is met or exceeded with data on the industry-level and/or State-level number of in-scope employees (discussed in section VIII.B.), baseline non-compliance rates (discussed in section VIII.C.II.A.), and State-level exposure to temperatures at or above the high heat trigger (discussed in section VIII.C.II.C.), OSHA estimates that approximately 71.72 percent of the total cost of compliance with rest breaks when the high heat trigger is met or exceeded (approximately $9.92 billion out of $13.83 billion) could be offset by avoided labor productivity losses due to pacing (i.e., avoided losses in worker efficiency).

II. Observation for Signs and Symptoms.

OSHA calculates the total costs for observing signs and symptoms when the high heat trigger is met or exceeded by multiplying the unit costs for both the designated person and at-risk worker by the number of affected employees and the number of 8-hour work shift equivalents. The method to calculate the number of work-shift equivalents is the same approach used in the calculation of total costs for rest breaks.

III. Hazard Alert.

OSHA also calculates the total costs for notifying employees of high heat conditions using 8-hour work shift equivalents. OSHA multiplies these 8-hour work shift equivalents by the number of affected establishments and the corresponding unit cost for a designated person to perform this requirement.

IV. Warning Signs for Excessively High Heat Areas.

OSHA assumed that the cost of placing warning signs for excessively high heat areas is only applicable to industries assumed to have radiant heat sources (as outlined in OSHA, 2024c and discussed in section VIII.C.IV.E.IV.). To calculate total costs of this provision, OSHA multiplies the number of affected establishments with radiant heat sources by the unit cost for a warning sign. Similarly, OSHA multiplies the number of

affected establishments by the unit cost for a designated person to place that warning sign in an excessively high heat area.

Table VIII.C.25. shows the annualized one-time, annual, and total annualized costs for each of these requirements by industry category and region, discounted (2 percent over a 10-year period) and undiscounted. Note that the best available evidence OSHA employed in this analysis showed no days exceeding the high heat trigger in Alaska and therefore, the agency estimated that most industries in Alaska will not have costs of compliance for requirements at or above the high heat trigger. This may understate the effects in establishments where employees are exposed to process heat. However, OSHA identified no data that would allow an adjustment for this consideration but welcomes comment on the issue.

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Rest Breaks at High Heat Trigger – Indoor						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$10,576,482	$8,053,295	$2,523,187	$2,523,187
Eastern	$0	$0	$8,784,224	$6,685,916	$2,098,307	$2,098,307
Pacific	$0	$0	$138,806	$105,610	$33,196	$33,196
Southern	$0	$0	$47,848,109	$36,415,246	$11,432,863	$11,432,863
Western	$0	$0	$6,577,885	$5,037,349	$1,540,536	$1,540,536
Subtotal	**$0**	**$0**	**$73,925,505**	**$56,297,416**	**$17,628,090**	**$17,628,090**
Building Materials and Equipment Suppliers						
Central	$0	$0	$9,303,121	$7,086,386	$2,216,735	$2,216,735
Eastern	$0	$0	$16,643,764	$12,668,300	$3,975,464	$3,975,464
Pacific	$0	$0	$420,880	$320,205	$100,675	$100,675
Southern	$0	$0	$68,319,209	$51,995,293	$16,323,916	$16,323,916
Western	$0	$0	$6,134,338	$4,688,454	$1,445,885	$1,445,885
Subtotal	**$0**	**$0**	**$100,821,312**	**$76,758,637**	**$24,062,675**	**$24,062,675**
Commercial Kitchens						
Central	$0	$0	$60,520,663	$46,100,638	$14,420,026	$14,420,026
Eastern	$0	$0	$134,221,171	$102,165,211	$32,055,959	$32,055,959
Pacific	$0	$0	$4,437,895	$3,376,261	$1,061,634	$1,061,634
Southern	$0	$0	$511,271,461	$389,110,577	$122,160,884	$122,160,884
Western	$0	$0	$52,350,165	$39,989,637	$12,360,528	$12,360,528
Subtotal	**$0**	**$0**	**$762,801,355**	**$580,742,324**	**$182,059,030**	**$182,059,030**
Construction						
Central	$0	$0	$70,052,483	$53,357,614	$16,694,869	$16,694,869
Eastern	$0	$0	$159,083,213	$121,101,655	$37,981,559	$37,981,559
Pacific	$0	$0	$4,895,384	$3,724,409	$1,170,975	$1,170,975
Southern	$0	$0	$618,272,678	$470,546,413	$147,726,264	$147,726,264
Western	$0	$0	$63,400,197	$48,418,585	$14,981,612	$14,981,612
Subtotal	**$0**	**$0**	**$915,703,956**	**$697,148,676**	**$218,555,280**	**$218,555,280**
Drycleaning and Commercial Laundries						
Central	$0	$0	$1,543,453	$1,175,718	$367,735	$367,735
Eastern	$0	$0	$4,226,300	$3,216,917	$1,009,383	$1,009,383
Pacific	$0	$0	$152,778	$116,231	$36,547	$36,547
Southern	$0	$0	$13,967,752	$10,630,371	$3,337,381	$3,337,381
Western	$0	$0	$1,365,680	$1,043,429	$322,251	$322,251
Subtotal	**$0**	**$0**	**$21,255,963**	**$16,182,666**	**$5,073,297**	**$5,073,297**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Landscaping and Facilities Support						
Central	$0	$0	$11,258,311	$8,576,633	$2,681,678	$2,681,678
Eastern	$0	$0	$29,789,561	$22,677,209	$7,112,351	$7,112,351
Pacific	$0	$0	$877,456	$667,554	$209,902	$209,902
Southern	$0	$0	$98,622,223	$75,057,866	$23,564,358	$23,564,358
Western	$0	$0	$9,857,882	$7,529,435	$2,328,447	$2,328,447
Subtotal	**$0**	**$0**	**$150,405,433**	**$114,508,696**	**$35,896,737**	**$35,896,737**
Maintenance and Repair						
Central	$0	$0	$12,180,429	$9,277,696	$2,902,733	$2,902,733
Eastern	$0	$0	$24,027,523	$18,289,697	$5,737,826	$5,737,826
Pacific	$0	$0	$468,728	$356,611	$112,117	$112,117
Southern	$0	$0	$91,248,519	$69,446,128	$21,802,391	$21,802,391
Western	$0	$0	$9,080,801	$6,936,248	$2,144,553	$2,144,553
Subtotal	**$0**	**$0**	**$137,006,001**	**$104,306,380**	**$32,699,620**	**$32,699,620**
Manufacturing						
Central	$0	$0	$144,486,598	$110,031,414	$34,455,184	$34,455,184
Eastern	$0	$0	$208,190,782	$158,448,947	$49,741,835	$49,741,835
Pacific	$0	$0	$935,094	$711,392	$223,702	$223,702
Southern	$0	$0	$593,557,344	$451,731,773	$141,825,572	$141,825,572
Western	$0	$0	$47,373,376	$36,217,813	$11,155,562	$11,155,562
Subtotal	**$0**	**$0**	**$994,543,195**	**$757,141,340**	**$237,401,855**	**$237,401,855**
Oil and Gas						
Central	$0	$0	$1,667,275	$1,270,325	$396,950	$396,950
Eastern	$0	$0	$1,374,956	$1,046,323	$328,634	$328,634
Southern	$0	$0	$75,216,238	$57,244,908	$17,971,330	$17,971,330
Western	$0	$0	$939,050	$716,692	$222,358	$222,358
Subtotal	**$0**	**$0**	**$79,197,520**	**$60,278,247**	**$18,919,272**	**$18,919,272**
Postal and Delivery Services						
Central	$0	$0	$3,723,031	$2,835,752	$887,279	$887,279
Eastern	$0	$0	$8,437,591	$6,422,458	$2,015,134	$2,015,134
Pacific	$0	$0	$135,720	$103,249	$32,471	$32,471
Southern	$0	$0	$26,176,215	$19,921,838	$6,254,377	$6,254,377
Western	$0	$0	$2,784,618	$2,127,847	$656,770	$656,770
Subtotal	**$0**	**$0**	**$41,257,175**	**$31,411,144**	**$9,846,030**	**$9,846,030**
Recreation and Amusement						
Central	$0	$0	$4,665,130	$3,553,632	$1,111,498	$1,111,498

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$0	$0	$11,919,186	$9,072,587	$2,846,599	$2,846,599
Pacific	$0	$0	$237,458	$180,652	$56,806	$56,806
Southern	$0	$0	$44,104,195	$33,566,359	$10,537,836	$10,537,836
Western	$0	$0	$4,864,366	$3,716,150	$1,148,216	$1,148,216
Subtotal	**$0**	**$0**	**$65,790,335**	**$50,089,379**	**$15,700,955**	**$15,700,955**
Sanitation and Waste Removal						
Central	$0	$0	$1,230,874	$937,606	$293,268	$293,268
Eastern	$0	$0	$2,949,063	$2,244,815	$704,248	$704,248
Pacific	$0	$0	$92,266	$70,195	$22,070	$22,070
Southern	$0	$0	$10,641,076	$8,098,531	$2,542,545	$2,542,545
Western	$0	$0	$997,007	$761,835	$235,171	$235,171
Subtotal	**$0**	**$0**	**$15,910,286**	**$12,112,982**	**$3,797,303**	**$3,797,303**
Telecommunications						
Central	$0	$0	$4,853,408	$3,697,024	$1,156,384	$1,156,384
Eastern	$0	$0	$11,279,180	$8,585,138	$2,694,041	$2,694,041
Pacific	$0	$0	$206,445	$157,053	$49,392	$49,392
Southern	$0	$0	$38,488,372	$29,292,248	$9,196,124	$9,196,124
Western	$0	$0	$3,629,760	$2,771,557	$858,203	$858,203
Subtotal	**$0**	**$0**	**$58,457,165**	**$44,503,020**	**$13,954,145**	**$13,954,145**
Temporary Help Services						
Central	$0	$0	$25,313,302	$19,287,681	$6,025,621	$6,025,621
Eastern	$0	$0	$62,178,214	$47,326,395	$14,851,819	$14,851,819
Pacific	$0	$0	$2,126,287	$1,617,581	$508,707	$508,707
Southern	$0	$0	$426,178,792	$324,351,948	$101,826,844	$101,826,844
Western	$0	$0	$29,005,005	$22,159,171	$6,845,833	$6,845,833
Subtotal	**$0**	**$0**	**$544,801,600**	**$414,742,776**	**$130,058,824**	**$130,058,824**
Transportation						
Central	$0	$0	$13,351,018	$10,169,447	$3,181,571	$3,181,571
Eastern	$0	$0	$20,126,557	$15,318,830	$4,807,727	$4,807,727
Pacific	$0	$0	$1,051,426	$799,912	$251,514	$251,514
Southern	$0	$0	$107,284,179	$81,650,279	$25,633,900	$25,633,900
Western	$0	$0	$9,283,022	$7,087,575	$2,195,447	$2,195,447
Subtotal	**$0**	**$0**	**$151,096,202**	**$115,026,042**	**$36,070,160**	**$36,070,160**
Utilities						
Central	$0	$0	$7,982,072	$6,079,447	$1,902,625	$1,902,625
Eastern	$0	$0	$16,193,659	$12,325,758	$3,867,901	$3,867,901

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$115,621	$87,979	$27,642	$27,642
Southern	$0	$0	$58,183,741	$44,281,543	$13,902,198	$13,902,198
Western	$0	$0	$4,643,754	$3,546,260	$1,097,494	$1,097,494
Subtotal	**$0**	**$0**	**$87,118,847**	**$66,320,986**	**$20,797,860**	**$20,797,860**
Warehousing						
Central	$0	$0	$7,749,473	$5,903,019	$1,846,455	$1,846,455
Eastern	$0	$0	$16,298,484	$12,405,449	$3,893,035	$3,893,035
Pacific	$0	$0	$102,820	$78,225	$24,596	$24,596
Southern	$0	$0	$49,918,912	$37,991,496	$11,927,417	$11,927,417
Western	$0	$0	$5,276,312	$4,032,474	$1,243,838	$1,243,838
Subtotal	**$0**	**$0**	**$79,346,001**	**$60,410,661**	**$18,935,340**	**$18,935,340**
Non-Core						
Central	$0	$0	$303,342,032	$231,097,706	$72,244,327	$72,244,327
Eastern	$0	$0	$803,385,621	$611,525,275	$191,860,345	$191,860,345
Pacific	$0	$0	$17,129,327	$13,031,481	$4,097,846	$4,097,846
Southern	$0	$0	$1,850,916,061	$1,408,664,889	$442,251,172	$442,251,172
Western	$0	$0	$283,757,707	$216,816,012	$66,941,695	$66,941,695
Subtotal	**$0**	**$0**	**$3,258,530,748**	**$2,481,135,363**	**$777,395,385**	**$777,395,385**
Total Costs for Rest Breaks at High Heat Trigger – Indoor						
Central	$0	$0	$693,799,156	$528,491,032	$165,308,125	$165,308,125
Eastern	$0	$0	$1,539,109,050	$1,171,526,881	$367,582,169	$367,582,169
Pacific	$0	$0	$33,524,391	$25,504,598	$8,019,793	$8,019,793
Southern	$0	$0	$4,730,215,075	$3,599,997,704	$1,130,217,372	$1,130,217,372
Western	$0	$0	$541,320,924	$413,596,523	$127,724,401	$127,724,401
Total	**$0**	**$0**	**$7,537,968,597**	**$5,739,116,737**	**$1,798,851,859**	**$1,798,851,859**
Rest Breaks at High Heat Trigger – Outdoor						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$30,421,837	$20,207,084	$10,214,753	$10,214,753
Eastern	$0	$0	$25,905,352	$17,200,149	$8,705,204	$8,705,204
Pacific	$0	$0	$401,164	$266,259	$134,906	$134,906
Southern	$0	$0	$139,227,176	$92,433,271	$46,793,905	$46,793,905
Western	$0	$0	$18,824,524	$12,575,462	$6,249,063	$6,249,063
Subtotal	**$0**	**$0**	**$214,780,053**	**$142,682,223**	**$72,097,830**	**$72,097,830**
Building Materials and Equipment Suppliers						
Central	$0	$0	$5,468,916	$3,634,104	$1,834,811	$1,834,811
Eastern	$0	$0	$10,027,967	$6,658,390	$3,369,577	$3,369,577

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$255,772	$169,751	$86,021	$86,021
Southern	$0	$0	$43,109,868	$28,620,964	$14,488,903	$14,488,903
Western	$0	$0	$3,801,057	$2,534,221	$1,266,836	$1,266,836
Subtotal	**$0**	**$0**	**$62,663,579**	**$41,617,431**	**$21,046,149**	**$21,046,149**
Commercial Kitchens						
Central	$0	$0	$5,882,754	$3,909,101	$1,973,653	$1,973,653
Eastern	$0	$0	$13,027,811	$8,650,431	$4,377,380	$4,377,380
Pacific	$0	$0	$433,257	$287,536	$145,722	$145,722
Southern	$0	$0	$48,771,686	$32,379,881	$16,391,805	$16,391,805
Western	$0	$0	$5,042,717	$3,360,397	$1,682,319	$1,682,319
Subtotal	**$0**	**$0**	**$73,158,225**	**$48,587,346**	**$24,570,879**	**$24,570,879**
Construction						
Central	$0	$0	$132,944,386	$88,332,828	$44,611,559	$44,611,559
Eastern	$0	$0	$293,649,877	$195,001,930	$98,647,947	$98,647,947
Pacific	$0	$0	$9,517,395	$6,316,496	$3,200,899	$3,200,899
Southern	$0	$0	$1,169,092,863	$776,171,055	$392,921,808	$392,921,808
Western	$0	$0	$121,291,239	$80,799,556	$40,491,683	$40,491,683
Subtotal	**$0**	**$0**	**$1,726,495,760**	**$1,146,621,865**	**$579,873,896**	**$579,873,896**
Drycleaning and Commercial Laundries						
Central	$0	$0	$504,941	$335,534	$169,407	$169,407
Eastern	$0	$0	$1,382,635	$918,064	$464,571	$464,571
Pacific	$0	$0	$49,982	$33,171	$16,811	$16,811
Southern	$0	$0	$4,569,552	$3,033,762	$1,535,790	$1,535,790
Western	$0	$0	$446,782	$297,780	$149,002	$149,002
Subtotal	**$0**	**$0**	**$6,953,891**	**$4,618,311**	**$2,335,580**	**$2,335,580**
Landscaping and Facilities Support						
Central	$0	$0	$25,722,284	$17,093,146	$8,629,138	$8,629,138
Eastern	$0	$0	$66,910,496	$44,432,777	$22,477,719	$22,477,719
Pacific	$0	$0	$2,078,513	$1,379,437	$699,076	$699,076
Southern	$0	$0	$221,198,874	$146,855,494	$74,343,380	$74,343,380
Western	$0	$0	$22,088,210	$14,716,664	$7,371,546	$7,371,546
Subtotal	**$0**	**$0**	**$337,998,378**	**$224,477,518**	**$113,520,859**	**$113,520,859**
Maintenance and Repair						
Central	$0	$0	$10,028,628	$6,663,497	$3,365,131	$3,365,131
Eastern	$0	$0	$19,822,596	$13,162,703	$6,659,893	$6,659,893
Pacific	$0	$0	$393,120	$260,906	$132,214	$132,214

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$0	$0	$73,735,754	$48,953,791	$24,781,963	$24,781,963
Western	$0	$0	$7,565,618	$5,041,201	$2,524,416	$2,524,416
Subtotal	**$0**	**$0**	**$111,545,715**	**$74,082,098**	**$37,463,618**	**$37,463,618**
Manufacturing						
Central	$0	$0	$33,375,481	$22,171,602	$11,203,879	$11,203,879
Eastern	$0	$0	$50,014,418	$33,205,559	$16,808,859	$16,808,859
Pacific	$0	$0	$284,377	$188,727	$95,651	$95,651
Southern	$0	$0	$152,996,536	$101,574,747	$51,421,789	$51,421,789
Western	$0	$0	$11,220,859	$7,484,528	$3,736,331	$3,736,331
Subtotal	**$0**	**$0**	**$247,891,671**	**$164,625,163**	**$83,266,508**	**$83,266,508**
Oil and Gas						
Central	$0	$0	$2,987,040	$1,985,344	$1,001,697	$1,001,697
Eastern	$0	$0	$2,472,347	$1,641,236	$831,110	$831,110
Southern	$0	$0	$138,600,039	$92,018,389	$46,581,650	$46,581,650
Western	$0	$0	$1,710,867	$1,139,088	$571,779	$571,779
Subtotal	**$0**	**$0**	**$145,770,293**	**$96,784,057**	**$48,986,237**	**$48,986,237**
Postal and Delivery Services						
Central	$0	$0	$3,054,541	$2,029,561	$1,024,980	$1,024,980
Eastern	$0	$0	$6,863,635	$4,557,461	$2,306,173	$2,306,173
Pacific	$0	$0	$115,557	$76,687	$38,870	$38,870
Southern	$0	$0	$21,099,271	$14,007,996	$7,091,276	$7,091,276
Western	$0	$0	$2,207,011	$1,471,109	$735,902	$735,902
Subtotal	**$0**	**$0**	**$33,340,014**	**$22,142,814**	**$11,197,200**	**$11,197,200**
Recreation and Amusement						
Central	$0	$0	$6,372,352	$4,234,424	$2,137,928	$2,137,928
Eastern	$0	$0	$16,280,661	$10,810,418	$5,470,244	$5,470,244
Pacific	$0	$0	$323,230	$214,513	$108,717	$108,717
Southern	$0	$0	$59,913,596	$39,777,337	$20,136,259	$20,136,259
Western	$0	$0	$6,637,770	$4,423,522	$2,214,248	$2,214,248
Subtotal	**$0**	**$0**	**$89,527,609**	**$59,460,214**	**$30,067,395**	**$30,067,395**
Sanitation and Waste Removal						
Central	$0	$0	$1,445,654	$960,612	$485,042	$485,042
Eastern	$0	$0	$3,664,148	$2,433,075	$1,231,073	$1,231,073
Pacific	$0	$0	$117,244	$77,811	$39,433	$39,433
Southern	$0	$0	$13,100,478	$8,697,486	$4,402,992	$4,402,992
Western	$0	$0	$1,172,994	$781,984	$391,010	$391,010

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$19,500,518**	**$12,950,968**	**$6,549,550**	**$6,549,550**
Telecommunications						
Central	$0	$0	$4,034,928	$2,681,188	$1,353,740	$1,353,740
Eastern	$0	$0	$9,377,005	$6,226,155	$3,150,850	$3,150,850
Pacific	$0	$0	$171,635	$113,903	$57,732	$57,732
Southern	$0	$0	$31,997,519	$21,243,470	$10,754,049	$10,754,049
Western	$0	$0	$3,017,642	$2,010,016	$1,007,626	$1,007,626
Subtotal	**$0**	**$0**	**$48,598,728**	**$32,274,732**	**$16,323,997**	**$16,323,997**
Temporary Help Services						
Central	$0	$0	$12,933,584	$8,596,785	$4,336,798	$4,336,798
Eastern	$0	$0	$31,769,349	$21,094,027	$10,675,322	$10,675,322
Pacific	$0	$0	$1,086,406	$720,978	$365,428	$365,428
Southern	$0	$0	$217,751,879	$144,568,138	$73,183,741	$73,183,741
Western	$0	$0	$14,819,823	$9,876,648	$4,943,175	$4,943,175
Subtotal	**$0**	**$0**	**$278,361,040**	**$184,856,576**	**$93,504,464**	**$93,504,464**
Transportation						
Central	$0	$0	$17,389,771	$11,555,006	$5,834,765	$5,834,765
Eastern	$0	$0	$25,857,112	$17,168,009	$8,689,103	$8,689,103
Pacific	$0	$0	$1,401,978	$930,441	$471,537	$471,537
Southern	$0	$0	$139,702,133	$92,749,396	$46,952,737	$46,952,737
Western	$0	$0	$12,071,618	$8,039,763	$4,031,855	$4,031,855
Subtotal	**$0**	**$0**	**$196,422,612**	**$130,442,615**	**$65,979,997**	**$65,979,997**
Utilities						
Central	$0	$0	$11,068,721	$7,354,144	$3,714,577	$3,714,577
Eastern	$0	$0	$22,460,044	$14,913,008	$7,547,036	$7,547,036
Pacific	$0	$0	$159,839	$106,099	$53,740	$53,740
Southern	$0	$0	$80,684,859	$53,567,225	$27,117,634	$27,117,634
Western	$0	$0	$6,429,129	$4,282,922	$2,146,208	$2,146,208
Subtotal	**$0**	**$0**	**$120,802,593**	**$80,223,398**	**$40,579,195**	**$40,579,195**
Warehousing						
Central	$0	$0	$3,247,215	$2,157,740	$1,089,476	$1,089,476
Eastern	$0	$0	$6,829,456	$4,534,583	$2,294,873	$2,294,873
Pacific	$0	$0	$43,084	$28,594	$14,491	$14,491
Southern	$0	$0	$20,917,223	$13,887,092	$7,030,131	$7,030,131
Western	$0	$0	$2,210,901	$1,473,997	$736,905	$736,905
Subtotal	**$0**	**$0**	**$33,247,880**	**$22,082,005**	**$11,165,875**	**$11,165,875**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Non-Core						
Central	$0	$0	$246,952,116	$164,137,970	$82,814,146	$82,814,146
Eastern	$0	$0	$727,561,870	$483,115,960	$244,445,911	$244,445,911
Pacific	$0	$0	$16,378,766	$10,869,733	$5,509,033	$5,509,033
Southern	$0	$0	$1,291,042,547	$857,129,196	$433,913,351	$433,913,351
Western	$0	$0	$262,677,028	$175,094,081	$87,582,947	$87,582,947
Subtotal	**$0**	**$0**	**$2,544,612,328**	**$1,690,346,939**	**$854,265,389**	**$854,265,389**
Total Costs for Rest Breaks at High Heat Trigger – Outdoor						
Central	$0	$0	$553,835,149	$368,039,670	$185,795,480	$185,795,480
Eastern	$0	$0	$1,333,876,779	$885,723,935	$448,152,844	$448,152,844
Pacific	$0	$0	$33,211,320	$22,041,040	$11,170,280	$11,170,280
Southern	$0	$0	$3,867,511,852	$2,567,668,689	$1,299,843,163	$1,299,843,163
Western	$0	$0	$503,235,789	$335,402,938	$167,832,851	$167,832,851
Total	**$0**	**$0**	**$6,291,670,889**	**$4,178,876,272**	**$2,112,794,617**	**$2,112,794,617**
Observation for Signs and Symptoms – Designated Person						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$559,511	$0	$559,511	$559,511
Eastern	$0	$0	$406,548	$0	$406,548	$406,548
Pacific	$0	$0	$6,788	$0	$6,788	$6,788
Southern	$0	$0	$2,084,391	$0	$2,084,391	$2,084,391
Western	$0	$0	$909,503	$0	$909,503	$909,503
Subtotal	**$0**	**$0**	**$3,966,740**	**$0**	**$3,966,740**	**$3,966,740**
Building Materials and Equipment Suppliers						
Central	$0	$0	$207,109	$0	$207,109	$207,109
Eastern	$0	$0	$297,661	$0	$297,661	$297,661
Pacific	$0	$0	$7,987	$0	$7,987	$7,987
Southern	$0	$0	$1,133,972	$0	$1,133,972	$1,133,972
Western	$0	$0	$255,007	$0	$255,007	$255,007
Subtotal	**$0**	**$0**	**$1,901,736**	**$0**	**$1,901,736**	**$1,901,736**
Commercial Kitchens						
Central	$0	$0	$836,294	$0	$836,294	$836,294
Eastern	$0	$0	$1,474,289	$0	$1,474,289	$1,474,289
Pacific	$0	$0	$52,685	$0	$52,685	$52,685
Southern	$0	$0	$5,113,140	$0	$5,113,140	$5,113,140
Western	$0	$0	$1,225,216	$0	$1,225,216	$1,225,216
Subtotal	**$0**	**$0**	**$8,701,625**	**$0**	**$8,701,625**	**$8,701,625**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Construction						
Central	$0	$0	$2,502,225	$0	$2,502,225	$2,502,225
Eastern	$0	$0	$4,636,411	$0	$4,636,411	$4,636,411
Pacific	$0	$0	$153,665	$0	$153,665	$153,665
Southern	$0	$0	$16,364,447	$0	$16,364,447	$16,364,447
Western	$0	$0	$3,765,603	$0	$3,765,603	$3,765,603
Subtotal	**$0**	**$0**	**$27,422,352**	**$0**	**$27,422,352**	**$27,422,352**
Drycleaning and Commercial Laundries						
Central	$0	$0	$28,691	$0	$28,691	$28,691
Eastern	$0	$0	$62,646	$0	$62,646	$62,646
Pacific	$0	$0	$2,402	$0	$2,402	$2,402
Southern	$0	$0	$187,883	$0	$187,883	$187,883
Western	$0	$0	$44,171	$0	$44,171	$44,171
Subtotal	**$0**	**$0**	**$325,794**	**$0**	**$325,794**	**$325,794**
Landscaping and Facilities Support						
Central	$0	$0	$610,504	$0	$610,504	$610,504
Eastern	$0	$0	$1,284,623	$0	$1,284,623	$1,284,623
Pacific	$0	$0	$40,324	$0	$40,324	$40,324
Southern	$0	$0	$3,782,727	$0	$3,782,727	$3,782,727
Western	$0	$0	$861,380	$0	$861,380	$861,380
Subtotal	**$0**	**$0**	**$6,579,558**	**$0**	**$6,579,558**	**$6,579,558**
Maintenance and Repair						
Central	$0	$0	$296,626	$0	$296,626	$296,626
Eastern	$0	$0	$477,300	$0	$477,300	$477,300
Pacific	$0	$0	$9,812	$0	$9,812	$9,812
Southern	$0	$0	$1,627,494	$0	$1,627,494	$1,627,494
Western	$0	$0	$378,264	$0	$378,264	$378,264
Subtotal	**$0**	**$0**	**$2,789,495**	**$0**	**$2,789,495**	**$2,789,495**
Manufacturing						
Central	$0	$0	$2,815,756	$0	$2,815,756	$2,815,756
Eastern	$0	$0	$3,309,944	$0	$3,309,944	$3,309,944
Pacific	$0	$0	$17,507	$0	$17,507	$17,507
Southern	$0	$0	$9,185,471	$0	$9,185,471	$9,185,471
Western	$0	$0	$1,892,238	$0	$1,892,238	$1,892,238
Subtotal	**$0**	**$0**	**$17,220,917**	**$0**	**$17,220,917**	**$17,220,917**
Oil and Gas						

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Central	$0	$0	$71,167	$0	$71,167	$71,167
Eastern	$0	$0	$43,763	$0	$43,763	$43,763
Southern	$0	$0	$2,287,363	$0	$2,287,363	$2,287,363
Western	$0	$0	$57,779	$0	$57,779	$57,779
Subtotal	**$0**	**$0**	**$2,460,073**	**$0**	**$2,460,073**	**$2,460,073**
Postal and Delivery Services						
Central	$0	$0	$103,744	$0	$103,744	$103,744
Eastern	$0	$0	$192,372	$0	$192,372	$192,372
Pacific	$0	$0	$3,375	$0	$3,375	$3,375
Southern	$0	$0	$535,190	$0	$535,190	$535,190
Western	$0	$0	$138,225	$0	$138,225	$138,225
Subtotal	**$0**	**$0**	**$972,907**	**$0**	**$972,907**	**$972,907**
Recreation and Amusement						
Central	$0	$0	$171,128	$0	$171,128	$171,128
Eastern	$0	$0	$349,544	$0	$349,544	$349,544
Pacific	$0	$0	$7,457	$0	$7,457	$7,457
Southern	$0	$0	$1,169,540	$0	$1,169,540	$1,169,540
Western	$0	$0	$304,739	$0	$304,739	$304,739
Subtotal	**$0**	**$0**	**$2,002,408**	**$0**	**$2,002,408**	**$2,002,408**
Sanitation and Waste Removal						
Central	$0	$0	$45,838	$0	$45,838	$45,838
Eastern	$0	$0	$92,339	$0	$92,339	$92,339
Pacific	$0	$0	$3,032	$0	$3,032	$3,032
Southern	$0	$0	$295,978	$0	$295,978	$295,978
Western	$0	$0	$66,648	$0	$66,648	$66,648
Subtotal	**$0**	**$0**	**$503,834**	**$0**	**$503,834**	**$503,834**
Telecommunications						
Central	$0	$0	$116,889	$0	$116,889	$116,889
Eastern	$0	$0	$215,275	$0	$215,275	$215,275
Pacific	$0	$0	$4,305	$0	$4,305	$4,305
Southern	$0	$0	$674,933	$0	$674,933	$674,933
Western	$0	$0	$138,645	$0	$138,645	$138,645
Subtotal	**$0**	**$0**	**$1,150,047**	**$0**	**$1,150,047**	**$1,150,047**
Temporary Help Services						
Central	$0	$0	$724,251	$0	$724,251	$724,251
Eastern	$0	$0	$1,296,067	$0	$1,296,067	$1,296,067

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$48,819	$0	$48,819	$48,819
Southern	$0	$0	$8,228,325	$0	$8,228,325	$8,228,325
Western	$0	$0	$1,330,859	$0	$1,330,859	$1,330,859
Subtotal	**$0**	**$0**	**$11,628,319**	**$0**	**$11,628,319**	**$11,628,319**
Transportation						
Central	$0	$0	$466,232	$0	$466,232	$466,232
Eastern	$0	$0	$554,960	$0	$554,960	$554,960
Pacific	$0	$0	$31,866	$0	$31,866	$31,866
Southern	$0	$0	$2,752,408	$0	$2,752,408	$2,752,408
Western	$0	$0	$508,720	$0	$508,720	$508,720
Subtotal	**$0**	**$0**	**$4,314,186**	**$0**	**$4,314,186**	**$4,314,186**
Utilities						
Central	$0	$0	$193,162	$0	$193,162	$193,162
Eastern	$0	$0	$321,518	$0	$321,518	$321,518
Pacific	$0	$0	$2,267	$0	$2,267	$2,267
Southern	$0	$0	$1,055,740	$0	$1,055,740	$1,055,740
Western	$0	$0	$186,661	$0	$186,661	$186,661
Subtotal	**$0**	**$0**	**$1,759,348**	**$0**	**$1,759,348**	**$1,759,348**
Warehousing						
Central	$0	$0	$174,882	$0	$174,882	$174,882
Eastern	$0	$0	$290,194	$0	$290,194	$290,194
Pacific	$0	$0	$1,963	$0	$1,963	$1,963
Southern	$0	$0	$819,396	$0	$819,396	$819,396
Western	$0	$0	$217,114	$0	$217,114	$217,114
Subtotal	**$0**	**$0**	**$1,503,548**	**$0**	**$1,503,548**	**$1,503,548**
Non-Core						
Central	$0	$0	$7,619,024	$0	$7,619,024	$7,619,024
Eastern	$0	$0	$16,120,110	$0	$16,120,110	$16,120,110
Pacific	$0	$0	$379,699	$0	$379,699	$379,699
Southern	$0	$0	$31,249,924	$0	$31,249,924	$31,249,924
Western	$0	$0	$12,562,661	$0	$12,562,661	$12,562,661
Subtotal	**$0**	**$0**	**$67,931,418**	**$0**	**$67,931,418**	**$67,931,418**
Total Costs for Observation for Signs and Symptoms – Designated Person						
Central	$0	$0	$17,543,033	$0	$17,543,033	$17,543,033
Eastern	$0	$0	$31,425,564	$0	$31,425,564	$31,425,564
Pacific	$0	$0	$773,951	$0	$773,951	$773,951

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$0	$0	$88,548,322	$0	$88,548,322	$88,548,322
Western	$0	$0	$24,843,433	$0	$24,843,433	$24,843,433
Total	**$0**	**$0**	**$163,134,305**	**$0**	**$163,134,305**	**$163,134,305**
Observation for Signs and Symptoms – At–Risk Worker						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$601,783	$0	$601,783	$601,783
Eastern	$0	$0	$437,263	$0	$437,263	$437,263
Pacific	$0	$0	$7,300	$0	$7,300	$7,300
Southern	$0	$0	$2,241,869	$0	$2,241,869	$2,241,869
Western	$0	$0	$978,217	$0	$978,217	$978,217
Subtotal	**$0**	**$0**	**$4,266,431**	**$0**	**$4,266,431**	**$4,266,431**
Building Materials and Equipment Suppliers						
Central	$0	$0	$254,972	$0	$254,972	$254,972
Eastern	$0	$0	$366,669	$0	$366,669	$366,669
Pacific	$0	$0	$9,837	$0	$9,837	$9,837
Southern	$0	$0	$1,398,311	$0	$1,398,311	$1,398,311
Western	$0	$0	$314,304	$0	$314,304	$314,304
Subtotal	**$0**	**$0**	**$2,344,092**	**$0**	**$2,344,092**	**$2,344,092**
Commercial Kitchens						
Central	$0	$0	$1,191,647	$0	$1,191,647	$1,191,647
Eastern	$0	$0	$2,100,615	$0	$2,100,615	$2,100,615
Pacific	$0	$0	$74,334	$0	$74,334	$74,334
Southern	$0	$0	$7,309,702	$0	$7,309,702	$7,309,702
Western	$0	$0	$1,744,049	$0	$1,744,049	$1,744,049
Subtotal	**$0**	**$0**	**$12,420,346**	**$0**	**$12,420,346**	**$12,420,346**
Construction						
Central	$0	$0	$3,298,568	$0	$3,298,568	$3,298,568
Eastern	$0	$0	$6,157,847	$0	$6,157,847	$6,157,847
Pacific	$0	$0	$201,444	$0	$201,444	$201,444
Southern	$0	$0	$21,599,905	$0	$21,599,905	$21,599,905
Western	$0	$0	$4,969,725	$0	$4,969,725	$4,969,725
Subtotal	**$0**	**$0**	**$36,227,490**	**$0**	**$36,227,490**	**$36,227,490**
Drycleaning and Commercial Laundries						
Central	$0	$0	$36,171	$0	$36,171	$36,171
Eastern	$0	$0	$78,978	$0	$78,978	$78,978
Pacific	$0	$0	$3,028	$0	$3,028	$3,028

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$0	$0	$236,867	$0	$236,867	$236,867
Western	$0	$0	$55,687	$0	$55,687	$55,687
Subtotal	**$0**	**$0**	**$410,732**	**$0**	**$410,732**	**$410,732**
Landscaping and Facilities Support						
Central	$0	$0	$622,110	$0	$622,110	$622,110
Eastern	$0	$0	$1,306,100	$0	$1,306,100	$1,306,100
Pacific	$0	$0	$41,405	$0	$41,405	$41,405
Southern	$0	$0	$3,849,145	$0	$3,849,145	$3,849,145
Western	$0	$0	$876,430	$0	$876,430	$876,430
Subtotal	**$0**	**$0**	**$6,695,191**	**$0**	**$6,695,191**	**$6,695,191**
Maintenance and Repair						
Central	$0	$0	$373,959	$0	$373,959	$373,959
Eastern	$0	$0	$601,737	$0	$601,737	$601,737
Pacific	$0	$0	$12,370	$0	$12,370	$12,370
Southern	$0	$0	$2,051,800	$0	$2,051,800	$2,051,800
Western	$0	$0	$476,882	$0	$476,882	$476,882
Subtotal	**$0**	**$0**	**$3,516,748**	**$0**	**$3,516,748**	**$3,516,748**
Manufacturing						
Central	$0	$0	$2,952,264	$0	$2,952,264	$2,952,264
Eastern	$0	$0	$3,470,410	$0	$3,470,410	$3,470,410
Pacific	$0	$0	$18,356	$0	$18,356	$18,356
Southern	$0	$0	$9,630,782	$0	$9,630,782	$9,630,782
Western	$0	$0	$1,983,974	$0	$1,983,974	$1,983,974
Subtotal	**$0**	**$0**	**$18,055,786**	**$0**	**$18,055,786**	**$18,055,786**
Oil and Gas						
Central	$0	$0	$80,025	$0	$80,025	$80,025
Eastern	$0	$0	$49,232	$0	$49,232	$49,232
Southern	$0	$0	$2,578,365	$0	$2,578,365	$2,578,365
Western	$0	$0	$65,098	$0	$65,098	$65,098
Subtotal	**$0**	**$0**	**$2,772,721**	**$0**	**$2,772,721**	**$2,772,721**
Postal and Delivery Services						
Central	$0	$0	$113,937	$0	$113,937	$113,937
Eastern	$0	$0	$211,272	$0	$211,272	$211,272
Pacific	$0	$0	$3,706	$0	$3,706	$3,706
Southern	$0	$0	$587,771	$0	$587,771	$587,771
Western	$0	$0	$151,805	$0	$151,805	$151,805

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Subtotal	**$0**	**$0**	**$1,068,492**	**$0**	**$1,068,492**	**$1,068,492**
Recreation and Amusement						
Central	$0	$0	$185,509	$0	$185,509	$185,509
Eastern	$0	$0	$379,348	$0	$379,348	$379,348
Pacific	$0	$0	$8,045	$0	$8,045	$8,045
Southern	$0	$0	$1,268,180	$0	$1,268,180	$1,268,180
Western	$0	$0	$331,134	$0	$331,134	$331,134
Subtotal	**$0**	**$0**	**$2,172,216**	**$0**	**$2,172,216**	**$2,172,216**
Sanitation and Waste Removal						
Central	$0	$0	$45,151	$0	$45,151	$45,151
Eastern	$0	$0	$90,957	$0	$90,957	$90,957
Pacific	$0	$0	$2,986	$0	$2,986	$2,986
Southern	$0	$0	$291,545	$0	$291,545	$291,545
Western	$0	$0	$65,650	$0	$65,650	$65,650
Subtotal	**$0**	**$0**	**$496,289**	**$0**	**$496,289**	**$496,289**
Telecommunications						
Central	$0	$0	$151,517	$0	$151,517	$151,517
Eastern	$0	$0	$279,051	$0	$279,051	$279,051
Pacific	$0	$0	$5,581	$0	$5,581	$5,581
Southern	$0	$0	$874,884	$0	$874,884	$874,884
Western	$0	$0	$179,719	$0	$179,719	$179,719
Subtotal	**$0**	**$0**	**$1,490,753**	**$0**	**$1,490,753**	**$1,490,753**
Temporary Help Services						
Central	$0	$0	$713,404	$0	$713,404	$713,404
Eastern	$0	$0	$1,276,657	$0	$1,276,657	$1,276,657
Pacific	$0	$0	$48,088	$0	$48,088	$48,088
Southern	$0	$0	$8,105,101	$0	$8,105,101	$8,105,101
Western	$0	$0	$1,310,928	$0	$1,310,928	$1,310,928
Subtotal	**$0**	**$0**	**$11,454,178**	**$0**	**$11,454,178**	**$11,454,178**
Transportation						
Central	$0	$0	$512,038	$0	$512,038	$512,038
Eastern	$0	$0	$609,483	$0	$609,483	$609,483
Pacific	$0	$0	$34,996	$0	$34,996	$34,996
Southern	$0	$0	$3,022,823	$0	$3,022,823	$3,022,823
Western	$0	$0	$558,700	$0	$558,700	$558,700
Subtotal	**$0**	**$0**	**$4,738,041**	**$0**	**$4,738,041**	**$4,738,041**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Utilities						
Central	$0	$0	$310,601	$0	$310,601	$310,601
Eastern	$0	$0	$516,996	$0	$516,996	$516,996
Pacific	$0	$0	$3,645	$0	$3,645	$3,645
Southern	$0	$0	$1,697,613	$0	$1,697,613	$1,697,613
Western	$0	$0	$300,148	$0	$300,148	$300,148
Subtotal	**$0**	**$0**	**$2,829,003**	**$0**	**$2,829,003**	**$2,829,003**
Warehousing						
Central	$0	$0	$192,063	$0	$192,063	$192,063
Eastern	$0	$0	$318,704	$0	$318,704	$318,704
Pacific	$0	$0	$2,156	$0	$2,156	$2,156
Southern	$0	$0	$899,899	$0	$899,899	$899,899
Western	$0	$0	$238,445	$0	$238,445	$238,445
Subtotal	**$0**	**$0**	**$1,651,267**	**$0**	**$1,651,267**	**$1,651,267**
Non-Core						
Central	$0	$0	$9,855,541	$0	$9,855,541	$9,855,541
Eastern	$0	$0	$21,006,382	$0	$21,006,382	$21,006,382
Pacific	$0	$0	$487,706	$0	$487,706	$487,706
Southern	$0	$0	$39,335,004	$0	$39,335,004	$39,335,004
Western	$0	$0	$16,443,906	$0	$16,443,906	$16,443,906
Subtotal	**$0**	**$0**	**$87,128,538**	**$0**	**$87,128,538**	**$87,128,538**
Total Costs for Observation for Signs and Symptoms – At–Risk Worker						
Central	$0	$0	$21,491,261	$0	$21,491,261	$21,491,261
Eastern	$0	$0	$39,257,702	$0	$39,257,702	$39,257,702
Pacific	$0	$0	$964,984	$0	$964,984	$964,984
Southern	$0	$0	$106,979,565	$0	$106,979,565	$106,979,565
Western	$0	$0	$31,044,802	$0	$31,044,802	$31,044,802
Total	**$0**	**$0**	**$199,738,313**	**$0**	**$199,738,313**	**$199,738,313**
Initial Hazard Alert – Supervisor						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$71,187	$0	$71,187	$71,187
Eastern	$0	$0	$38,887	$0	$38,887	$38,887
Pacific	$0	$0	$525	$0	$525	$525
Southern	$0	$0	$67,550	$0	$67,550	$67,550
Western	$0	$0	$23,579	$0	$23,579	$23,579
Subtotal	**$0**	**$0**	**$201,728**	**$0**	**$201,728**	**$201,728**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Building Materials and Equipment Suppliers						
Central	$0	$0	$8,975	$0	$8,975	$8,975
Eastern	$0	$0	$13,148	$0	$13,148	$13,148
Pacific	$0	$0	$215	$0	$215	$215
Southern	$0	$0	$12,095	$0	$12,095	$12,095
Western	$0	$0	$8,884	$0	$8,884	$8,884
Subtotal	**$0**	**$0**	**$43,316**	**$0**	**$43,316**	**$43,316**
Commercial Kitchens						
Central	$0	$0	$67,932	$0	$67,932	$67,932
Eastern	$0	$0	$113,247	$0	$113,247	$113,247
Pacific	$0	$0	$2,165	$0	$2,165	$2,165
Southern	$0	$0	$83,089	$0	$83,089	$83,089
Western	$0	$0	$71,282	$0	$71,282	$71,282
Subtotal	**$0**	**$0**	**$337,715**	**$0**	**$337,715**	**$337,715**
Construction						
Central	$0	$0	$94,901	$0	$94,901	$94,901
Eastern	$0	$0	$139,158	$0	$139,158	$139,158
Pacific	$0	$0	$2,136	$0	$2,136	$2,136
Southern	$0	$0	$103,318	$0	$103,318	$103,318
Western	$0	$0	$55,542	$0	$55,542	$55,542
Subtotal	**$0**	**$0**	**$395,055**	**$0**	**$395,055**	**$395,055**
Drycleaning and Commercial Laundries						
Central	$0	$0	$5,638	$0	$5,638	$5,638
Eastern	$0	$0	$14,483	$0	$14,483	$14,483
Pacific	$0	$0	$114	$0	$114	$114
Southern	$0	$0	$8,547	$0	$8,547	$8,547
Western	$0	$0	$6,139	$0	$6,139	$6,139
Subtotal	**$0**	**$0**	**$34,922**	**$0**	**$34,922**	**$34,922**
Landscaping and Facilities Support						
Central	$0	$0	$30,364	$0	$30,364	$30,364
Eastern	$0	$0	$49,428	$0	$49,428	$49,428
Pacific	$0	$0	$719	$0	$719	$719
Southern	$0	$0	$34,796	$0	$34,796	$34,796
Western	$0	$0	$30,665	$0	$30,665	$30,665
Subtotal	**$0**	**$0**	**$145,973**	**$0**	**$145,973**	**$145,973**
Maintenance and Repair						

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Central	$0	$0	$49,834	$0	$49,834	$49,834
Eastern	$0	$0	$66,053	$0	$66,053	$66,053
Pacific	$0	$0	$794	$0	$794	$794
Southern	$0	$0	$53,651	$0	$53,651	$53,651
Western	$0	$0	$42,009	$0	$42,009	$42,009
Subtotal	**$0**	**$0**	**$212,341**	**$0**	**$212,341**	**$212,341**
Manufacturing						
Central	$0	$0	$18,064	$0	$18,064	$18,064
Eastern	$0	$0	$20,957	$0	$20,957	$20,957
Pacific	$0	$0	$167	$0	$167	$167
Southern	$0	$0	$15,718	$0	$15,718	$15,718
Western	$0	$0	$14,869	$0	$14,869	$14,869
Subtotal	**$0**	**$0**	**$69,774**	**$0**	**$69,774**	**$69,774**
Oil and Gas						
Central	$0	$0	$12,981	$0	$12,981	$12,981
Eastern	$0	$0	$6,913	$0	$6,913	$6,913
Southern	$0	$0	$0	$0	$0	$0
Western	$0	$0	$47,995	$0	$47,995	$47,995
Subtotal	$0	$0	$6,619	$0	$6,619	$6,619
Postal and Delivery Services						
Central	$0	$0	$24,791	$0	$24,791	$24,791
Eastern	$0	$0	$31,359	$0	$31,359	$31,359
Pacific	$0	$0	$331	$0	$331	$331
Southern	$0	$0	$23,087	$0	$23,087	$23,087
Western	$0	$0	$14,795	$0	$14,795	$14,795
Subtotal	**$0**	**$0**	**$94,363**	**$0**	**$94,363**	**$94,363**
Recreation and Amusement						
Central	$0	$0	$20,673	$0	$20,673	$20,673
Eastern	$0	$0	$31,001	$0	$31,001	$31,001
Pacific	$0	$0	$389	$0	$389	$389
Southern	$0	$0	$20,185	$0	$20,185	$20,185
Western	$0	$0	$17,180	$0	$17,180	$17,180
Subtotal	**$0**	**$0**	**$89,428**	**$0**	**$89,428**	**$89,428**
Sanitation and Waste Removal						
Central	$0	$0	$1,900	$0	$1,900	$1,900
Eastern	$0	$0	$2,742	$0	$2,742	$2,742

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Pacific	$0	$0	$42	$0	$42	$42
Southern	$0	$0	$1,990	$0	$1,990	$1,990
Western	$0	$0	$1,343	$0	$1,343	$1,343
Subtotal	**$0**	**$0**	**$8,016**	**$0**	**$8,016**	**$8,016**
Telecommunications						
Central	$0	$0	$6,853	$0	$6,853	$6,853
Eastern	$0	$0	$9,379	$0	$9,379	$9,379
Pacific	$0	$0	$102	$0	$102	$102
Southern	$0	$0	$8,239	$0	$8,239	$8,239
Western	$0	$0	$5,748	$0	$5,748	$5,748
Subtotal	**$0**	**$0**	**$30,322**	**$0**	**$30,322**	**$30,322**
Temporary Help Services						
Central	$0	$0	$3,784	$0	$3,784	$3,784
Eastern	$0	$0	$5,332	$0	$5,332	$5,332
Pacific	$0	$0	$51	$0	$51	$51
Southern	$0	$0	$4,527	$0	$4,527	$4,527
Western	$0	$0	$3,253	$0	$3,253	$3,253
Subtotal	**$0**	**$0**	**$16,947**	**$0**	**$16,947**	**$16,947**
Transportation						
Central	$0	$0	$99,748	$0	$99,748	$99,748
Eastern	$0	$0	$89,795	$0	$89,795	$89,795
Pacific	$0	$0	$1,119	$0	$1,119	$1,119
Southern	$0	$0	$91,342	$0	$91,342	$91,342
Western	$0	$0	$35,838	$0	$35,838	$35,838
Subtotal	**$0**	**$0**	**$317,842**	**$0**	**$317,842**	**$317,842**
Utilities						
Central	$0	$0	$16,409	$0	$16,409	$16,409
Eastern	$0	$0	$20,570	$0	$20,570	$20,570
Pacific	$0	$0	$141	$0	$141	$141
Southern	$0	$0	$23,071	$0	$23,071	$23,071
Western	$0	$0	$11,751	$0	$11,751	$11,751
Subtotal	**$0**	**$0**	**$71,942**	**$0**	**$71,942**	**$71,942**
Warehousing						
Central	$0	$0	$8,066	$0	$8,066	$8,066
Eastern	$0	$0	$10,200	$0	$10,200	$10,200
Pacific	$0	$0	$129	$0	$129	$129

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$0	$0	$10,013	$0	$10,013	$10,013
Western	$0	$0	$7,574	$0	$7,574	$7,574
Subtotal	**$0**	**$0**	**$35,982**	**$0**	**$35,982**	**$35,982**
Non-Core						
Central	$0	$0	$781,190	$0	$781,190	$781,190
Eastern	$0	$0	$1,221,415	$0	$1,221,415	$1,221,415
Pacific	$0	$0	$18,719	$0	$18,719	$18,719
Southern	$0	$0	$969,956	$0	$969,956	$969,956
Western	$0	$0	$778,728	$0	$778,728	$778,728
Subtotal	**$0**	**$0**	**$3,770,009**	**$0**	**$3,770,009**	**$3,770,009**
Total Costs for Initial Hazard Alert – Supervisor						
Central	$0	$0	$1,323,291	$0	$1,323,291	$1,323,291
Eastern	$0	$0	$1,884,066	$0	$1,884,066	$1,884,066
Pacific	$0	$0	$27,858	$0	$27,858	$27,858
Southern	$0	$0	$1,579,170	$0	$1,579,170	$1,579,170
Western	$0	$0	$1,135,797	$0	$1,135,797	$1,135,797
Total	**$0**	**$0**	**$5,950,182**	**$0**	**$5,950,182**	**$5,950,182**
Subsequent Hazard Alert – Supervisor						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$149,209	$0	$149,209	$149,209
Eastern	$0	$0	$88,960	$0	$88,960	$88,960
Pacific	$0	$0	$1,530	$0	$1,530	$1,530
Southern	$0	$0	$568,001	$0	$568,001	$568,001
Western	$0	$0	$38,555	$0	$38,555	$38,555
Subtotal	**$0**	**$0**	**$846,254**	**$0**	**$846,254**	**$846,254**
Building Materials and Equipment Suppliers						
Central	$0	$0	$16,253	$0	$16,253	$16,253
Eastern	$0	$0	$25,292	$0	$25,292	$25,292
Pacific	$0	$0	$626	$0	$626	$626
Southern	$0	$0	$115,252	$0	$115,252	$115,252
Western	$0	$0	$24,002	$0	$24,002	$24,002
Subtotal	**$0**	**$0**	**$181,424**	**$0**	**$181,424**	**$181,424**
Commercial Kitchens						
Central	$0	$0	$120,142	$0	$120,142	$120,142
Eastern	$0	$0	$218,769	$0	$218,769	$218,769
Pacific	$0	$0	$6,307	$0	$6,307	$6,307

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$0	$0	$781,907	$0	$781,907	$781,907
Western	$0	$0	$195,280	$0	$195,280	$195,280
Subtotal	**$0**	**$0**	**$1,322,405**	**$0**	**$1,322,405**	**$1,322,405**
Construction						
Central	$0	$0	$164,418	$0	$164,418	$164,418
Eastern	$0	$0	$279,925	$0	$279,925	$279,925
Pacific	$0	$0	$6,223	$0	$6,223	$6,223
Southern	$0	$0	$990,737	$0	$990,737	$990,737
Western	$0	$0	$131,620	$0	$131,620	$131,620
Subtotal	**$0**	**$0**	**$1,572,922**	**$0**	**$1,572,922**	**$1,572,922**
Drycleaning and Commercial Laundries						
Central	$0	$0	$10,046	$0	$10,046	$10,046
Eastern	$0	$0	$26,309	$0	$26,309	$26,309
Pacific	$0	$0	$332	$0	$332	$332
Southern	$0	$0	$80,016	$0	$80,016	$80,016
Western	$0	$0	$17,282	$0	$17,282	$17,282
Subtotal	**$0**	**$0**	**$133,985**	**$0**	**$133,985**	**$133,985**
Landscaping and Facilities Support						
Central	$0	$0	$54,037	$0	$54,037	$54,037
Eastern	$0	$0	$98,530	$0	$98,530	$98,530
Pacific	$0	$0	$2,096	$0	$2,096	$2,096
Southern	$0	$0	$336,231	$0	$336,231	$336,231
Western	$0	$0	$84,009	$0	$84,009	$84,009
Subtotal	**$0**	**$0**	**$574,904**	**$0**	**$574,904**	**$574,904**
Maintenance and Repair						
Central	$0	$0	$88,347	$0	$88,347	$88,347
Eastern	$0	$0	$132,539	$0	$132,539	$132,539
Pacific	$0	$0	$2,313	$0	$2,313	$2,313
Southern	$0	$0	$506,615	$0	$506,615	$506,615
Western	$0	$0	$115,861	$0	$115,861	$115,861
Subtotal	**$0**	**$0**	**$845,675**	**$0**	**$845,675**	**$845,675**
Manufacturing						
Central	$0	$0	$30,252	$0	$30,252	$30,252
Eastern	$0	$0	$39,098	$0	$39,098	$39,098
Pacific	$0	$0	$487	$0	$487	$487
Southern	$0	$0	$141,837	$0	$141,837	$141,837

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Western	$0	$0	$39,037	$0	$39,037	$39,037
Subtotal	**$0**	**$0**	**$250,711**	**$0**	**$250,711**	**$250,711**
Oil and Gas						
Central	$0	$0	$26,387	$0	$26,387	$26,387
Eastern	$0	$0	$10,013	$0	$10,013	$10,013
Southern	$0	$0	$420,050	$0	$420,050	$420,050
Western	$0	$0	$11,239	$0	$11,239	$11,239
Subtotal	**$0**	**$0**	**$467,689**	**$0**	**$467,689**	**$467,689**
Postal and Delivery Services						
Central	$0	$0	$47,695	$0	$47,695	$47,695
Eastern	$0	$0	$58,857	$0	$58,857	$58,857
Pacific	$0	$0	$965	$0	$965	$965
Southern	$0	$0	$194,296	$0	$194,296	$194,296
Western	$0	$0	$37,304	$0	$37,304	$37,304
Subtotal	**$0**	**$0**	**$339,116**	**$0**	**$339,116**	**$339,116**
Recreation and Amusement						
Central	$0	$0	$35,170	$0	$35,170	$35,170
Eastern	$0	$0	$60,614	$0	$60,614	$60,614
Pacific	$0	$0	$1,133	$0	$1,133	$1,133
Southern	$0	$0	$188,542	$0	$188,542	$188,542
Western	$0	$0	$44,903	$0	$44,903	$44,903
Subtotal	**$0**	**$0**	**$330,363**	**$0**	**$330,363**	**$330,363**
Sanitation and Waste Removal						
Central	$0	$0	$3,271	$0	$3,271	$3,271
Eastern	$0	$0	$5,309	$0	$5,309	$5,309
Pacific	$0	$0	$121	$0	$121	$121
Southern	$0	$0	$18,021	$0	$18,021	$18,021
Western	$0	$0	$3,586	$0	$3,586	$3,586
Subtotal	**$0**	**$0**	**$30,308**	**$0**	**$30,308**	**$30,308**
Telecommunications						
Central	$0	$0	$12,587	$0	$12,587	$12,587
Eastern	$0	$0	$19,110	$0	$19,110	$19,110
Pacific	$0	$0	$298	$0	$298	$298
Southern	$0	$0	$73,609	$0	$73,609	$73,609
Western	$0	$0	$15,550	$0	$15,550	$15,550
Subtotal	**$0**	**$0**	**$121,154**	**$0**	**$121,154**	**$121,154**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Temporary Help Services						
Central	$0	$0	$6,407	$0	$6,407	$6,407
Eastern	$0	$0	$11,059	$0	$11,059	$11,059
Pacific	$0	$0	$149	$0	$149	$149
Southern	$0	$0	$41,583	$0	$41,583	$41,583
Western	$0	$0	$9,367	$0	$9,367	$9,367
Subtotal	**$0**	**$0**	**$68,566**	**$0**	**$68,566**	**$68,566**
Transportation						
Central	$0	$0	$184,544	$0	$184,544	$184,544
Eastern	$0	$0	$184,968	$0	$184,968	$184,968
Pacific	$0	$0	$3,259	$0	$3,259	$3,259
Southern	$0	$0	$842,960	$0	$842,960	$842,960
Western	$0	$0	$83,587	$0	$83,587	$83,587
Subtotal	**$0**	**$0**	**$1,299,318**	**$0**	**$1,299,318**	**$1,299,318**
Utilities						
Central	$0	$0	$30,683	$0	$30,683	$30,683
Eastern	$0	$0	$44,025	$0	$44,025	$44,025
Pacific	$0	$0	$411	$0	$411	$411
Southern	$0	$0	$201,775	$0	$201,775	$201,775
Western	$0	$0	$29,334	$0	$29,334	$29,334
Subtotal	**$0**	**$0**	**$306,228**	**$0**	**$306,228**	**$306,228**
Warehousing						
Central	$0	$0	$15,139	$0	$15,139	$15,139
Eastern	$0	$0	$22,380	$0	$22,380	$22,380
Pacific	$0	$0	$377	$0	$377	$377
Southern	$0	$0	$87,373	$0	$87,373	$87,373
Western	$0	$0	$21,292	$0	$21,292	$21,292
Subtotal	**$0**	**$0**	**$146,561**	**$0**	**$146,561**	**$146,561**
Non-Core						
Central	$0	$0	$1,389,956	$0	$1,389,956	$1,389,956
Eastern	$0	$0	$2,433,884	$0	$2,433,884	$2,433,884
Pacific	$0	$0	$54,538	$0	$54,538	$54,538
Southern	$0	$0	$9,127,069	$0	$9,127,069	$9,127,069
Western	$0	$0	$2,149,829	$0	$2,149,829	$2,149,829
Subtotal	**$0**	**$0**	**$15,155,276**	**$0**	**$15,155,276**	**$15,155,276**
Total Costs for Subsequent Hazard Alert – Supervisor						

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Central	$0	$0	$2,384,543	$0	$2,384,543	$2,384,543
Eastern	$0	$0	$3,759,640	$0	$3,759,640	$3,759,640
Pacific	$0	$0	$81,165	$0	$81,165	$81,165
Southern	$0	$0	$14,715,873	$0	$14,715,873	$14,715,873
Western	$0	$0	$3,051,637	$0	$3,051,637	$3,051,637
Total	**$0**	**$0**	**$23,992,858**	**$0**	**$23,992,858**	**$23,992,858**
Warning Signs						
Commercial Kitchens						
Alaskan	$564	$627	$0	$0	$564	$627
Central	$44,703	$49,766	$0	$0	$44,703	$49,766
Eastern	$77,765	$86,573	$0	$0	$77,765	$86,573
Pacific	$1,463	$1,629	$0	$0	$1,463	$1,629
Southern	$57,794	$64,340	$0	$0	$57,794	$64,340
Western	$49,059	$54,616	$0	$0	$49,059	$54,616
Subtotal	**$231,347**	**$257,551**	**$0**	**$0**	**$231,347**	**$257,551**
Construction						
Alaskan	$151	$168	$0	$0	$151	$168
Central	$10,082	$11,224	$0	$0	$10,082	$11,224
Eastern	$16,073	$17,893	$0	$0	$16,073	$17,893
Pacific	$257	$286	$0	$0	$257	$286
Southern	$12,900	$14,361	$0	$0	$12,900	$14,361
Western	$6,793	$7,563	$0	$0	$6,793	$7,563
Subtotal	**$46,255**	**$51,494**	**$0**	**$0**	**$46,255**	**$51,494**
Drycleaning and Commercial Laundries						
Alaskan	$20	$22	$0	$0	$20	$22
Central	$2,516	$2,801	$0	$0	$2,516	$2,801
Eastern	$6,463	$7,195	$0	$0	$6,463	$7,195
Pacific	$51	$57	$0	$0	$51	$57
Southern	$3,814	$4,246	$0	$0	$3,814	$4,246
Western	$2,740	$3,050	$0	$0	$2,740	$3,050
Subtotal	**$15,604**	**$17,371**	**$0**	**$0**	**$15,604**	**$17,371**
Landscaping and Facilities Support						
Alaskan	$11	$12	$0	$0	$11	$12
Central	$2,626	$2,924	$0	$0	$2,626	$2,924
Eastern	$3,808	$4,239	$0	$0	$3,808	$4,239
Pacific	$18	$20	$0	$0	$18	$20

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$2,320	$2,583	$0	$0	$2,320	$2,583
Western	$939	$1,046	$0	$0	$939	$1,046
Subtotal	**$9,722**	**$10,824**	**$0**	**$0**	**$9,722**	**$10,824**
Maintenance and Repair						
Alaskan	$40	$44	$0	$0	$40	$44
Central	$2,629	$2,927	$0	$0	$2,629	$2,927
Eastern	$2,729	$3,038	$0	$0	$2,729	$3,038
Pacific	$39	$44	$0	$0	$39	$44
Southern	$2,972	$3,309	$0	$0	$2,972	$3,309
Western	$1,688	$1,879	$0	$0	$1,688	$1,879
Subtotal	**$10,097**	**$11,240**	**$0**	**$0**	**$10,097**	**$11,240**
Manufacturing						
Alaskan	$13	$14	$0	$0	$13	$14
Central	$3,739	$4,162	$0	$0	$3,739	$4,162
Eastern	$4,182	$4,656	$0	$0	$4,182	$4,656
Pacific	$28	$32	$0	$0	$28	$32
Southern	$3,298	$3,672	$0	$0	$3,298	$3,672
Western	$2,854	$3,177	$0	$0	$2,854	$3,177
Subtotal	**$14,114**	**$15,713**	**$0**	**$0**	**$14,114**	**$15,713**
Oil and Gas						
Alaskan	$10	$11	$0	$0	$10	$11
Central	$736	$819	$0	$0	$736	$819
Eastern	$499	$555	$0	$0	$499	$555
Southern	$1,582	$1,761	$0	$0	$1,582	$1,761
Western	$253	$281	$0	$0	$253	$281
Subtotal	**$3,079**	**$3,428**	**$0**	**$0**	**$3,079**	**$3,428**
Transportation						
Alaskan	$20	$23	$0	$0	$20	$23
Central	$56	$63	$0	$0	$56	$63
Eastern	$137	$153	$0	$0	$137	$153
Pacific	$5	$6	$0	$0	$5	$6
Southern	$208	$231	$0	$0	$208	$231
Western	$55	$62	$0	$0	$55	$62
Subtotal	**$482**	**$536**	**$0**	**$0**	**$482**	**$536**
Utilities						
Alaskan	$79	$88	$0	$0	$79	$88

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Central	$2,710	$3,017	$0	$0	$2,710	$3,017
Eastern	$3,593	$4,000	$0	$0	$3,593	$4,000
Pacific	$3	$3	$0	$0	$3	$3
Southern	$3,300	$3,673	$0	$0	$3,300	$3,673
Western	$1,554	$1,730	$0	$0	$1,554	$1,730
Subtotal	**$11,240**	**$12,513**	**$0**	**$0**	**$11,240**	**$12,513**
Non-Core						
Alaskan	$8	$9	$0	$0	$8	$9
Central	$681	$758	$0	$0	$681	$758
Eastern	$1,759	$1,958	$0	$0	$1,759	$1,958
Pacific	$19	$22	$0	$0	$19	$22
Southern	$804	$895	$0	$0	$804	$895
Western	$1,388	$1,546	$0	$0	$1,388	$1,546
Subtotal	**$4,659**	**$5,187**	**$0**	**$0**	**$4,659**	**$5,187**
Total Costs for Warning Signs						
Alaskan	$915	$1,019	$0	$0	$915	$1,019
Central	$70,478	$78,460	$0	$0	$70,478	$78,460
Eastern	$117,007	$130,260	$0	$0	$117,007	$130,260
Pacific	$1,884	$2,098	$0	$0	$1,884	$2,098
Southern	$88,991	$99,071	$0	$0	$88,991	$99,071
Western	$67,324	$74,949	$0	$0	$67,324	$74,949
Total	**$346,599**	**$385,857**	**$0**	**$0**	**$346,599**	**$385,857**
Signage Placement						
Commercial Kitchens						
Alaskan	$116	$129	$0	$0	$116	$129
Central	$9,215	$10,259	$0	$0	$9,215	$10,259
Eastern	$16,044	$17,862	$0	$0	$16,044	$17,862
Pacific	$303	$337	$0	$0	$303	$337
Southern	$11,913	$13,262	$0	$0	$11,913	$13,262
Western	$10,122	$11,268	$0	$0	$10,122	$11,268
Subtotal	**$47,714**	**$53,118**	**$0**	**$0**	**$47,714**	**$53,118**
Construction						
Alaskan	$73	$82	$0	$0	$73	$82
Central	$4,761	$5,301	$0	$0	$4,761	$5,301
Eastern	$7,589	$8,449	$0	$0	$7,589	$8,449
Pacific	$125	$139	$0	$0	$125	$139

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Southern	$6,167	$6,866	$0	$0	$6,167	$6,866
Western	$3,500	$3,896	$0	$0	$3,500	$3,896
Subtotal	**$22,216**	**$24,732**	**$0**	**$0**	**$22,216**	**$24,732**
Drycleaning and Commercial Laundries						
Alaskan	$7	$8	$0	$0	$7	$8
Central	$846	$941	$0	$0	$846	$941
Eastern	$2,172	$2,419	$0	$0	$2,172	$2,419
Pacific	$17	$19	$0	$0	$17	$19
Southern	$1,282	$1,427	$0	$0	$1,282	$1,427
Western	$921	$1,025	$0	$0	$921	$1,025
Subtotal	**$5,245**	**$5,839**	**$0**	**$0**	**$5,245**	**$5,839**
Landscaping and Facilities Support						
Alaskan	$4	$4	$0	$0	$4	$4
Central	$883	$983	$0	$0	$883	$983
Eastern	$1,280	$1,425	$0	$0	$1,280	$1,425
Pacific	$6	$7	$0	$0	$6	$7
Southern	$780	$868	$0	$0	$780	$868
Western	$316	$352	$0	$0	$316	$352
Subtotal	**$3,268**	**$3,638**	**$0**	**$0**	**$3,268**	**$3,638**
Maintenance and Repair						
Alaskan	$13	$15	$0	$0	$13	$15
Central	$884	$984	$0	$0	$884	$984
Eastern	$917	$1,021	$0	$0	$917	$1,021
Pacific	$13	$15	$0	$0	$13	$15
Southern	$999	$1,112	$0	$0	$999	$1,112
Western	$567	$632	$0	$0	$567	$632
Subtotal	**$3,394**	**$3,778**	**$0**	**$0**	**$3,394**	**$3,778**
Manufacturing						
Alaskan	$6	$6	$0	$0	$6	$6
Central	$1,615	$1,798	$0	$0	$1,615	$1,798
Eastern	$1,806	$2,011	$0	$0	$1,806	$2,011
Pacific	$12	$14	$0	$0	$12	$14
Southern	$1,425	$1,586	$0	$0	$1,425	$1,586
Western	$1,233	$1,372	$0	$0	$1,233	$1,372
Subtotal	**$6,096**	**$6,787**	**$0**	**$0**	**$6,096**	**$6,787**
Oil and Gas						

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Alaskan	$4	$4	$0	$0	$4	$4
Central	$275	$306	$0	$0	$275	$306
Eastern	$187	$208	$0	$0	$187	$208
Southern	$592	$659	$0	$0	$592	$659
Western	$95	$105	$0	$0	$95	$105
Subtotal	**$1,152**	**$1,282**	**$0**	**$0**	**$1,152**	**$1,282**
Transportation						
Alaskan	$8	$9	$0	$0	$8	$9
Central	$21	$23	$0	$0	$21	$23
Eastern	$51	$57	$0	$0	$51	$57
Pacific	$2	$2	$0	$0	$2	$2
Southern	$78	$86	$0	$0	$78	$86
Western	$21	$23	$0	$0	$21	$23
Subtotal	**$180**	**$201**	**$0**	**$0**	**$180**	**$201**
Utilities						
Alaskan	$46	$51	$0	$0	$46	$51
Central	$1,572	$1,750	$0	$0	$1,572	$1,750
Eastern	$2,084	$2,320	$0	$0	$2,084	$2,320
Pacific	$2	$2	$0	$0	$2	$2
Southern	$1,914	$2,130	$0	$0	$1,914	$2,130
Western	$901	$1,003	$0	$0	$901	$1,003
Subtotal	**$6,518**	**$7,256**	**$0**	**$0**	**$6,518**	**$7,256**
Non-Core						
Alaskan	$5	$5	$0	$0	$5	$5
Central	$402	$448	$0	$0	$402	$448
Eastern	$1,039	$1,156	$0	$0	$1,039	$1,156
Pacific	$11	$13	$0	$0	$11	$13
Southern	$475	$528	$0	$0	$475	$528
Western	$820	$913	$0	$0	$820	$913
Subtotal	**$2,751**	**$3,063**	**$0**	**$0**	**$2,751**	**$3,063**
Total Costs for Signage Placement						
Alaskan	$281	$312	$0	$0	$281	$312
Central	$20,474	$22,793	$0	$0	$20,474	$22,793
Eastern	$33,170	$36,927	$0	$0	$33,170	$36,927
Pacific	$492	$547	$0	$0	$492	$547
Southern	$25,623	$28,525	$0	$0	$25,623	$28,525

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Western	$18,495	$20,590	$0	$0	$18,495	$20,590
Total	**$98,534**	**$109,694**	**$0**	**$0**	**$98,534**	**$109,694**
Total Costs for Requirements at or above the High Heat Trigger						
Agriculture, Forestry, and Fishing						
Central	$0	$0	$42,380,008	$28,260,379	$14,119,630	$14,119,630
Eastern	$0	$0	$35,661,233	$23,886,065	$11,775,168	$11,775,168
Pacific	$0	$0	$556,114	$371,868	$184,245	$184,245
Southern	$0	$0	$192,037,096	$128,848,517	$63,188,579	$63,188,579
Western	$0	$0	$27,352,262	$17,612,811	$9,739,451	$9,739,451
Subtotal	**$0**	**$0**	**$297,986,712**	**$198,979,639**	**$99,007,073**	**$99,007,073**
Building Materials and Equipment Suppliers						
Central	$0	$0	$15,259,345	$10,720,490	$4,538,855	$4,538,855
Eastern	$0	$0	$27,374,501	$19,326,690	$8,047,810	$8,047,810
Pacific	$0	$0	$695,315	$489,955	$205,360	$205,360
Southern	$0	$0	$114,088,707	$80,616,258	$33,472,449	$33,472,449
Western	$0	$0	$10,537,593	$7,222,675	$3,314,918	$3,314,918
Subtotal	**$0**	**$0**	**$167,955,460**	**$118,376,068**	**$49,579,392**	**$49,579,392**
Commercial Kitchens						
Alaskan	$680	$757	$0	$0	$680	$757
Central	$53,918	$60,025	$68,619,433	$50,009,739	$18,663,611	$18,669,718
Eastern	$93,809	$104,434	$151,155,901	$110,815,642	$40,434,069	$40,444,694
Pacific	$1,767	$1,967	$5,006,642	$3,663,797	$1,344,612	$1,344,812
Southern	$69,707	$77,602	$573,330,985	$421,490,458	$151,910,234	$151,918,129
Western	$59,181	$65,884	$60,628,710	$43,350,035	$17,337,856	$17,344,559
Subtotal	**$279,061**	**$310,669**	**$858,741,671**	**$629,329,670**	**$229,691,061**	**$229,722,669**
Construction						
Alaskan	$224	$249	$0	$0	$224	$249
Central	$14,843	$16,524	$209,056,982	$141,690,442	$67,381,383	$67,383,064
Eastern	$23,662	$26,342	$463,946,432	$316,103,585	$147,866,509	$147,869,189
Pacific	$382	$425	$14,776,247	$10,040,905	$4,735,724	$4,735,767
Southern	$19,067	$21,226	$1,826,423,948	$1,246,717,469	$579,725,546	$579,727,706
Western	$10,293	$11,459	$193,613,925	$129,218,140	$64,406,078	$64,407,244
Subtotal	**$68,470**	**$76,226**	**$2,707,817,534**	**$1,843,770,540**	**$864,115,464**	**$864,123,220**
Drycleaning and Commercial Laundries						
Alaskan	$27	$30	$0	$0	$27	$30
Central	$3,362	$3,742	$2,128,940	$1,511,252	$621,050	$621,431

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Eastern	$8,636	$9,614	$5,791,351	$4,134,982	$1,665,005	$1,665,983
Pacific	$68	$76	$208,637	$149,402	$59,303	$59,311
Southern	$5,096	$5,674	$19,050,617	$13,664,133	$5,391,581	$5,392,158
Western	$3,660	$4,075	$1,935,742	$1,341,209	$598,194	$598,608
Subtotal	**$20,849**	**$23,210**	**$29,115,287**	**$20,800,977**	**$8,335,159**	**$8,337,520**
Landscaping and Facilities Support						
Alaskan	$14	$16	$0	$0	$14	$16
Central	$3,509	$3,907	$38,297,610	$25,669,779	$12,631,341	$12,631,739
Eastern	$5,088	$5,664	$99,438,739	$67,109,986	$32,333,840	$32,334,416
Pacific	$24	$27	$3,040,514	$2,046,991	$993,547	$993,550
Southern	$3,100	$3,451	$327,823,997	$221,913,360	$105,913,738	$105,914,089
Western	$1,255	$1,397	$33,798,576	$22,246,099	$11,553,732	$11,553,874
Subtotal	**$12,990**	**$14,462**	**$502,399,436**	**$338,986,214**	**$163,426,212**	**$163,427,683**
Maintenance and Repair						
Alaskan	$53	$59	$0	$0	$53	$59
Central	$3,513	$3,911	$23,017,823	$15,941,193	$7,080,143	$7,080,541
Eastern	$3,646	$4,059	$45,127,748	$31,452,400	$13,678,994	$13,679,407
Pacific	$53	$59	$887,136	$617,516	$269,672	$269,678
Southern	$3,971	$4,421	$169,223,833	$118,399,919	$50,827,885	$50,828,335
Western	$2,255	$2,511	$17,659,435	$11,977,449	$5,684,241	$5,684,496
Subtotal	**$13,491**	**$15,019**	**$255,915,975**	**$178,388,478**	**$77,540,988**	**$77,542,516**
Manufacturing						
Alaskan	$18	$20	$0	$0	$18	$20
Central	$5,353	$5,960	$183,678,416	$132,203,016	$51,480,754	$51,481,360
Eastern	$5,989	$6,667	$265,045,610	$191,654,507	$73,397,092	$73,397,770
Pacific	$41	$45	$1,255,989	$900,119	$355,911	$355,916
Southern	$4,723	$5,258	$765,527,687	$553,306,520	$212,225,890	$212,226,425
Western	$4,087	$4,550	$62,524,352	$43,702,341	$18,826,098	$18,826,561
Subtotal	**$20,211**	**$22,500**	**$1,278,032,055**	**$921,766,502**	**$356,285,763**	**$356,288,052**
Oil and Gas						
Alaskan	$14	$16	$0	$0	$14	$16
Central	$1,011	$1,125	$4,844,875	$3,255,669	$1,590,217	$1,590,331
Eastern	$685	$763	$3,957,224	$2,687,559	$1,270,351	$1,270,429
Southern	$2,173	$2,419	$219,150,051	$149,263,297	$69,888,927	$69,889,173
Western	$347	$387	$2,790,653	$1,855,780	$935,221	$935,260
Subtotal	**$4,231**	**$4,710**	**$230,742,803**	**$157,062,304**	**$73,684,730**	**$73,685,209**

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Postal and Delivery Services						
Central	$0	$0	$7,067,739	$4,865,313	$2,202,426	$2,202,426
Eastern	$0	$0	$15,795,086	$10,979,919	$4,815,167	$4,815,167
Pacific	$0	$0	$259,654	$179,937	$79,717	$79,717
Southern	$0	$0	$48,615,830	$33,929,834	$14,685,996	$14,685,996
Western	$0	$0	$5,333,758	$3,598,956	$1,734,802	$1,734,802
Subtotal	**$0**	**$0**	**$77,072,067**	**$53,553,958**	**$23,518,109**	**$23,518,109**
Recreation and Amusement						
Central	$0	$0	$11,449,963	$7,788,056	$3,661,907	$3,661,907
Eastern	$0	$0	$29,020,353	$19,883,004	$9,137,349	$9,137,349
Pacific	$0	$0	$577,712	$395,164	$182,548	$182,548
Southern	$0	$0	$106,664,237	$73,343,696	$33,320,541	$33,320,541
Western	$0	$0	$12,200,093	$8,139,672	$4,060,421	$4,060,421
Subtotal	**$0**	**$0**	**$159,912,358**	**$109,549,593**	**$50,362,765**	**$50,362,765**
Sanitation and Waste Removal						
Central	$0	$0	$2,772,688	$1,898,218	$874,470	$874,470
Eastern	$0	$0	$6,804,557	$4,677,890	$2,126,667	$2,126,667
Pacific	$0	$0	$215,690	$148,006	$67,684	$67,684
Southern	$0	$0	$24,349,088	$16,796,017	$7,553,071	$7,553,071
Western	$0	$0	$2,307,226	$1,543,819	$763,407	$763,407
Subtotal	**$0**	**$0**	**$36,449,250**	**$25,063,950**	**$11,385,300**	**$11,385,300**
Telecommunications						
Central	$0	$0	$9,176,182	$6,378,212	$2,797,971	$2,797,971
Eastern	$0	$0	$21,179,000	$14,811,293	$6,367,707	$6,367,707
Pacific	$0	$0	$388,366	$270,956	$117,410	$117,410
Southern	$0	$0	$72,117,556	$50,535,718	$21,581,839	$21,581,839
Western	$0	$0	$6,987,064	$4,781,573	$2,205,491	$2,205,491
Subtotal	**$0**	**$0**	**$109,848,169**	**$76,777,752**	**$33,070,417**	**$33,070,417**
Temporary Help Services						
Central	$0	$0	$39,694,731	$27,884,466	$11,810,265	$11,810,265
Eastern	$0	$0	$96,536,678	$68,420,422	$28,116,256	$28,116,256
Pacific	$0	$0	$3,309,799	$2,338,558	$971,241	$971,241
Southern	$0	$0	$660,310,207	$468,920,086	$191,390,121	$191,390,121
Western	$0	$0	$46,479,235	$32,035,820	$14,443,415	$14,443,415
Subtotal	**$0**	**$0**	**$846,330,650**	**$599,599,352**	**$246,731,298**	**$246,731,298**
Transportation						

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Alaskan	$28	$31	$0	$0	$28	$31
Central	$77	$86	$32,003,351	$21,724,453	$10,278,975	$10,278,984
Eastern	$188	$210	$47,422,875	$32,486,839	$14,936,225	$14,936,247
Pacific	$7	$8	$2,524,644	$1,730,353	$794,298	$794,299
Southern	$285	$318	$253,695,845	$174,399,675	$79,296,456	$79,296,488
Western	$76	$85	$22,541,484	$15,127,338	$7,414,223	$7,414,231
Subtotal	**$662**	**$737**	**$358,188,201**	**$245,468,657**	**$112,720,205**	**$112,720,280**
Utilities						
Alaskan	$125	$139	$0	$0	$125	$139
Central	$4,282	$4,767	$19,601,649	$13,433,591	$6,172,340	$6,172,825
Eastern	$5,677	$6,320	$39,556,812	$27,238,766	$12,323,724	$12,324,367
Pacific	$5	$5	$281,923	$194,078	$87,850	$87,850
Southern	$5,213	$5,804	$141,846,798	$97,848,768	$44,003,243	$44,003,834
Western	$2,455	$2,734	$11,600,777	$7,829,182	$3,774,051	$3,774,329
Subtotal	**$17,758**	**$19,769**	**$212,887,959**	**$146,544,384**	**$66,361,333**	**$66,363,344**
Warehousing						
Central	$0	$0	$11,386,839	$8,060,758	$3,326,081	$3,326,081
Eastern	$0	$0	$23,769,417	$16,940,032	$6,829,384	$6,829,384
Pacific	$0	$0	$150,530	$106,818	$43,711	$43,711
Southern	$0	$0	$72,652,817	$51,878,587	$20,774,229	$20,774,229
Western	$0	$0	$7,971,638	$5,506,470	$2,465,168	$2,465,168
Subtotal	**$0**	**$0**	**$115,931,240**	**$82,492,666**	**$33,438,574**	**$33,438,574**
Non-Core						
Alaskan	$13	$14	$0	$0	$13	$14
Central	$1,083	$1,206	$569,939,859	$395,235,676	$174,705,267	$174,705,390
Eastern	$2,798	$3,114	$1,571,729,282	$1,094,641,235	$477,090,844	$477,091,161
Pacific	$31	$34	$34,448,756	$23,901,214	$10,547,573	$10,547,576
Southern	$1,278	$1,423	$3,222,640,561	$2,265,794,085	$956,847,754	$956,847,899
Western	$2,208	$2,458	$578,369,859	$391,910,093	$186,461,974	$186,462,224
Subtotal	**$7,410**	**$8,250**	**$5,977,128,316**	**$4,171,482,302**	**$1,805,653,424**	**$1,805,654,264**
Total						
Alaskan	$1,196	$1,331	$0	$0	$1,196	$1,331
Central	$90,952	$101,253	$1,290,376,435	$896,530,702	$393,936,685	$393,946,986
Eastern	$150,177	$167,187	$2,949,312,800	$2,057,250,816	$892,212,161	$892,229,171
Pacific	$2,376	$2,645	$68,583,668	$47,545,638	$21,040,406	$21,040,676
Southern	$114,614	$127,596	$8,809,549,859	$6,167,666,393	$2,641,998,079	$2,642,011,061

Table VIII.C.25. Total Costs – Requirements at or above the High Heat Trigger (2023$)

Industry Category	One-Time Annualized		Annual	Annual Cost Savings	Total Annualized	
	0%	2%			0%	2%
Western	$85,819	$95,539	$1,104,632,382	$748,999,461	$355,718,740	$355,728,460
Total	**$445,133**	**$495,551**	**$14,222,455,144**	**$9,917,993,009**	**$4,304,907,268**	**$4,304,957,686**

Source: OSHA estimate.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

F. Heat Illness and Emergency Response and Planning.

All covered employers would be required to respond when employees are experiencing signs and symptoms of heat-related illness or when there is a heat-related emergency at their work sites.

OSHA calculates the total costs associated with responding to heat-related illnesses by multiplying the labor-based unit cost by the number of affected establishments and the number of heat-related illnesses per establishment (shown in table VIII.C.6.).

OSHA calculates the total costs associated with responding to heat-related emergencies as a sum of total labor-based costs and capital-based costs. Total labor-based costs are calculated by multiplying the labor-based unit costs by the number of affected establishments and the number of heat-related emergencies per establishment (also shown in table VIII.C.6.). As discussed in section VIII.C.IV.F., labor-based unit costs incurred during heat-related emergencies consist of reducing an employee's body temperature before emergency medical services arrive as well as contacting emergency medical services and transporting employees to a place where they can be reached by an emergency medical provider. Total capital-based costs are calculated by multiplying the capital-based unit costs by the number of affected establishments. As discussed in section VIII.C.IV.F., capital-based unit costs consist of ice, ice sheets, and ice coolers. Cost frequency is assumed to be one-time for purchases of ice sheets and ice coolers and the costs of purchasing ice when the initial heat trigger is met or exceeded are calculated on an annual basis. OSHA assumes that ice costs are incurred only when the initial heat trigger is met or exceeded. Using this assumption, OSHA multiplied the number of 8-hour work shift equivalents by the number of affected establishments and the unit cost for ice to determine the total annual costs associated with ice purchases.

Table VIII.C.26. shows the annualized one-time, annual, and total annualized costs for each of these requirements by industry category and region, discounted (2 percent over a 10-year period) and undiscounted.

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Medical Response – Non–Emergency					
Agriculture, Forestry, and Fishing					
Alaskan	$0	$0	$22	$22	$22
Central	$0	$0	$1,561	$1,561	$1,561
Eastern	$0	$0	$822	$822	$822
Pacific	$0	$0	$11	$11	$11
Southern	$0	$0	$1,427	$1,427	$1,427
Western	$0	$0	$212	$212	$212
Subtotal	**$0**	**$0**	**$4,055**	**$4,055**	**$4,055**
Building Materials and Equipment Suppliers					
Alaskan	$0	$0	$4	$4	$4
Central	$0	$0	$390	$390	$390
Eastern	$0	$0	$608	$608	$608
Pacific	$0	$0	$10	$10	$10
Southern	$0	$0	$543	$543	$543
Western	$0	$0	$342	$342	$342
Subtotal	**$0**	**$0**	**$1,897**	**$1,897**	**$1,897**
Commercial Kitchens					
Alaskan	$0	$0	$8	$8	$8
Central	$0	$0	$656	$656	$656
Eastern	$0	$0	$1,098	$1,098	$1,098
Pacific	$0	$0	$23	$23	$23
Southern	$0	$0	$791	$791	$791
Western	$0	$0	$561	$561	$561
Subtotal	**$0**	**$0**	**$3,136**	**$3,136**	**$3,136**
Construction					
Alaskan	$0	$0	$39	$39	$39
Central	$0	$0	$3,014	$3,014	$3,014
Eastern	$0	$0	$3,653	$3,653	$3,653
Pacific	$0	$0	$54	$54	$54
Southern	$0	$0	$2,649	$2,649	$2,649
Western	$0	$0	$726	$726	$726
Subtotal	**$0**	**$0**	**$10,134**	**$10,134**	**$10,134**

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Drycleaning and Commercial Laundries					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$38	$38	$38
Eastern	$0	$0	$97	$97	$97
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$57	$57	$57
Western	$0	$0	$35	$35	$35
Subtotal	**$0**	**$0**	**$228**	**$228**	**$228**
Landscaping and Facilities Support					
Alaskan	$0	$0	$22	$22	$22
Central	$0	$0	$1,829	$1,829	$1,829
Eastern	$0	$0	$3,022	$3,022	$3,022
Pacific	$0	$0	$40	$40	$40
Southern	$0	$0	$2,154	$2,154	$2,154
Western	$0	$0	$1,699	$1,699	$1,699
Subtotal	**$0**	**$0**	**$8,766**	**$8,766**	**$8,766**
Maintenance and Repair					
Alaskan	$0	$0	$3	$3	$3
Central	$0	$0	$334	$334	$334
Eastern	$0	$0	$442	$442	$442
Pacific	$0	$0	$5	$5	$5
Southern	$0	$0	$359	$359	$359
Western	$0	$0	$231	$231	$231
Subtotal	**$0**	**$0**	**$1,376**	**$1,376**	**$1,376**
Manufacturing					
Alaskan	$0	$0	$13	$13	$13
Central	$0	$0	$2,617	$2,617	$2,617
Eastern	$0	$0	$2,545	$2,545	$2,545
Pacific	$0	$0	$20	$20	$20
Southern	$0	$0	$1,908	$1,908	$1,908
Western	$0	$0	$1,440	$1,440	$1,440
Subtotal	**$0**	**$0**	**$8,544**	**$8,544**	**$8,544**
Oil and Gas					
Alaskan	$0	$0	$17	$17	$17
Central	$0	$0	$671	$671	$671

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Eastern	$0	$0	$351	$351	$351
Southern	$0	$0	$2,546	$2,546	$2,546
Western	$0	$0	$335	$335	$335
Subtotal	**$0**	**$0**	**$3,921**	**$3,921**	**$3,921**
Postal and Delivery Services					
Alaskan	$0	$0	$19	$19	$19
Central	$0	$0	$799	$799	$799
Eastern	$0	$0	$1,011	$1,011	$1,011
Pacific	$0	$0	$11	$11	$11
Southern	$0	$0	$744	$744	$744
Western	$0	$0	$375	$375	$375
Subtotal	**$0**	**$0**	**$2,958**	**$2,958**	**$2,958**
Recreation and Amusement					
Alaskan	$0	$0	$6	$6	$6
Central	$0	$0	$267	$267	$267
Eastern	$0	$0	$401	$401	$401
Pacific	$0	$0	$5	$5	$5
Southern	$0	$0	$261	$261	$261
Western	$0	$0	$175	$175	$175
Subtotal	**$0**	**$0**	**$1,116**	**$1,116**	**$1,116**
Sanitation and Waste Removal					
Alaskan	$0	$0	$6	$6	$6
Central	$0	$0	$217	$217	$217
Eastern	$0	$0	$313	$313	$313
Pacific	$0	$0	$5	$5	$5
Southern	$0	$0	$227	$227	$227
Western	$0	$0	$119	$119	$119
Subtotal	**$0**	**$0**	**$887**	**$887**	**$887**
Telecommunications					
Alaskan	$0	$0	$11	$11	$11
Central	$0	$0	$696	$696	$696
Eastern	$0	$0	$952	$952	$952
Pacific	$0	$0	$10	$10	$10
Southern	$0	$0	$837	$837	$837
Western	$0	$0	$467	$467	$467

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Subtotal	**$0**	**$0**	**$2,974**	**$2,974**	**$2,974**
Temporary Help Services					
Alaskan	$0	$0	$2	$2	$2
Central	$0	$0	$432	$432	$432
Eastern	$0	$0	$609	$609	$609
Pacific	$0	$0	$6	$6	$6
Southern	$0	$0	$517	$517	$517
Western	$0	$0	$306	$306	$306
Subtotal	**$0**	**$0**	**$1,873**	**$1,873**	**$1,873**
Transportation					
Alaskan	$0	$0	$52	$52	$52
Central	$0	$0	$3,215	$3,215	$3,215
Eastern	$0	$0	$2,894	$2,894	$2,894
Pacific	$0	$0	$36	$36	$36
Southern	$0	$0	$2,944	$2,944	$2,944
Western	$0	$0	$726	$726	$726
Subtotal	**$0**	**$0**	**$9,867**	**$9,867**	**$9,867**
Utilities					
Alaskan	$0	$0	$13	$13	$13
Central	$0	$0	$546	$546	$546
Eastern	$0	$0	$685	$685	$685
Pacific	$0	$0	$5	$5	$5
Southern	$0	$0	$768	$768	$768
Western	$0	$0	$315	$315	$315
Subtotal	**$0**	**$0**	**$2,332**	**$2,332**	**$2,332**
Warehousing					
Alaskan	$0	$0	$2	$2	$2
Central	$0	$0	$260	$260	$260
Eastern	$0	$0	$329	$329	$329
Pacific	$0	$0	$4	$4	$4
Southern	$0	$0	$323	$323	$323
Western	$0	$0	$203	$203	$203
Subtotal	**$0**	**$0**	**$1,120**	**$1,120**	**$1,120**
Non-Core					
Alaskan	$0	$0	$953	$953	$953

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Central	$0	$0	$57,371	$57,371	$57,371
Eastern	$0	$0	$47,165	$47,165	$47,165
Pacific	$0	$0	$435	$435	$435
Southern	$0	$0	$22,835	$22,835	$22,835
Western	$0	$0	$19,411	$19,411	$19,411
Subtotal	**$0**	**$0**	**$148,169**	**$148,169**	**$148,169**
Total Costs for Medical Response – Non–Emergency					
Alaskan	$0	$0	$1,193	$1,193	$1,193
Central	$0	$0	$74,912	$74,912	$74,912
Eastern	$0	$0	$66,997	$66,997	$66,997
Pacific	$0	$0	$681	$681	$681
Southern	$0	$0	$41,890	$41,890	$41,890
Western	$0	$0	$27,678	$27,678	$27,678
Total	**$0**	**$0**	**$213,352**	**$213,352**	**$213,352**
Medical Response – Emergency					
Agriculture, Forestry, and Fishing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$28	$28	$28
Eastern	$0	$0	$15	$15	$15
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$25	$25	$25
Western	$0	$0	$4	$4	$4
Subtotal	**$0**	**$0**	**$72**	**$72**	**$72**
Building Materials and Equipment Suppliers					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$6	$6	$6
Eastern	$0	$0	$10	$10	$10
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$9	$9	$9
Western	$0	$0	$5	$5	$5
Subtotal	**$0**	**$0**	**$30**	**$30**	**$30**
Commercial Kitchens					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$11	$11	$11
Eastern	$0	$0	$18	$18	$18

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$13	$13	$13
Western	$0	$0	$9	$9	$9
Subtotal	**$0**	**$0**	**$51**	**$51**	**$51**
Construction					
Alaskan	$0	$0	$1	$1	$1
Central	$0	$0	$53	$53	$53
Eastern	$0	$0	$64	$64	$64
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$47	$47	$47
Western	$0	$0	$13	$13	$13
Subtotal	**$0**	**$0**	**$178**	**$178**	**$178**
Drycleaning and Commercial Laundries					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$2	$2	$2
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$4**	**$4**	**$4**
Landscaping and Facilities Support					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$31	$31	$31
Eastern	$0	$0	$51	$51	$51
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$36	$36	$36
Western	$0	$0	$29	$29	$29
Subtotal	**$0**	**$0**	**$147**	**$147**	**$147**
Maintenance and Repair					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$5	$5	$5
Eastern	$0	$0	$7	$7	$7
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$6	$6	$6
Western	$0	$0	$4	$4	$4

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Subtotal	**$0**	**$0**	**$22**	**$22**	**$22**
Manufacturing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$43	$43	$43
Eastern	$0	$0	$41	$41	$41
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$31	$31	$31
Western	$0	$0	$23	$23	$23
Subtotal	**$0**	**$0**	**$139**	**$139**	**$139**
Oil and Gas					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$12	$12	$12
Eastern	$0	$0	$6	$6	$6
Southern	$0	$0	$45	$45	$45
Western	$0	$0	$6	$6	$6
Subtotal	**$0**	**$0**	**$69**	**$69**	**$69**
Postal and Delivery Services					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$13	$13	$13
Eastern	$0	$0	$16	$16	$16
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$12	$12	$12
Western	$0	$0	$6	$6	$6
Subtotal	**$0**	**$0**	**$47**	**$47**	**$47**
Recreation and Amusement					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$4	$4	$4
Eastern	$0	$0	$7	$7	$7
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$4	$4	$4
Western	$0	$0	$3	$3	$3
Subtotal	**$0**	**$0**	**$18**	**$18**	**$18**
Sanitation and Waste Removal					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$4	$4	$4

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Eastern	$0	$0	$5	$5	$5
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$4	$4	$4
Western	$0	$0	$2	$2	$2
Subtotal	**$0**	**$0**	**$15**	**$15**	**$15**
Telecommunications					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$11	$11	$11
Eastern	$0	$0	$15	$15	$15
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$13	$13	$13
Western	$0	$0	$7	$7	$7
Subtotal	**$0**	**$0**	**$48**	**$48**	**$48**
Temporary Help Services					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$7	$7	$7
Eastern	$0	$0	$10	$10	$10
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$9	$9	$9
Western	$0	$0	$5	$5	$5
Subtotal	**$0**	**$0**	**$32**	**$32**	**$32**
Transportation					
Alaskan	$0	$0	$1	$1	$1
Central	$0	$0	$51	$51	$51
Eastern	$0	$0	$46	$46	$46
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$47	$47	$47
Western	$0	$0	$12	$12	$12
Subtotal	**$0**	**$0**	**$158**	**$158**	**$158**
Utilities					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$9	$9	$9
Eastern	$0	$0	$11	$11	$11
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$12	$12	$12

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Western	$0	$0	$5	$5	$5
Subtotal	**$0**	**$0**	**$37**	**$37**	**$37**
Warehousing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$4	$4	$4
Eastern	$0	$0	$5	$5	$5
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$5	$5	$5
Western	$0	$0	$3	$3	$3
Subtotal	**$0**	**$0**	**$18**	**$18**	**$18**
Non-Core					
Alaskan	$0	$0	$15	$15	$15
Central	$0	$0	$914	$914	$914
Eastern	$0	$0	$756	$756	$756
Pacific	$0	$0	$7	$7	$7
Southern	$0	$0	$369	$369	$369
Western	$0	$0	$313	$313	$313
Subtotal	**$0**	**$0**	**$2,375**	**$2,375**	**$2,375**
Total Costs for Medical Response – Emergency					
Alaskan	$0	$0	$19	$19	$19
Central	$0	$0	$1,207	$1,207	$1,207
Eastern	$0	$0	$1,086	$1,086	$1,086
Pacific	$0	$0	$11	$11	$11
Southern	$0	$0	$688	$688	$688
Western	$0	$0	$449	$449	$449
Total	**$0**	**$0**	**$3,460**	**$3,460**	**$3,460**
Contact Emergency Medical Services					
Agriculture, Forestry, and Fishing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$4	$4	$4
Eastern	$0	$0	$2	$2	$2
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$4	$4	$4
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$12**	**$12**	**$12**

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Building Materials and Equipment Suppliers					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$2	$2	$2
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$5**	**$5**	**$5**
Commercial Kitchens					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$2	$2	$2
Eastern	$0	$0	$3	$3	$3
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$2	$2	$2
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$8**	**$8**	**$8**
Construction					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$8	$8	$8
Eastern	$0	$0	$10	$10	$10
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$7	$7	$7
Western	$0	$0	$2	$2	$2
Subtotal	**$0**	**$0**	**$28**	**$28**	**$28**
Drycleaning and Commercial Laundries					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$0	$0	$0
Eastern	$0	$0	$0	$0	$0
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$0	$0	$0
Western	$0	$0	$0	$0	$0
Subtotal	**$0**	**$0**	**$1**	**$1**	**$1**
Landscaping and Facilities Support					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$5	$5	$5

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Eastern	$0	$0	$8	$8	$8
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$6	$6	$6
Western	$0	$0	$5	$5	$5
Subtotal	**$0**	**$0**	**$24**	**$24**	**$24**
Maintenance and Repair					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$1	$1	$1
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$4**	**$4**	**$4**
Manufacturing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$2	$2	$2
Eastern	$0	$0	$1	$1	$1
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$5	$5	$5
Western	$0	$0	$4	$4	$4
Subtotal	**$0**	**$0**	**$22**	**$22**	**$22**
Oil and Gas					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$2	$2	$2
Eastern	$0	$0	$1	$1	$1
Southern	$0	$0	$7	$7	$7
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$11**	**$11**	**$11**
Postal and Delivery Services					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$2	$2	$2
Eastern	$0	$0	$3	$3	$3
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$2	$2	$2
Western	$0	$0	$1	$1	$1

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Subtotal	**$0**	**$0**	**$8**	**$8**	**$8**
Recreation and Amusement					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$1	$1	$1
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$0	$0	$0
Subtotal	**$0**	**$0**	**$3**	**$3**	**$3**
Sanitation and Waste Removal					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$1	$1	$1
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$0	$0	$0
Subtotal	**$0**	**$0**	**$2**	**$2**	**$2**
Telecommunications					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$2	$2	$2
Eastern	$0	$0	$2	$2	$2
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$2	$2	$2
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$8**	**$8**	**$8**
Temporary Help Services					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$2	$2	$2
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$5**	**$5**	**$5**
Transportation					
Alaskan	$0	$0	$0	$0	$0

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Central	$0	$0	$8	$8	$8
Eastern	$0	$0	$7	$7	$7
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$8	$8	$8
Western	$0	$0	$2	$2	$2
Subtotal	**$0**	**$0**	**$25**	**$25**	**$25**
Utilities					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$2	$2	$2
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$2	$2	$2
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$6**	**$6**	**$6**
Warehousing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$1	$1	$1
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$1	$1	$1
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$3**	**$3**	**$3**
Non-Core					
Alaskan	$0	$0	$2	$2	$2
Central	$0	$0	$146	$146	$146
Eastern	$0	$0	$121	$121	$121
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$59	$59	$59
Western	$0	$0	$50	$50	$50
Subtotal	**$0**	**$0**	**$380**	**$380**	**$380**
Total Costs for Contact Emergency Medical Services					
Alaskan	$0	$0	$3	$3	$3
Central	$0	$0	$193	$193	$193
Eastern	$0	$0	$174	$174	$174
Pacific	$0	$0	$2	$2	$2

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Southern	$0	$0	$110	$110	$110
Western	$0	$0	$72	$72	$72
Total	**$0**	**$0**	**$554**	**$554**	**$554**
Transport Worker					
Agriculture, Forestry, and Fishing					
Alaskan	$0	$0	$1	$1	$1
Central	$0	$0	$67	$67	$67
Eastern	$0	$0	$35	$35	$35
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$61	$61	$61
Western	$0	$0	$9	$9	$9
Subtotal	**$0**	**$0**	**$173**	**$173**	**$173**
Building Materials and Equipment Suppliers					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$15	$15	$15
Eastern	$0	$0	$23	$23	$23
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$21	$21	$21
Western	$0	$0	$13	$13	$13
Subtotal	**$0**	**$0**	**$73**	**$73**	**$73**
Commercial Kitchens					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$26	$26	$26
Eastern	$0	$0	$43	$43	$43
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$31	$31	$31
Western	$0	$0	$22	$22	$22
Subtotal	**$0**	**$0**	**$122**	**$122**	**$122**
Construction					
Alaskan	$0	$0	$2	$2	$2
Central	$0	$0	$127	$127	$127
Eastern	$0	$0	$154	$154	$154
Pacific	$0	$0	$2	$2	$2
Southern	$0	$0	$112	$112	$112
Western	$0	$0	$31	$31	$31

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Subtotal	**$0**	**$0**	**$427**	**$427**	**$427**
Drycleaning and Commercial Laundries					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$1	$1	$1
Eastern	$0	$0	$4	$4	$4
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$2	$2	$2
Western	$0	$0	$1	$1	$1
Subtotal	**$0**	**$0**	**$9**	**$9**	**$9**
Landscaping and Facilities Support					
Alaskan	$0	$0	$1	$1	$1
Central	$0	$0	$74	$74	$74
Eastern	$0	$0	$122	$122	$122
Pacific	$0	$0	$2	$2	$2
Southern	$0	$0	$87	$87	$87
Western	$0	$0	$69	$69	$69
Subtotal	**$0**	**$0**	**$354**	**$354**	**$354**
Maintenance and Repair					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$13	$13	$13
Eastern	$0	$0	$17	$17	$17
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$14	$14	$14
Western	$0	$0	$9	$9	$9
Subtotal	**$0**	**$0**	**$53**	**$53**	**$53**
Manufacturing					
Alaskan	$0	$0	$1	$1	$1
Central	$0	$0	$102	$102	$102
Eastern	$0	$0	$100	$100	$100
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$75	$75	$75
Western	$0	$0	$56	$56	$56
Subtotal	**$0**	**$0**	**$334**	**$334**	**$334**
Oil and Gas					
Alaskan	$0	$0	$1	$1	$1

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Central	$0	$0	$28	$28	$28
Eastern	$0	$0	$15	$15	$15
Southern	$0	$0	$108	$108	$108
Western	$0	$0	$14	$14	$14
Subtotal	**$0**	**$0**	**$166**	**$166**	**$166**
Postal and Delivery Services					
Alaskan	$0	$0	$1	$1	$1
Central	$0	$0	$31	$31	$31
Eastern	$0	$0	$39	$39	$39
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$29	$29	$29
Western	$0	$0	$14	$14	$14
Subtotal	**$0**	**$0**	**$113**	**$113**	**$113**
Recreation and Amusement					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$10	$10	$10
Eastern	$0	$0	$16	$16	$16
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$10	$10	$10
Western	$0	$0	$7	$7	$7
Subtotal	**$0**	**$0**	**$43**	**$43**	**$43**
Sanitation and Waste Removal					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$9	$9	$9
Eastern	$0	$0	$13	$13	$13
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$9	$9	$9
Western	$0	$0	$5	$5	$5
Subtotal	**$0**	**$0**	**$36**	**$36**	**$36**
Telecommunications					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$27	$27	$27
Eastern	$0	$0	$37	$37	$37
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$32	$32	$32

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Western	$0	$0	$18	$18	$18
Subtotal	**$0**	**$0**	**$114**	**$114**	**$114**
Temporary Help Services					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$17	$17	$17
Eastern	$0	$0	$25	$25	$25
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$21	$21	$21
Western	$0	$0	$12	$12	$12
Subtotal	**$0**	**$0**	**$76**	**$76**	**$76**
Transportation					
Alaskan	$0	$0	$2	$2	$2
Central	$0	$0	$123	$123	$123
Eastern	$0	$0	$111	$111	$111
Pacific	$0	$0	$1	$1	$1
Southern	$0	$0	$113	$113	$113
Western	$0	$0	$28	$28	$28
Subtotal	**$0**	**$0**	**$379**	**$379**	**$379**
Utilities					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$21	$21	$21
Eastern	$0	$0	$26	$26	$26
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$29	$29	$29
Western	$0	$0	$12	$12	$12
Subtotal	**$0**	**$0**	**$89**	**$89**	**$89**
Warehousing					
Alaskan	$0	$0	$0	$0	$0
Central	$0	$0	$10	$10	$10
Eastern	$0	$0	$13	$13	$13
Pacific	$0	$0	$0	$0	$0
Southern	$0	$0	$12	$12	$12
Western	$0	$0	$8	$8	$8
Subtotal	**$0**	**$0**	**$43**	**$43**	**$43**
Non-Core					

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Alaskan	$0	$0	$36	$36	$36
Central	$0	$0	$2,194	$2,194	$2,194
Eastern	$0	$0	$1,815	$1,815	$1,815
Pacific	$0	$0	$17	$17	$17
Southern	$0	$0	$886	$886	$886
Western	$0	$0	$751	$751	$751
Subtotal	**$0**	**$0**	**$5,699**	**$5,699**	**$5,699**
Total Costs for Transport Worker					
Alaskan	$0	$0	$46	$46	$46
Central	$0	$0	$2,896	$2,896	$2,896
Eastern	$0	$0	$2,606	$2,606	$2,606
Pacific	$0	$0	$27	$27	$27
Southern	$0	$0	$1,652	$1,652	$1,652
Western	$0	$0	$1,079	$1,079	$1,079
Total	**$0**	**$0**	**$8,305**	**$8,305**	**$8,305**
Ice Sheets					
Agriculture, Forestry, and Fishing					
Alaskan	$3,919	$4,363	$0	$3,919	$4,363
Central	$284,403	$316,616	$0	$284,403	$316,616
Eastern	$149,682	$166,636	$0	$149,682	$166,636
Pacific	$2,022	$2,251	$0	$2,022	$2,251
Southern	$260,013	$289,464	$0	$260,013	$289,464
Western	$38,559	$42,926	$0	$38,559	$42,926
Subtotal	**$738,598**	**$822,255**	**$0**	**$738,598**	**$822,255**
Building Materials and Equipment Suppliers					
Alaskan	$409	$455	$0	$409	$455
Central	$32,691	$36,393	$0	$32,691	$36,393
Eastern	$46,817	$52,120	$0	$46,817	$52,120
Pacific	$741	$825	$0	$741	$825
Southern	$42,659	$47,491	$0	$42,659	$47,491
Western	$25,237	$28,096	$0	$25,237	$28,096
Subtotal	**$148,554**	**$165,380**	**$0**	**$148,554**	**$165,380**
Commercial Kitchens					
Alaskan	$4,919	$5,477	$0	$4,919	$5,477
Central	$392,047	$436,452	$0	$392,047	$436,452

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Eastern	$652,643	$726,565	$0	$652,643	$726,565
Pacific	$12,463	$13,875	$0	$12,463	$13,875
Southern	$478,939	$533,186	$0	$478,939	$533,186
Western	$333,020	$370,740	$0	$333,020	$370,740
Subtotal	**$1,874,032**	**$2,086,295**	**$0**	**$1,874,032**	**$2,086,295**
Construction					
Alaskan	$7,015	$7,810	$0	$7,015	$7,810
Central	$538,801	$599,828	$0	$538,801	$599,828
Eastern	$656,231	$730,559	$0	$656,231	$730,559
Pacific	$9,774	$10,881	$0	$9,774	$10,881
Southern	$478,099	$532,251	$0	$478,099	$532,251
Western	$136,369	$151,815	$0	$136,369	$151,815
Subtotal	**$1,826,289**	**$2,033,145**	**$0**	**$1,826,289**	**$2,033,145**
Drycleaning and Commercial Laundries					
Alaskan	$159	$177	$0	$159	$177
Central	$19,859	$22,109	$0	$19,859	$22,109
Eastern	$51,015	$56,794	$0	$51,015	$56,794
Pacific	$402	$447	$0	$402	$447
Southern	$30,107	$33,517	$0	$30,107	$33,517
Western	$18,521	$20,619	$0	$18,521	$20,619
Subtotal	**$120,063**	**$133,662**	**$0**	**$120,063**	**$133,662**
Landscaping and Facilities Support					
Alaskan	$1,015	$1,130	$0	$1,015	$1,130
Central	$105,516	$117,467	$0	$105,516	$117,467
Eastern	$171,723	$191,173	$0	$171,723	$191,173
Pacific	$2,503	$2,786	$0	$2,503	$2,786
Southern	$120,865	$134,555	$0	$120,865	$134,555
Western	$86,959	$96,809	$0	$86,959	$96,809
Subtotal	**$488,581**	**$543,921**	**$0**	**$488,581**	**$543,921**
Maintenance and Repair					
Alaskan	$1,733	$1,929	$0	$1,733	$1,929
Central	$175,535	$195,417	$0	$175,535	$195,417
Eastern	$232,663	$259,016	$0	$232,663	$259,016
Pacific	$2,796	$3,113	$0	$2,796	$3,113
Southern	$188,980	$210,385	$0	$188,980	$210,385

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Western	$121,702	$135,486	$0	$121,702	$135,486
Subtotal	**$723,409**	**$805,346**	**$0**	**$723,409**	**$805,346**
Manufacturing					
Alaskan	$550	$613	$0	$550	$613
Central	$108,365	$120,639	$0	$108,365	$120,639
Eastern	$105,352	$117,284	$0	$105,352	$117,284
Pacific	$841	$936	$0	$841	$936
Southern	$79,014	$87,964	$0	$79,014	$87,964
Western	$59,634	$66,388	$0	$59,634	$66,388
Subtotal	**$353,755**	**$393,824**	**$0**	**$353,755**	**$393,824**
Oil and Gas					
Alaskan	$784	$873	$0	$784	$873
Central	$31,780	$35,379	$0	$31,780	$35,379
Eastern	$17,148	$19,091	$0	$17,148	$19,091
Southern	$115,134	$128,175	$0	$115,134	$128,175
Western	$15,218	$16,941	$0	$15,218	$16,941
Subtotal	**$180,064**	**$200,459**	**$0**	**$180,064**	**$200,459**
Postal and Delivery Services					
Alaskan	$1,828	$2,035	$0	$1,828	$2,035
Central	$78,479	$87,368	$0	$78,479	$87,368
Eastern	$99,269	$110,513	$0	$99,269	$110,513
Pacific	$1,048	$1,167	$0	$1,048	$1,167
Southern	$73,083	$81,361	$0	$73,083	$81,361
Western	$36,803	$40,972	$0	$36,803	$40,972
Subtotal	**$290,510**	**$323,415**	**$0**	**$290,510**	**$323,415**
Recreation and Amusement					
Alaskan	$2,173	$2,419	$0	$2,173	$2,419
Central	$86,303	$96,078	$0	$86,303	$96,078
Eastern	$129,160	$143,789	$0	$129,160	$143,789
Pacific	$1,602	$1,783	$0	$1,602	$1,783
Southern	$84,110	$93,637	$0	$84,110	$93,637
Western	$56,791	$63,223	$0	$56,791	$63,223
Subtotal	**$360,139**	**$400,930**	**$0**	**$360,139**	**$400,930**
Sanitation and Waste Removal					
Alaskan	$177	$197	$0	$177	$197

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Central	$6,511	$7,249	$0	$6,511	$7,249
Eastern	$9,397	$10,461	$0	$9,397	$10,461
Pacific	$142	$159	$0	$142	$159
Southern	$6,819	$7,591	$0	$6,819	$7,591
Western	$3,557	$3,960	$0	$3,557	$3,960
Subtotal	**$26,604**	**$29,617**	**$0**	**$26,604**	**$29,617**
Telecommunications					
Alaskan	$244	$271	$0	$244	$271
Central	$14,806	$16,483	$0	$14,806	$16,483
Eastern	$20,265	$22,560	$0	$20,265	$22,560
Pacific	$221	$246	$0	$221	$246
Southern	$17,801	$19,818	$0	$17,801	$19,818
Western	$9,937	$11,063	$0	$9,937	$11,063
Subtotal	**$63,274**	**$70,441**	**$0**	**$63,274**	**$70,441**
Temporary Help Services					
Alaskan	$69	$76	$0	$69	$76
Central	$12,968	$14,437	$0	$12,968	$14,437
Eastern	$18,273	$20,343	$0	$18,273	$20,343
Pacific	$175	$195	$0	$175	$195
Southern	$15,516	$17,274	$0	$15,516	$17,274
Western	$9,194	$10,236	$0	$9,194	$10,236
Subtotal	**$56,196**	**$62,561**	**$0**	**$56,196**	**$62,561**
Transportation					
Alaskan	$5,154	$5,738	$0	$5,154	$5,738
Central	$315,763	$351,528	$0	$315,763	$351,528
Eastern	$284,254	$316,450	$0	$284,254	$316,450
Pacific	$3,541	$3,942	$0	$3,541	$3,942
Southern	$289,153	$321,904	$0	$289,153	$321,904
Western	$71,295	$79,371	$0	$71,295	$79,371
Subtotal	**$969,160**	**$1,078,933**	**$0**	**$969,160**	**$1,078,933**
Utilities					
Alaskan	$783	$872	$0	$783	$872
Central	$33,502	$37,297	$0	$33,502	$37,297
Eastern	$41,998	$46,755	$0	$41,998	$46,755
Pacific	$288	$320	$0	$288	$320

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Southern	$47,105	$52,440	$0	$47,105	$52,440
Western	$19,317	$21,505	$0	$19,317	$21,505
Subtotal	**$142,993**	**$159,189**	**$0**	**$142,993**	**$159,189**
Warehousing					
Alaskan	$175	$194	$0	$175	$194
Central	$25,535	$28,427	$0	$25,535	$28,427
Eastern	$32,288	$35,945	$0	$32,288	$35,945
Pacific	$410	$456	$0	$410	$456
Southern	$31,697	$35,287	$0	$31,697	$35,287
Western	$19,910	$22,165	$0	$19,910	$22,165
Subtotal	**$110,014**	**$122,475**	**$0**	**$110,014**	**$122,475**
Non-Core					
Alaskan	$31,903	$35,517	$0	$31,903	$35,517
Central	$2,345,882	$2,611,589	$0	$2,345,882	$2,611,589
Eastern	$3,852,103	$4,288,412	$0	$3,852,103	$4,288,412
Pacific	$60,769	$67,652	$0	$60,769	$67,652
Southern	$3,037,027	$3,381,017	$0	$3,037,027	$3,381,017
Western	$1,978,080	$2,202,128	$0	$1,978,080	$2,202,128
Subtotal	**$11,305,765**	**$12,586,315**	**$0**	**$11,305,765**	**$12,586,315**
Total Costs for Ice Sheets					
Alaskan	$63,010	$70,146	$0	$63,010	$70,146
Central	$4,608,745	$5,130,756	$0	$4,608,745	$5,130,756
Eastern	$6,570,282	$7,314,467	$0	$6,570,282	$7,314,467
Pacific	$99,738	$111,034	$0	$99,738	$111,034
Southern	$5,396,123	$6,007,317	$0	$5,396,123	$6,007,317
Western	$3,040,103	$3,384,441	$0	$3,040,103	$3,384,441
Total	**$19,778,001**	**$22,018,161**	**$0**	**$19,778,001**	**$22,018,161**
Ice					
Agriculture, Forestry, and Fishing					
Alaskan	$0	$0	$446	$446	$446
Central	$0	$0	$5,904,480	$5,904,480	$5,904,480
Eastern	$0	$0	$3,256,910	$3,256,910	$3,256,910
Pacific	$0	$0	$145,592	$145,592	$145,592
Southern	$0	$0	$13,828,413	$13,828,413	$13,828,413
Western	$0	$0	$984,176	$984,176	$984,176

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Subtotal	**$0**	**$0**	**$24,120,016**	**$24,120,016**	**$24,120,016**
Building Materials and Equipment Suppliers					
Alaskan	$0	$0	$46	$46	$46
Central	$0	$0	$647,575	$647,575	$647,575
Eastern	$0	$0	$912,708	$912,708	$912,708
Pacific	$0	$0	$53,375	$53,375	$53,375
Southern	$0	$0	$2,568,554	$2,568,554	$2,568,554
Western	$0	$0	$670,491	$670,491	$670,491
Subtotal	**$0**	**$0**	**$4,852,749**	**$4,852,749**	**$4,852,749**
Commercial Kitchens					
Alaskan	$0	$0	$559	$559	$559
Central	$0	$0	$7,717,626	$7,717,626	$7,717,626
Eastern	$0	$0	$12,712,137	$12,712,137	$12,712,137
Pacific	$0	$0	$897,553	$897,553	$897,553
Southern	$0	$0	$28,462,002	$28,462,002	$28,462,002
Western	$0	$0	$8,930,719	$8,930,719	$8,930,719
Subtotal	**$0**	**$0**	**$58,720,595**	**$58,720,595**	**$58,720,595**
Construction					
Alaskan	$0	$0	$797	$797	$797
Central	$0	$0	$9,565,873	$9,565,873	$9,565,873
Eastern	$0	$0	$12,957,020	$12,957,020	$12,957,020
Pacific	$0	$0	$703,866	$703,866	$703,866
Southern	$0	$0	$28,772,465	$28,772,465	$28,772,465
Western	$0	$0	$4,062,547	$4,062,547	$4,062,547
Subtotal	**$0**	**$0**	**$56,062,569**	**$56,062,569**	**$56,062,569**
Drycleaning and Commercial Laundries					
Alaskan	$0	$0	$18	$18	$18
Central	$0	$0	$396,549	$396,549	$396,549
Eastern	$0	$0	$954,226	$954,226	$954,226
Pacific	$0	$0	$28,916	$28,916	$28,916
Southern	$0	$0	$1,772,663	$1,772,663	$1,772,663
Western	$0	$0	$490,895	$490,895	$490,895
Subtotal	**$0**	**$0**	**$3,643,268**	**$3,643,268**	**$3,643,268**
Landscaping and Facilities Support					
Alaskan	$0	$0	$115	$115	$115

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Central	$0	$0	$2,084,690	$2,084,690	$2,084,690
Eastern	$0	$0	$3,394,782	$3,394,782	$3,394,782
Pacific	$0	$0	$180,238	$180,238	$180,238
Southern	$0	$0	$7,349,405	$7,349,405	$7,349,405
Western	$0	$0	$2,327,639	$2,327,639	$2,327,639
Subtotal	**$0**	**$0**	**$15,336,869**	**$15,336,869**	**$15,336,869**
Maintenance and Repair					
Alaskan	$0	$0	$197	$197	$197
Central	$0	$0	$3,446,620	$3,446,620	$3,446,620
Eastern	$0	$0	$4,631,181	$4,631,181	$4,631,181
Pacific	$0	$0	$201,369	$201,369	$201,369
Southern	$0	$0	$11,236,731	$11,236,731	$11,236,731
Western	$0	$0	$3,270,460	$3,270,460	$3,270,460
Subtotal	**$0**	**$0**	**$22,786,559**	**$22,786,559**	**$22,786,559**
Manufacturing					
Alaskan	$0	$0	$63	$63	$63
Central	$0	$0	$1,878,565	$1,878,565	$1,878,565
Eastern	$0	$0	$2,043,899	$2,043,899	$2,043,899
Pacific	$0	$0	$60,540	$60,540	$60,540
Southern	$0	$0	$4,507,111	$4,507,111	$4,507,111
Western	$0	$0	$1,570,311	$1,570,311	$1,570,311
Subtotal	**$0**	**$0**	**$10,060,489**	**$10,060,489**	**$10,060,489**
Oil and Gas					
Alaskan	$0	$0	$89	$89	$89
Central	$0	$0	$679,900	$679,900	$679,900
Eastern	$0	$0	$310,644	$310,644	$310,644
Southern	$0	$0	$6,186,305	$6,186,305	$6,186,305
Western	$0	$0	$322,752	$322,752	$322,752
Subtotal	**$0**	**$0**	**$7,499,690**	**$7,499,690**	**$7,499,690**
Postal and Delivery Services					
Alaskan	$0	$0	$208	$208	$208
Central	$0	$0	$1,592,194	$1,592,194	$1,592,194
Eastern	$0	$0	$1,908,549	$1,908,549	$1,908,549
Pacific	$0	$0	$75,491	$75,491	$75,491
Southern	$0	$0	$3,900,095	$3,900,095	$3,900,095

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Western	$0	$0	$957,348	$957,348	$957,348
Subtotal	**$0**	**$0**	**$8,433,885**	**$8,433,885**	**$8,433,885**
Recreation and Amusement					
Alaskan	$0	$0	$247	$247	$247
Central	$0	$0	$1,656,570	$1,656,570	$1,656,570
Eastern	$0	$0	$2,519,069	$2,519,069	$2,519,069
Pacific	$0	$0	$115,370	$115,370	$115,370
Southern	$0	$0	$4,946,955	$4,946,955	$4,946,955
Western	$0	$0	$1,503,157	$1,503,157	$1,503,157
Subtotal	**$0**	**$0**	**$10,741,370**	**$10,741,370**	**$10,741,370**
Sanitation and Waste Removal					
Alaskan	$0	$0	$20	$20	$20
Central	$0	$0	$125,786	$125,786	$125,786
Eastern	$0	$0	$183,236	$183,236	$183,236
Pacific	$0	$0	$10,260	$10,260	$10,260
Southern	$0	$0	$390,745	$390,745	$390,745
Western	$0	$0	$96,609	$96,609	$96,609
Subtotal	**$0**	**$0**	**$806,655**	**$806,655**	**$806,655**
Telecommunications					
Alaskan	$0	$0	$28	$28	$28
Central	$0	$0	$296,733	$296,733	$296,733
Eastern	$0	$0	$407,173	$407,173	$407,173
Pacific	$0	$0	$15,899	$15,899	$15,899
Southern	$0	$0	$997,075	$997,075	$997,075
Western	$0	$0	$267,246	$267,246	$267,246
Subtotal	**$0**	**$0**	**$1,984,154**	**$1,984,154**	**$1,984,154**
Temporary Help Services					
Alaskan	$0	$0	$8	$8	$8
Central	$0	$0	$249,978	$249,978	$249,978
Eastern	$0	$0	$371,092	$371,092	$371,092
Pacific	$0	$0	$12,610	$12,610	$12,610
Southern	$0	$0	$896,743	$896,743	$896,743
Western	$0	$0	$253,049	$253,049	$253,049
Subtotal	**$0**	**$0**	**$1,783,480**	**$1,783,480**	**$1,783,480**
Transportation					

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Alaskan	$0	$0	$586	$586	$586
Central	$0	$0	$6,347,834	$6,347,834	$6,347,834
Eastern	$0	$0	$5,777,439	$5,777,439	$5,777,439
Pacific	$0	$0	$255,024	$255,024	$255,024
Southern	$0	$0	$16,735,409	$16,735,409	$16,735,409
Western	$0	$0	$2,032,671	$2,032,671	$2,032,671
Subtotal	**$0**	**$0**	**$31,148,963**	**$31,148,963**	**$31,148,963**
Utilities					
Alaskan	$0	$0	$89	$89	$89
Central	$0	$0	$676,799	$676,799	$676,799
Eastern	$0	$0	$880,610	$880,610	$880,610
Pacific	$0	$0	$20,720	$20,720	$20,720
Southern	$0	$0	$2,564,705	$2,564,705	$2,564,705
Western	$0	$0	$498,202	$498,202	$498,202
Subtotal	**$0**	**$0**	**$4,641,124**	**$4,641,124**	**$4,641,124**
Warehousing					
Alaskan	$0	$0	$20	$20	$20
Central	$0	$0	$517,417	$517,417	$517,417
Eastern	$0	$0	$684,456	$684,456	$684,456
Pacific	$0	$0	$29,519	$29,519	$29,519
Southern	$0	$0	$1,745,873	$1,745,873	$1,745,873
Western	$0	$0	$539,749	$539,749	$539,749
Subtotal	**$0**	**$0**	**$3,517,034**	**$3,517,034**	**$3,517,034**
Non-Core					
Alaskan	$0	$0	$3,627	$3,627	$3,627
Central	$0	$0	$47,433,999	$47,433,999	$47,433,999
Eastern	$0	$0	$76,037,869	$76,037,869	$76,037,869
Pacific	$0	$0	$4,376,294	$4,376,294	$4,376,294
Southern	$0	$0	$178,850,258	$178,850,258	$178,850,258
Western	$0	$0	$52,965,329	$52,965,329	$52,965,329
Subtotal	**$0**	**$0**	**$359,667,375**	**$359,667,375**	**$359,667,375**
Total Costs for Ice					
Alaskan	$0	$0	$7,163	$7,163	$7,163
Central	$0	$0	$91,219,187	$91,219,187	$91,219,187
Eastern	$0	$0	$129,943,000	$129,943,000	$129,943,000

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Pacific	$0	$0	$7,182,636	$7,182,636	$7,182,636
Southern	$0	$0	$315,711,506	$315,711,506	$315,711,506
Western	$0	$0	$81,743,351	$81,743,351	$81,743,351
Total	**$0**	**$0**	**$625,806,844**	**$625,806,844**	**$625,806,844**
Ice Cooler					
Agriculture, Forestry, and Fishing					
Alaskan	$1,555	$1,731	$0	$1,555	$1,731
Central	$112,807	$125,585	$0	$112,807	$125,585
Eastern	$59,371	$66,096	$0	$59,371	$66,096
Pacific	$802	$893	$0	$802	$893
Southern	$103,133	$114,815	$0	$103,133	$114,815
Western	$15,294	$17,027	$0	$15,294	$17,027
Subtotal	**$292,962**	**$326,145**	**$0**	**$292,962**	**$326,145**
Building Materials and Equipment Suppliers					
Alaskan	$162	$180	$0	$162	$180
Central	$12,967	$14,435	$0	$12,967	$14,435
Eastern	$18,570	$20,673	$0	$18,570	$20,673
Pacific	$294	$327	$0	$294	$327
Southern	$16,921	$18,837	$0	$16,921	$18,837
Western	$10,010	$11,144	$0	$10,010	$11,144
Subtotal	**$58,923**	**$65,597**	**$0**	**$58,923**	**$65,597**
Commercial Kitchens					
Alaskan	$1,951	$2,172	$0	$1,951	$2,172
Central	$155,504	$173,117	$0	$155,504	$173,117
Eastern	$258,869	$288,189	$0	$258,869	$288,189
Pacific	$4,944	$5,503	$0	$4,944	$5,503
Southern	$189,970	$211,487	$0	$189,970	$211,487
Western	$132,091	$147,053	$0	$132,091	$147,053
Subtotal	**$743,329**	**$827,522**	**$0**	**$743,329**	**$827,522**
Construction					
Alaskan	$2,783	$3,098	$0	$2,783	$3,098
Central	$213,714	$237,920	$0	$213,714	$237,920
Eastern	$260,292	$289,774	$0	$260,292	$289,774
Pacific	$3,877	$4,316	$0	$3,877	$4,316
Southern	$189,636	$211,116	$0	$189,636	$211,116

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Western	$54,090	$60,217	$0	$54,090	$60,217
Subtotal	**$724,392**	**$806,440**	**$0**	**$724,392**	**$806,440**
Drycleaning and Commercial Laundries					
Alaskan	$63	$70	$0	$63	$70
Central	$7,877	$8,769	$0	$7,877	$8,769
Eastern	$20,235	$22,527	$0	$20,235	$22,527
Pacific	$159	$177	$0	$159	$177
Southern	$11,942	$13,294	$0	$11,942	$13,294
Western	$7,346	$8,178	$0	$7,346	$8,178
Subtotal	**$47,623**	**$53,017**	**$0**	**$47,623**	**$53,017**
Landscaping and Facilities Support					
Alaskan	$403	$448	$0	$403	$448
Central	$41,853	$46,593	$0	$41,853	$46,593
Eastern	$68,113	$75,828	$0	$68,113	$75,828
Pacific	$993	$1,105	$0	$993	$1,105
Southern	$47,941	$53,371	$0	$47,941	$53,371
Western	$34,492	$38,399	$0	$34,492	$38,399
Subtotal	**$193,794**	**$215,744**	**$0**	**$193,794**	**$215,744**
Maintenance and Repair					
Alaskan	$687	$765	$0	$687	$765
Central	$69,625	$77,511	$0	$69,625	$77,511
Eastern	$92,285	$102,738	$0	$92,285	$102,738
Pacific	$1,109	$1,235	$0	$1,109	$1,235
Southern	$74,958	$83,449	$0	$74,958	$83,449
Western	$48,273	$53,740	$0	$48,273	$53,740
Subtotal	**$286,938**	**$319,438**	**$0**	**$286,938**	**$319,438**
Manufacturing					
Alaskan	$218	$243	$0	$218	$243
Central	$42,983	$47,851	$0	$42,983	$47,851
Eastern	$41,787	$46,520	$0	$41,787	$46,520
Pacific	$333	$371	$0	$333	$371
Southern	$31,341	$34,890	$0	$31,341	$34,890
Western	$23,653	$26,333	$0	$23,653	$26,333
Subtotal	**$140,316**	**$156,209**	**$0**	**$140,316**	**$156,209**
Oil and Gas					

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Alaskan	$311	$346	$0	$311	$346
Central	$12,605	$14,033	$0	$12,605	$14,033
Eastern	$6,802	$7,572	$0	$6,802	$7,572
Southern	$45,668	$50,840	$0	$45,668	$50,840
Western	$6,036	$6,720	$0	$6,036	$6,720
Subtotal	**$71,422**	**$79,512**	**$0**	**$71,422**	**$79,512**
Postal and Delivery Services					
Alaskan	$725	$807	$0	$725	$807
Central	$31,128	$34,654	$0	$31,128	$34,654
Eastern	$39,375	$43,835	$0	$39,375	$43,835
Pacific	$416	$463	$0	$416	$463
Southern	$28,988	$32,271	$0	$28,988	$32,271
Western	$14,598	$16,251	$0	$14,598	$16,251
Subtotal	**$115,230**	**$128,281**	**$0**	**$115,230**	**$128,281**
Recreation and Amusement					
Alaskan	$862	$960	$0	$862	$960
Central	$34,232	$38,109	$0	$34,232	$38,109
Eastern	$51,231	$57,034	$0	$51,231	$57,034
Pacific	$635	$707	$0	$635	$707
Southern	$33,362	$37,141	$0	$33,362	$37,141
Western	$22,526	$25,077	$0	$22,526	$25,077
Subtotal	**$142,848**	**$159,027**	**$0**	**$142,848**	**$159,027**
Sanitation and Waste Removal					
Alaskan	$70	$78	$0	$70	$78
Central	$2,583	$2,875	$0	$2,583	$2,875
Eastern	$3,727	$4,149	$0	$3,727	$4,149
Pacific	$57	$63	$0	$57	$63
Southern	$2,705	$3,011	$0	$2,705	$3,011
Western	$1,411	$1,571	$0	$1,411	$1,571
Subtotal	**$10,552**	**$11,748**	**$0**	**$10,552**	**$11,748**
Telecommunications					
Alaskan	$97	$108	$0	$97	$108
Central	$5,873	$6,538	$0	$5,873	$6,538
Eastern	$8,038	$8,948	$0	$8,038	$8,948
Pacific	$88	$97	$0	$88	$97

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Southern	$7,061	$7,861	$0	$7,061	$7,861
Western	$3,942	$4,388	$0	$3,942	$4,388
Subtotal	**$25,097**	**$27,940**	**$0**	**$25,097**	**$27,940**
Temporary Help Services					
Alaskan	$27	$30	$0	$27	$30
Central	$5,144	$5,726	$0	$5,144	$5,726
Eastern	$7,248	$8,069	$0	$7,248	$8,069
Pacific	$69	$77	$0	$69	$77
Southern	$6,155	$6,852	$0	$6,155	$6,852
Western	$3,647	$4,060	$0	$3,647	$4,060
Subtotal	**$22,290**	**$24,815**	**$0**	**$22,290**	**$24,815**
Transportation					
Alaskan	$2,044	$2,276	$0	$2,044	$2,276
Central	$125,246	$139,432	$0	$125,246	$139,432
Eastern	$112,749	$125,519	$0	$112,749	$125,519
Pacific	$1,405	$1,564	$0	$1,405	$1,564
Southern	$114,692	$127,682	$0	$114,692	$127,682
Western	$28,279	$31,482	$0	$28,279	$31,482
Subtotal	**$384,414**	**$427,955**	**$0**	**$384,414**	**$427,955**
Utilities					
Alaskan	$311	$346	$0	$311	$346
Central	$13,289	$14,794	$0	$13,289	$14,794
Eastern	$16,658	$18,545	$0	$16,658	$18,545
Pacific	$114	$127	$0	$114	$127
Southern	$18,684	$20,800	$0	$18,684	$20,800
Western	$7,662	$8,530	$0	$7,662	$8,530
Subtotal	**$56,718**	**$63,142**	**$0**	**$56,718**	**$63,142**
Warehousing					
Alaskan	$69	$77	$0	$69	$77
Central	$10,128	$11,275	$0	$10,128	$11,275
Eastern	$12,807	$14,257	$0	$12,807	$14,257
Pacific	$163	$181	$0	$163	$181
Southern	$12,572	$13,996	$0	$12,572	$13,996
Western	$7,897	$8,792	$0	$7,897	$8,792
Subtotal	**$43,637**	**$48,579**	**$0**	**$43,637**	**$48,579**

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Non-Core					
Alaskan	$12,654	$14,088	$0	$12,654	$14,088
Central	$930,486	$1,035,878	$0	$930,486	$1,035,878
Eastern	$1,527,924	$1,700,984	$0	$1,527,924	$1,700,984
Pacific	$24,104	$26,834	$0	$24,104	$26,834
Southern	$1,204,627	$1,341,069	$0	$1,204,627	$1,341,069
Western	$784,599	$873,467	$0	$784,599	$873,467
Subtotal	**$4,484,394**	**$4,992,320**	**$0**	**$4,484,394**	**$4,992,320**
Total Costs for Ice Cooler					
Alaskan	$24,993	$27,823	$0	$24,993	$27,823
Central	$1,828,043	$2,035,097	$0	$1,828,043	$2,035,097
Eastern	$2,606,080	$2,901,259	$0	$2,606,080	$2,901,259
Pacific	$39,561	$44,041	$0	$39,561	$44,041
Southern	$2,140,354	$2,382,782	$0	$2,140,354	$2,382,782
Western	$1,205,847	$1,342,427	$0	$1,205,847	$1,342,427
Total	**$7,844,878**	**$8,733,430**	**$0**	**$7,844,878**	**$8,733,430**
Total Costs for Heat Illness and Emergency Response and Planning					
Agriculture, Forestry, and Fishing					
Alaskan	$5,474	$6,094	$468	$5,942	$6,562
Central	$397,210	$442,200	$5,906,140	$6,303,350	$6,348,340
Eastern	$209,053	$232,732	$3,257,783	$3,466,836	$3,490,515
Pacific	$2,824	$3,143	$145,604	$148,427	$148,747
Southern	$363,147	$404,279	$13,829,931	$14,193,078	$14,234,210
Western	$53,853	$59,953	$984,402	$1,038,255	$1,044,354
Subtotal	**$1,031,560**	**$1,148,400**	**$24,124,328**	**$25,155,888**	**$25,272,728**
Building Materials and Equipment Suppliers					
Alaskan	$571	$635	$51	$622	$686
Central	$45,657	$50,828	$647,987	$693,644	$698,815
Eastern	$65,387	$72,793	$913,350	$978,737	$986,143
Pacific	$1,035	$1,152	$53,385	$54,421	$54,538
Southern	$59,579	$66,328	$2,569,128	$2,628,707	$2,635,456
Western	$35,248	$39,240	$670,853	$706,100	$710,093
Subtotal	**$207,477**	**$230,977**	**$4,854,754**	**$5,062,231**	**$5,085,731**
Commercial Kitchens					
Alaskan	$6,871	$7,649	$568	$7,438	$8,216

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Central	$547,551	$609,570	$7,718,320	$8,265,871	$8,327,889
Eastern	$911,512	$1,014,754	$12,713,298	$13,624,809	$13,728,052
Pacific	$17,407	$19,379	$897,577	$914,984	$916,955
Southern	$668,909	$744,673	$28,462,838	$29,131,747	$29,207,511
Western	$465,111	$517,792	$8,931,312	$9,396,424	$9,449,105
Subtotal	**$2,617,361**	**$2,913,817**	**$58,723,912**	**$61,341,273**	**$61,637,729**
Construction					
Alaskan	$9,798	$10,908	$839	$10,637	$11,746
Central	$752,515	$837,748	$9,569,076	$10,321,590	$10,406,824
Eastern	$916,523	$1,020,333	$12,960,902	$13,877,425	$13,981,235
Pacific	$13,651	$15,197	$703,923	$717,574	$719,120
Southern	$667,736	$743,367	$28,775,279	$29,443,015	$29,518,646
Western	$190,459	$212,032	$4,063,319	$4,253,778	$4,275,350
Subtotal	**$2,550,681**	**$2,839,585**	**$56,073,337**	**$58,624,018**	**$58,912,922**
Drycleaning and Commercial Laundries					
Alaskan	$222	$247	$18	$241	$266
Central	$27,736	$30,878	$396,589	$424,325	$427,467
Eastern	$71,250	$79,320	$954,328	$1,025,579	$1,033,649
Pacific	$561	$624	$28,917	$29,477	$29,541
Southern	$42,049	$46,812	$1,772,724	$1,814,773	$1,819,536
Western	$25,867	$28,797	$490,932	$516,799	$519,729
Subtotal	**$167,685**	**$186,678**	**$3,643,509**	**$3,811,195**	**$3,830,188**
Landscaping and Facilities Support					
Alaskan	$1,418	$1,579	$139	$1,557	$1,718
Central	$147,368	$164,060	$2,086,628	$2,233,996	$2,250,688
Eastern	$239,837	$267,002	$3,397,985	$3,637,822	$3,664,987
Pacific	$3,495	$3,891	$180,281	$183,777	$184,172
Southern	$168,806	$187,926	$7,351,688	$7,520,494	$7,539,613
Western	$121,451	$135,207	$2,329,439	$2,450,890	$2,464,646
Subtotal	**$682,376**	**$759,665**	**$15,346,160**	**$16,028,535**	**$16,105,825**
Maintenance and Repair					
Alaskan	$2,420	$2,694	$200	$2,620	$2,895
Central	$245,160	$272,928	$3,446,973	$3,692,133	$3,719,902
Eastern	$324,948	$361,754	$4,631,648	$4,956,597	$4,993,402
Pacific	$3,905	$4,348	$201,375	$205,280	$205,722

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Southern	$263,939	$293,834	$11,237,111	$11,501,050	$11,530,945
Western	$169,974	$189,226	$3,270,705	$3,440,679	$3,459,931
Subtotal	**$1,010,347**	**$1,124,784**	**$22,788,013**	**$23,798,360**	**$23,912,797**
Manufacturing					
Alaskan	$768	$856	$77	$845	$932
Central	$151,348	$168,490	$1,881,334	$2,032,682	$2,049,825
Eastern	$147,139	$163,805	$2,046,592	$2,193,731	$2,210,396
Pacific	$1,174	$1,307	$60,562	$61,736	$61,869
Southern	$110,355	$122,854	$4,509,130	$4,619,485	$4,631,984
Western	$83,287	$92,721	$1,571,835	$1,655,122	$1,664,556
Subtotal	**$494,071**	**$550,032**	**$10,069,529**	**$10,563,601**	**$10,619,562**
Oil and Gas					
Alaskan	$1,095	$1,219	$108	$1,202	$1,326
Central	$44,385	$49,412	$680,613	$724,998	$730,025
Eastern	$23,950	$26,663	$311,017	$334,968	$337,681
Southern	$160,802	$179,015	$6,189,011	$6,349,813	$6,368,027
Western	$21,254	$23,661	$323,109	$344,363	$346,770
Subtotal	**$251,486**	**$279,971**	**$7,503,858**	**$7,755,344**	**$7,783,829**
Postal and Delivery Services					
Alaskan	$2,553	$2,842	$227	$2,780	$3,069
Central	$109,607	$122,022	$1,593,038	$1,702,645	$1,715,060
Eastern	$138,644	$154,348	$1,909,617	$2,048,261	$2,063,965
Pacific	$1,464	$1,630	$75,502	$76,966	$77,132
Southern	$102,071	$113,632	$3,900,882	$4,002,953	$4,014,514
Western	$51,401	$57,223	$957,744	$1,009,145	$1,014,967
Subtotal	**$405,740**	**$451,696**	**$8,437,011**	**$8,842,751**	**$8,888,707**
Recreation and Amusement					
Alaskan	$3,035	$3,379	$254	$3,289	$3,632
Central	$120,534	$134,187	$1,656,853	$1,777,387	$1,791,040
Eastern	$180,391	$200,823	$2,519,494	$2,699,885	$2,720,317
Pacific	$2,237	$2,491	$115,376	$117,613	$117,866
Southern	$117,472	$130,778	$4,947,232	$5,064,704	$5,078,010
Western	$79,316	$88,300	$1,503,343	$1,582,659	$1,591,643
Subtotal	**$502,986**	**$559,957**	**$10,742,550**	**$11,245,537**	**$11,302,508**
Sanitation and Waste Removal					

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Alaskan	$248	$276	$26	$274	$302
Central	$9,094	$10,124	$126,016	$135,110	$136,140
Eastern	$13,124	$14,610	$183,568	$196,691	$198,178
Pacific	$199	$222	$10,265	$10,464	$10,487
Southern	$9,524	$10,603	$390,986	$400,510	$401,588
Western	$4,968	$5,531	$96,734	$101,703	$102,266
Subtotal	**$37,157**	**$41,365**	**$807,595**	**$844,752**	**$848,960**
Telecommunications					
Alaskan	$340	$379	$40	$380	$419
Central	$20,679	$23,021	$297,469	$318,148	$320,490
Eastern	$28,303	$31,508	$408,180	$436,483	$439,688
Pacific	$308	$343	$15,910	$16,219	$16,254
Southern	$24,862	$27,678	$997,959	$1,022,821	$1,025,637
Western	$13,879	$15,451	$267,740	$281,618	$283,190
Subtotal	**$88,371**	**$98,381**	**$1,987,297**	**$2,075,668**	**$2,085,678**
Temporary Help Services					
Alaskan	$96	$107	$10	$106	$117
Central	$18,112	$20,163	$250,436	$268,548	$270,600
Eastern	$25,521	$28,412	$371,738	$397,259	$400,150
Pacific	$245	$272	$12,616	$12,861	$12,888
Southern	$21,671	$24,125	$897,291	$918,962	$921,417
Western	$12,841	$14,296	$253,374	$266,215	$267,669
Subtotal	**$78,486**	**$87,376**	**$1,785,465**	**$1,863,951**	**$1,872,841**
Transportation					
Alaskan	$7,198	$8,014	$641	$7,840	$8,655
Central	$441,009	$490,960	$6,351,231	$6,792,240	$6,842,191
Eastern	$397,003	$441,969	$5,780,498	$6,177,501	$6,222,468
Pacific	$4,946	$5,506	$255,062	$260,008	$260,568
Southern	$403,844	$449,586	$16,738,520	$17,142,365	$17,188,106
Western	$99,574	$110,853	$2,033,438	$2,133,012	$2,144,291
Subtotal	**$1,353,575**	**$1,506,888**	**$31,159,391**	**$32,512,966**	**$32,666,279**
Utilities					
Alaskan	$1,094	$1,218	$103	$1,196	$1,320
Central	$46,791	$52,091	$677,376	$724,167	$729,467
Eastern	$58,656	$65,300	$881,334	$939,991	$946,634

Table VIII.C.26. Total Costs – Heat Illness and Emergency Response and Planning (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Pacific	$402	$447	$20,725	$21,126	$21,172
Southern	$65,789	$73,240	$2,565,516	$2,631,305	$2,638,757
Western	$26,979	$30,034	$498,535	$525,513	$528,569
Subtotal	**$199,711**	**$222,331**	**$4,643,589**	**$4,843,299**	**$4,865,920**
Warehousing					
Alaskan	$244	$272	$22	$266	$293
Central	$35,663	$39,702	$517,691	$553,354	$557,394
Eastern	$45,095	$50,202	$684,804	$729,898	$735,006
Pacific	$572	$637	$29,523	$30,096	$30,161
Southern	$44,269	$49,283	$1,746,214	$1,790,483	$1,795,497
Western	$27,808	$30,957	$539,964	$567,771	$570,921
Subtotal	**$153,651**	**$171,054**	**$3,518,218**	**$3,671,869**	**$3,689,272**
Non-Core					
Alaskan	$44,558	$49,605	$4,634	$49,191	$54,238
Central	$3,276,369	$3,647,467	$47,494,625	$50,770,993	$51,142,092
Eastern	$5,380,026	$5,989,397	$76,087,725	$81,467,752	$82,077,122
Pacific	$84,873	$94,486	$4,376,753	$4,461,626	$4,471,239
Southern	$4,241,654	$4,722,086	$178,874,407	$183,116,060	$183,596,492
Western	$2,762,679	$3,075,595	$52,985,853	$55,748,532	$56,061,448
Subtotal	**$15,790,158**	**$17,578,635**	**$359,823,997**	**$375,614,155**	**$377,402,632**
Total					
Alaskan	$88,002	$97,970	$8,424	$96,426	$106,394
Central	$6,436,788	$7,165,853	$91,298,395	$97,735,184	$98,464,248
Eastern	$9,176,362	$10,215,726	$130,013,862	$139,190,225	$140,229,588
Pacific	$139,298	$155,076	$7,183,357	$7,322,655	$7,338,433
Southern	$7,536,477	$8,390,099	$315,755,847	$323,292,325	$324,145,946
Western	$4,245,950	$4,726,869	$81,772,629	$86,018,579	$86,499,498
Total	**$27,622,878**	**$30,751,591**	**$626,032,515**	**$653,655,393**	**$656,784,106**

Source: OSHA estimate.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

G. Training.

All affected establishments would be required to provide training on heat-related hazards to at-risk workers and designated persons both upon promulgation and periodically thereafter.[79] OSHA calculates the total costs of each training requirement by either multiplying the number of affected establishments by the corresponding unit costs or multiplying the number of affected employees by the corresponding unit costs. The unit costs to undergo employee trainings (initial, annual refresher, and supplemental) are employee-based and are combined with the number of affected employees. All other training-related unit costs are establishment-based (developing, preparing, conducting employee training (initial, annual refresher, supplemental) and supervisor training (initial, annual refresher)) and are combined with the number of affected establishments. OSHA assumes that one percent of affected establishments would incur the establishment-based cost of supplemental trainings annually. Additionally, OSHA assumes employers would incur the cost of providing supplemental training to one percent of employees annually.

Table VIII.C.27. shows the annualized one-time, annual, and total annualized costs for each of these requirements by industry category, discounted (2 percent over a 10-year period) and undiscounted.

[79] Employers would be required to conduct refresher trainings annually for both at-risk workers and designated persons. Supplemental trainings would also be required for at-risk workers when either (1) worker(s) heat exposure changes, (2) policies and procedures change, (3) worker(s) does not retain information, or (4) a heat-related injury or illness occurs that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness.

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Initial Employee Training Development					
Agriculture, Forestry, and Fishing	$874,213	$973,231	$0	$874,213	$973,231
Building Materials and Equipment Suppliers	$196,858	$219,155	$0	$196,858	$219,155
Commercial Kitchens	$1,551,304	$1,727,013	$0	$1,551,304	$1,727,013
Construction	$3,520,999	$3,919,806	$0	$3,520,999	$3,919,806
Drycleaning and Commercial Laundries	$161,955	$180,299	$0	$161,955	$180,299
Landscaping and Facilities Support	$661,920	$736,893	$0	$661,920	$736,893
Maintenance and Repair	$965,373	$1,074,716	$0	$965,373	$1,074,716
Manufacturing	$687,852	$765,762	$0	$687,852	$765,762
Oil and Gas	$356,567	$396,953	$0	$356,567	$396,953
Postal and Delivery Services	$429,895	$478,587	$0	$429,895	$478,587
Recreation and Amusement	$404,065	$449,832	$0	$404,065	$449,832
Sanitation and Waste Removal	$36,316	$40,430	$0	$36,316	$40,430
Telecommunications	$138,034	$153,668	$0	$138,034	$153,668
Temporary Help Services	$77,023	$85,747	$0	$77,023	$85,747
Transportation	$1,433,544	$1,595,915	$0	$1,433,544	$1,595,915
Utilities	$234,921	$261,529	$0	$234,921	$261,529
Warehousing	$164,390	$183,009	$0	$164,390	$183,009
Non-Core	$17,129,902	$19,070,125	$0	$17,129,902	$19,070,125
Subtotal	**$29,025,131**	**$32,312,671**	**$0**	**$29,025,131**	**$32,312,671**
Initial Employee Training – Designated Person					
Agriculture, Forestry, and Fishing	$327,830	$364,961	$0	$327,830	$364,961
Building Materials and Equipment Suppliers	$73,822	$82,183	$0	$73,822	$82,183
Commercial Kitchens	$581,739	$647,630	$0	$581,739	$647,630
Construction	$1,320,375	$1,469,927	$0	$1,320,375	$1,469,927
Drycleaning and Commercial Laundries	$60,733	$67,612	$0	$60,733	$67,612
Landscaping and Facilities Support	$248,220	$276,335	$0	$248,220	$276,335
Maintenance and Repair	$362,015	$403,019	$0	$362,015	$403,019
Manufacturing	$257,945	$287,161	$0	$257,945	$287,161

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Oil and Gas	$133,712	$148,857	$0	$133,712	$148,857
Postal and Delivery Services	$161,211	$179,470	$0	$161,211	$179,470
Recreation and Amusement	$151,524	$168,687	$0	$151,524	$168,687
Sanitation and Waste Removal	$13,619	$15,161	$0	$13,619	$15,161
Telecommunications	$51,763	$57,626	$0	$51,763	$57,626
Temporary Help Services	$28,883	$32,155	$0	$28,883	$32,155
Transportation	$537,579	$598,468	$0	$537,579	$598,468
Utilities	$88,095	$98,074	$0	$88,095	$98,074
Warehousing	$61,646	$68,628	$0	$61,646	$68,628
Non-Core	$6,423,713	$7,151,297	$0	$6,423,713	$7,151,297
Subtotal	**$10,884,424**	**$12,117,251**	**$0**	**$10,884,424**	**$12,117,251**
Initial Employee Training – At-Risk Worker					
Agriculture, Forestry, and Fishing	$934,279	$1,040,101	$0	$934,279	$1,040,101
Building Materials and Equipment Suppliers	$746,591	$831,153	$0	$746,591	$831,153
Commercial Kitchens	$4,066,902	$4,527,541	$0	$4,066,902	$4,527,541
Construction	$4,331,381	$4,821,976	$0	$4,331,381	$4,821,976
Drycleaning and Commercial Laundries	$122,360	$136,219	$0	$122,360	$136,219
Landscaping and Facilities Support	$1,942,964	$2,163,034	$0	$1,942,964	$2,163,034
Maintenance and Repair	$1,029,589	$1,146,206	$0	$1,029,589	$1,146,206
Manufacturing	$2,507,091	$2,791,058	$0	$2,507,091	$2,791,058
Oil and Gas	$541,637	$602,986	$0	$541,637	$602,986
Postal and Delivery Services	$361,448	$402,388	$0	$361,448	$402,388
Recreation and Amusement	$724,272	$806,307	$0	$724,272	$806,307
Sanitation and Waste Removal	$142,218	$158,326	$0	$142,218	$158,326
Telecommunications	$420,884	$468,556	$0	$420,884	$468,556
Temporary Help Services	$2,505,173	$2,788,922	$0	$2,505,173	$2,788,922
Transportation	$1,356,516	$1,510,162	$0	$1,356,516	$1,510,162
Utilities	$582,011	$647,932	$0	$582,011	$647,932
Warehousing	$553,790	$616,515	$0	$553,790	$616,515
Non-Core	$53,834,831	$59,932,448	$0	$53,834,831	$59,932,448
Subtotal	**$76,703,936**	**$85,391,828**	**$0**	**$76,703,936**	**$85,391,828**
Initial Supervisor Training Development					

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Agriculture, Forestry, and Fishing	$437,106	$486,615	$0	$437,106	$486,615
Building Materials and Equipment Suppliers	$98,429	$109,577	$0	$98,429	$109,577
Commercial Kitchens	$775,652	$863,507	$0	$775,652	$863,507
Construction	$1,760,499	$1,959,903	$0	$1,760,499	$1,959,903
Drycleaning and Commercial Laundries	$80,978	$90,150	$0	$80,978	$90,150
Landscaping and Facilities Support	$330,960	$368,446	$0	$330,960	$368,446
Maintenance and Repair	$482,687	$537,358	$0	$482,687	$537,358
Manufacturing	$343,926	$382,881	$0	$343,926	$382,881
Oil and Gas	$178,283	$198,477	$0	$178,283	$198,477
Postal and Delivery Services	$214,948	$239,294	$0	$214,948	$239,294
Recreation and Amusement	$202,033	$224,916	$0	$202,033	$224,916
Sanitation and Waste Removal	$18,158	$20,215	$0	$18,158	$20,215
Telecommunications	$69,017	$76,834	$0	$69,017	$76,834
Temporary Help Services	$38,511	$42,873	$0	$38,511	$42,873
Transportation	$716,772	$797,958	$0	$716,772	$797,958
Utilities	$117,460	$130,765	$0	$117,460	$130,765
Warehousing	$82,195	$91,505	$0	$82,195	$91,505
Non-Core	$8,564,951	$9,535,063	$0	$8,564,951	$9,535,063
Subtotal	**$14,512,566**	**$16,156,335**	**$0**	**$14,512,566**	**$16,156,335**
Initial Supervisor Training – Supervisor					
Agriculture, Forestry, and Fishing	$273,191	$304,135	$0	$273,191	$304,135
Building Materials and Equipment Suppliers	$61,518	$68,486	$0	$61,518	$68,486
Commercial Kitchens	$484,783	$539,692	$0	$484,783	$539,692
Construction	$1,100,312	$1,224,939	$0	$1,100,312	$1,224,939
Drycleaning and Commercial Laundries	$50,611	$56,344	$0	$50,611	$56,344
Landscaping and Facilities Support	$206,850	$230,279	$0	$206,850	$230,279
Maintenance and Repair	$301,679	$335,849	$0	$301,679	$335,849
Manufacturing	$214,954	$239,301	$0	$214,954	$239,301
Oil and Gas	$111,427	$124,048	$0	$111,427	$124,048

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Postal and Delivery Services	$134,342	$149,559	$0	$134,342	$149,559
Recreation and Amusement	$126,270	$140,572	$0	$126,270	$140,572
Sanitation and Waste Removal	$11,349	$12,634	$0	$11,349	$12,634
Telecommunications	$43,136	$48,021	$0	$43,136	$48,021
Temporary Help Services	$24,070	$26,796	$0	$24,070	$26,796
Transportation	$447,983	$498,723	$0	$447,983	$498,723
Utilities	$73,413	$81,728	$0	$73,413	$81,728
Warehousing	$51,372	$57,190	$0	$51,372	$57,190
Non-Core	$5,353,094	$5,959,414	$0	$5,353,094	$5,959,414
Subtotal	**$9,070,353**	**$10,097,710**	**$0**	**$9,070,353**	**$10,097,710**
Initial Supervisor Training – Designated Person					
Agriculture, Forestry, and Fishing	$218,553	$243,308	$0	$218,553	$243,308
Building Materials and Equipment Suppliers	$49,214	$54,789	$0	$49,214	$54,789
Commercial Kitchens	$387,826	$431,753	$0	$387,826	$431,753
Construction	$880,250	$979,951	$0	$880,250	$979,951
Drycleaning and Commercial Laundries	$40,489	$45,075	$0	$40,489	$45,075
Landscaping and Facilities Support	$165,480	$184,223	$0	$165,480	$184,223
Maintenance and Repair	$241,343	$268,679	$0	$241,343	$268,679
Manufacturing	$171,963	$191,440	$0	$171,963	$191,440
Oil and Gas	$89,142	$99,238	$0	$89,142	$99,238
Postal and Delivery Services	$107,474	$119,647	$0	$107,474	$119,647
Recreation and Amusement	$101,016	$112,458	$0	$101,016	$112,458
Sanitation and Waste Removal	$9,079	$10,107	$0	$9,079	$10,107
Telecommunications	$34,508	$38,417	$0	$34,508	$38,417
Temporary Help Services	$19,256	$21,437	$0	$19,256	$21,437
Transportation	$358,386	$398,979	$0	$358,386	$398,979
Utilities	$58,730	$65,382	$0	$58,730	$65,382
Warehousing	$41,097	$45,752	$0	$41,097	$45,752
Non-Core	$4,282,475	$4,767,531	$0	$4,282,475	$4,767,531
Subtotal	**$7,256,283**	**$8,078,168**	**$0**	**$7,256,283**	**$8,078,168**
Annual Employee Refresher Training – Designated Person					

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Agriculture, Forestry, and Fishing	$0	$0	$1,768,652	$1,768,652	$1,768,652
Building Materials and Equipment Suppliers	$0	$0	$369,108	$369,108	$369,108
Commercial Kitchens	$0	$0	$2,850,713	$2,850,713	$2,850,713
Construction	$0	$0	$527,929	$527,929	$527,929
Drycleaning and Commercial Laundries	$0	$0	$303,666	$303,666	$303,666
Landscaping and Facilities Support	$0	$0	$1,209,995	$1,209,995	$1,209,995
Maintenance and Repair	$0	$0	$1,810,074	$1,810,074	$1,810,074
Oil and Gas	$0	$0	$672,075	$672,075	$672,075
Postal and Delivery Services	$0	$0	$806,053	$806,053	$806,053
Recreation and Amusement	$0	$0	$757,622	$757,622	$757,622
Sanitation and Waste Removal	$0	$0	$68,093	$68,093	$68,093
Telecommunications	$0	$0	$258,814	$258,814	$258,814
Temporary Help Services	$0	$0	$144,417	$144,417	$144,417
Transportation	$0	$0	$2,950,027	$2,950,027	$2,950,027
Utilities	$0	$0	$618,234	$618,234	$618,234
Warehousing	$0	$0	$308,231	$308,231	$308,231
Non-Core	$0	$0	$32,061,160	$32,061,160	$32,061,160
Subtotal	**$0**	**$0**	**$47,484,865**	**$47,484,865**	**$47,484,865**
Annual Employee Refresher Training – At-Risk Worker					
Agriculture, Forestry, and Fishing	$0	$0	$6,150,895	$6,150,895	$6,150,895
Building Materials and Equipment Suppliers	$0	$0	$3,732,953	$3,732,953	$3,732,953
Commercial Kitchens	$0	$0	$19,973,908	$19,973,908	$19,973,908
Construction	$0	$0	$7,431,366	$7,431,366	$7,431,366
Drycleaning and Commercial Laundries	$0	$0	$611,800	$611,800	$611,800
Landscaping and Facilities Support	$0	$0	$9,244,018	$9,244,018	$9,244,018
Maintenance and Repair	$0	$0	$5,147,944	$5,147,944	$5,147,944
Oil and Gas	$0	$0	$2,725,803	$2,725,803	$2,725,803
Postal and Delivery Services	$0	$0	$1,807,242	$1,807,242	$1,807,242
Recreation and Amusement	$0	$0	$3,621,359	$3,621,359	$3,621,359

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Sanitation and Waste Removal	$0	$0	$711,089	$711,089	$711,089
Telecommunications	$0	$0	$2,104,420	$2,104,420	$2,104,420
Temporary Help Services	$0	$0	$12,525,865	$12,525,865	$12,525,865
Transportation	$0	$0	$7,140,067	$7,140,067	$7,140,067
Utilities	$0	$0	$4,739,454	$4,739,454	$4,739,454
Warehousing	$0	$0	$2,768,949	$2,768,949	$2,768,949
Non-Core	$0	$0	$268,614,044	$268,614,044	$268,614,044
Subtotal	**$0**	**$0**	**$359,051,175**	**$359,051,175**	**$359,051,175**
Annual Supervisor Refresher Training – Supervisor					
Agriculture, Forestry, and Fishing	$0	$0	$1,473,877	$1,473,877	$1,473,877
Building Materials and Equipment Suppliers	$0	$0	$307,590	$307,590	$307,590
Commercial Kitchens	$0	$0	$2,375,594	$2,375,594	$2,375,594
Construction	$0	$0	$439,941	$439,941	$439,941
Drycleaning and Commercial Laundries	$0	$0	$253,055	$253,055	$253,055
Landscaping and Facilities Support	$0	$0	$1,008,329	$1,008,329	$1,008,329
Maintenance and Repair	$0	$0	$1,508,395	$1,508,395	$1,508,395
Oil and Gas	$0	$0	$560,062	$560,062	$560,062
Postal and Delivery Services	$0	$0	$671,711	$671,711	$671,711
Recreation and Amusement	$0	$0	$631,352	$631,352	$631,352
Sanitation and Waste Removal	$0	$0	$56,744	$56,744	$56,744
Telecommunications	$0	$0	$215,678	$215,678	$215,678
Temporary Help Services	$0	$0	$120,348	$120,348	$120,348
Transportation	$0	$0	$2,458,356	$2,458,356	$2,458,356
Utilities	$0	$0	$515,195	$515,195	$515,195
Warehousing	$0	$0	$256,859	$256,859	$256,859
Non-Core	$0	$0	$26,717,633	$26,717,633	$26,717,633
Subtotal	**$0**	**$0**	**$39,570,721**	**$39,570,721**	**$39,570,721**
Annual Supervisor Refresher Training – Designated Person					
Agriculture, Forestry, and Fishing	$0	$0	$1,179,102	$1,179,102	$1,179,102
Building Materials and Equipment Suppliers	$0	$0	$246,072	$246,072	$246,072

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Commercial Kitchens	$0	$0	$1,900,475	$1,900,475	$1,900,475
Construction	$0	$0	$351,953	$351,953	$351,953
Drycleaning and Commercial Laundries	$0	$0	$202,444	$202,444	$202,444
Landscaping and Facilities Support	$0	$0	$806,663	$806,663	$806,663
Maintenance and Repair	$0	$0	$1,206,716	$1,206,716	$1,206,716
Oil and Gas	$0	$0	$448,050	$448,050	$448,050
Postal and Delivery Services	$0	$0	$537,369	$537,369	$537,369
Recreation and Amusement	$0	$0	$505,082	$505,082	$505,082
Sanitation and Waste Removal	$0	$0	$45,395	$45,395	$45,395
Telecommunications	$0	$0	$172,542	$172,542	$172,542
Temporary Help Services	$0	$0	$96,278	$96,278	$96,278
Transportation	$0	$0	$1,966,685	$1,966,685	$1,966,685
Utilities	$0	$0	$412,156	$412,156	$412,156
Warehousing	$0	$0	$205,487	$205,487	$205,487
Non-Core	$0	$0	$21,374,107	$21,374,107	$21,374,107
Subtotal	**$0**	**$0**	**$31,656,577**	**$31,656,577**	**$31,656,577**
Supplemental Employee Refresher Training – Designated Person					
Agriculture, Forestry, and Fishing	$0	$0	$17,687	$17,687	$17,687
Building Materials and Equipment Suppliers	$0	$0	$3,691	$3,691	$3,691
Commercial Kitchens	$0	$0	$28,507	$28,507	$28,507
Construction	$0	$0	$5,279	$5,279	$5,279
Drycleaning and Commercial Laundries	$0	$0	$3,037	$3,037	$3,037
Landscaping and Facilities Support	$0	$0	$12,100	$12,100	$12,100
Maintenance and Repair	$0	$0	$18,101	$18,101	$18,101
Oil and Gas	$0	$0	$6,721	$6,721	$6,721
Postal and Delivery Services	$0	$0	$8,061	$8,061	$8,061
Recreation and Amusement	$0	$0	$7,576	$7,576	$7,576
Sanitation and Waste Removal	$0	$0	$681	$681	$681
Telecommunications	$0	$0	$2,588	$2,588	$2,588
Temporary Help Services	$0	$0	$1,444	$1,444	$1,444

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Transportation	$0	$0	$29,500	$29,500	$29,500
Utilities	$0	$0	$6,182	$6,182	$6,182
Warehousing	$0	$0	$3,082	$3,082	$3,082
Non-Core	$0	$0	$320,612	$320,612	$320,612
Subtotal	**$0**	**$0**	**$474,849**	**$474,849**	**$474,849**
Supplemental Employee Refresher Training – At-Risk Worker					
Agriculture, Forestry, and Fishing	$0	$0	$61,509	$61,509	$61,509
Building Materials and Equipment Suppliers	$0	$0	$37,330	$37,330	$37,330
Commercial Kitchens	$0	$0	$199,739	$199,739	$199,739
Construction	$0	$0	$74,314	$74,314	$74,314
Drycleaning and Commercial Laundries	$0	$0	$6,118	$6,118	$6,118
Landscaping and Facilities Support	$0	$0	$92,440	$92,440	$92,440
Maintenance and Repair	$0	$0	$51,479	$51,479	$51,479
Oil and Gas	$0	$0	$27,258	$27,258	$27,258
Postal and Delivery Services	$0	$0	$18,072	$18,072	$18,072
Recreation and Amusement	$0	$0	$36,214	$36,214	$36,214
Sanitation and Waste Removal	$0	$0	$7,111	$7,111	$7,111
Telecommunications	$0	$0	$21,044	$21,044	$21,044
Temporary Help Services	$0	$0	$125,259	$125,259	$125,259
Transportation	$0	$0	$71,401	$71,401	$71,401
Utilities	$0	$0	$47,395	$47,395	$47,395
Warehousing	$0	$0	$27,689	$27,689	$27,689
Non-Core	$0	$0	$2,686,140	$2,686,140	$2,686,140
Subtotal	**$0**	**$0**	**$3,590,512**	**$3,590,512**	**$3,590,512**
Total					
Agriculture, Forestry, and Fishing	$3,065,172	$3,412,350	$10,651,721	$13,716,894	$14,064,071
Building Materials and Equipment Suppliers	$1,226,431	$1,365,343	$4,696,744	$5,923,175	$6,062,087
Commercial Kitchens	$7,848,207	$8,737,136	$27,328,936	$35,177,143	$36,066,072
Construction	$12,913,815	$14,376,502	$8,830,781	$21,744,597	$23,207,283
Drycleaning and Commercial Laundries	$517,126	$575,699	$1,380,121	$1,897,247	$1,955,819

Table VIII.C.27. Total Costs – Training (2023$)

Industry Category	One-Time Annualized		Annual	Total Annualized	
	0%	2%		0%	2%
Landscaping and Facilities Support	$3,556,395	$3,959,211	$12,373,546	$15,929,940	$16,332,756
Maintenance and Repair	$3,382,686	$3,765,827	$9,742,711	$13,125,396	$13,508,537
Manufacturing	$4,183,731	$4,657,602	$0	$4,183,731	$4,657,602
Oil and Gas	$1,410,768	$1,570,559	$4,439,969	$5,850,737	$6,010,528
Postal and Delivery Services	$1,409,318	$1,568,945	$3,848,509	$5,257,827	$5,417,453
Recreation and Amusement	$1,709,181	$1,902,772	$5,559,205	$7,268,385	$7,461,976
Sanitation and Waste Removal	$230,739	$256,874	$889,114	$1,119,853	$1,145,988
Telecommunications	$757,342	$843,122	$2,775,086	$3,532,428	$3,618,208
Temporary Help Services	$2,692,916	$2,997,929	$13,013,611	$15,706,527	$16,011,540
Transportation	$4,850,780	$5,400,205	$14,616,036	$19,466,817	$20,016,242
Utilities	$1,154,630	$1,285,410	$6,338,616	$7,493,247	$7,624,026
Warehousing	$954,490	$1,062,600	$3,570,298	$4,524,787	$4,632,898
Non-Core	$95,588,967	$106,415,877	$351,773,696	$447,362,662	$458,189,573
Total	**$147,452,693**	**$164,153,963**	**$481,828,698**	**$629,281,391**	**$645,982,661**

Source: OSHA.

Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

H. Recordkeeping.

The proposed standard would require affected indoor establishments to maintain environmental measurements for six months. Certain models of environmental monitoring equipment can automatically upload measurements taken to a recordkeeping database. OSHA assumes that establishments required to maintain these records would purchase a wireless temperature and humidity data logger with this capability (cost captured under the Identifying Heat Hazards provision in section VIII.C.V.C.). For this reason, OSHA assumes that establishments would not incur an additional cost to maintain these records beyond the time required to take the measurements themselves (also captured in section VIII.C.V.C.).

I. Total Costs of the Proposed Standard.

Accounting for the costs associated with all provisions, OSHA estimates that annualized costs, using a 2 percent discount rate over a ten-year period, would equal $7.8 billion. Table VIII.C.28. shows the total costs of the proposed standard by industry category and region. Table VIII.C.29. shows the total costs of the proposed standard by provision.

Table VIII.C.28. Total Costs of Proposed Standard by Industry Category and Region (2023$)

	One-Time	Periodic Costs Annualized		Annual	Cost Savings	Total Annualized [a]	
		0%	2%			0%	2%
Agriculture, Forestry, and Fishing							
Alaskan	$382,520	$25,400	$23,728	$91,573	$7	$132,358	$136,792
Central	$32,095,286	$1,874,386	$1,751,017	$62,352,975	$28,665,280	$37,084,663	$37,455,687
Eastern	$17,835,946	$955,385	$892,504	$47,389,145	$24,123,746	$25,144,533	$25,350,373
Pacific	$234,288	$13,394	$12,512	$934,183	$384,690	$574,262	$576,969
Southern	$30,484,939	$1,686,951	$1,575,919	$225,927,630	$129,505,465	$99,639,354	$99,991,389
Western	$10,348,543	$953,696	$890,925	$41,033,629	$18,153,681	$24,010,171	$24,131,198
Subtotal	**$91,381,522**	**$5,509,211**	**$5,146,605**	**$377,729,135**	**$200,832,869**	**$186,585,339**	**$187,642,407**
Building Materials and Equipment Suppliers							
Alaskan	$73,244	$6,454	$6,029	$22,293	$11	$30,252	$31,108
Central	$6,164,179	$536,834	$501,500	$20,645,717	$10,913,203	$10,402,615	$10,474,581
Eastern	$8,768,769	$785,209	$733,528	$34,605,315	$19,559,927	$16,000,785	$16,103,245
Pacific	$137,453	$12,450	$11,631	$1,020,163	$507,369	$527,784	$529,391
Southern	$8,097,617	$709,966	$663,237	$126,957,154	$81,071,558	$46,766,355	$46,860,912
Western	$5,225,565	$522,755	$488,349	$15,565,091	$7,398,609	$8,741,314	$8,802,592
Subtotal	**$28,466,828**	**$2,573,667**	**$2,404,273**	**$198,815,733**	**$119,450,676**	**$82,469,106**	**$82,801,829**
Commercial Kitchens							
Alaskan	$549,495	$76,847	$71,789	$165,987	$19	$228,602	$235,133
Central	$49,420,733	$6,134,657	$5,730,885	$102,302,796	$50,480,882	$57,377,453	$57,961,753
Eastern	$81,115,976	$10,278,954	$9,602,411	$205,636,428	$111,478,395	$103,297,526	$104,257,396
Pacific	$1,643,878	$197,251	$184,268	$8,155,868	$3,774,306	$4,565,675	$4,585,083
Southern	$64,789,002	$7,549,866	$7,052,947	$658,904,303	$422,956,059	$243,182,131	$243,946,159
Western	$45,955,018	$6,478,114	$6,051,736	$95,928,702	$43,836,108	$57,335,907	$57,882,325
Subtotal	**$243,474,102**	**$30,715,689**	**$28,694,036**	**$1,071,094,084**	**$632,525,768**	**$465,987,295**	**$468,867,850**
Construction							
Alaskan	$1,970,414	$90,248	$84,308	$381,506	$146	$587,427	$610,106
Central	$124,809,723	$5,773,126	$5,393,149	$276,994,643	$143,672,185	$146,380,743	$147,817,492
Eastern	$185,264,838	$8,472,733	$7,915,072	$563,370,759	$318,816,805	$263,927,711	$266,060,003
Pacific	$2,828,279	$128,458	$120,003	$20,460,443	$10,357,236	$10,398,881	$10,431,429
Southern	$140,183,098	$6,281,225	$5,867,806	$1,990,987,667	$1,252,043,769	$753,590,330	$755,203,238
Western	$95,685,192	$5,693,786	$5,319,031	$252,822,597	$131,327,431	$131,633,064	$132,739,616
Subtotal	**$550,741,543**	**$26,439,574**	**$24,699,368**	**$3,105,017,615**	**$1,856,217,570**	**$1,306,518,156**	**$1,312,861,883**
Drycleaning and Commercial Laundries							
Alaskan	$20,363	$3,291	$3,075	$6,992	$1	$9,356	$9,600
Central	$2,472,950	$410,674	$383,645	$3,748,206	$1,537,412	$2,499,157	$2,528,809
Eastern	$6,132,138	$1,054,962	$985,526	$9,594,795	$4,179,153	$6,134,352	$6,208,027

Table VIII.C.28. Total Costs of Proposed Standard by Industry Category and Region (2023$)

	One-Time	Periodic Costs Annualized		Annual	Cost Savings	Total Annualized [a]	
		0%	2%			0%	2%
Pacific	$60,013	$8,303	$7,757	$324,887	$154,506	$177,212	$177,925
Southern	$3,813,305	$622,595	$581,616	$23,397,552	$13,735,831	$10,105,311	$10,150,992
Western	$2,485,111	$447,179	$417,746	$3,716,313	$1,369,087	$2,640,455	$2,670,391
Subtotal	**$14,983,879**	**$2,547,005**	**$2,379,365**	**$40,788,745**	**$20,975,991**	**$21,565,843**	**$21,745,744**
Landscaping and Facilities Support							
Alaskan	$197,905	$9,247	$8,639	$57,613	$43	$78,285	$80,564
Central	$15,928,220	$910,565	$850,633	$52,336,359	$26,156,301	$27,863,936	$28,047,989
Eastern	$26,916,385	$1,487,495	$1,389,590	$122,773,476	$67,859,770	$57,754,094	$58,064,912
Pacific	$437,568	$23,090	$21,570	$4,330,295	$2,117,991	$2,258,370	$2,263,419
Southern	$20,065,797	$1,057,656	$988,043	$363,466,916	$223,153,028	$142,426,233	$142,657,739
Western	$15,235,305	$858,763	$802,240	$48,189,915	$22,716,571	$27,082,750	$27,258,747
Subtotal	**$78,781,181**	**$4,346,816**	**$4,060,716**	**$591,154,573**	**$342,003,705**	**$257,463,668**	**$258,373,369**
Maintenance and Repair							
Alaskan	$215,858	$26,776	$25,014	$67,597	$14	$91,847	$94,399
Central	$21,311,213	$2,695,519	$2,518,105	$37,119,880	$16,211,936	$23,308,617	$23,560,779
Eastern	$29,094,622	$3,559,615	$3,325,327	$64,302,224	$31,787,358	$35,780,290	$36,124,066
Pacific	$351,104	$42,847	$40,027	$1,479,871	$638,831	$880,434	$884,582
Southern	$24,302,282	$2,900,712	$2,709,792	$199,152,349	$119,019,773	$82,852,875	$83,139,736
Western	$16,832,123	$2,263,433	$2,114,457	$30,066,027	$12,222,844	$19,752,738	$19,952,439
Subtotal	**$92,107,202**	**$11,488,901**	**$10,732,722**	**$332,187,947**	**$179,880,757**	**$162,666,801**	**$163,756,002**
Manufacturing							
Alaskan	$208,090	$14,066	$13,141	$32,847	$44	$55,019	$57,432
Central	$46,722,857	$2,476,921	$2,313,895	$225,799,894	$134,580,429	$96,139,443	$96,678,557
Eastern	$49,352,278	$2,864,175	$2,675,660	$308,082,858	$193,954,812	$119,349,692	$119,920,136
Pacific	$275,775	$22,532	$21,049	$1,788,665	$931,985	$886,512	$889,725
Southern	$38,013,636	$2,135,219	$1,994,682	$830,736,198	$556,561,957	$278,189,127	$278,628,229
Western	$27,269,499	$2,028,785	$1,895,254	$86,192,896	$44,851,904	$44,270,821	$44,587,803
Subtotal	**$161,842,134**	**$9,541,698**	**$8,913,680**	**$1,452,633,359**	**$930,881,129**	**$538,890,613**	**$540,761,882**
Oil and Gas							
Alaskan	$230,784	$11,136	$10,403	$75,868	$53	$100,007	$102,665
Central	$5,254,963	$447,260	$417,823	$8,133,964	$3,324,037	$5,380,150	$5,441,459
Eastern	$2,946,199	$240,700	$224,857	$5,775,743	$2,726,288	$3,368,145	$3,402,478
Southern	$21,685,085	$1,640,611	$1,532,629	$245,969,418	$149,975,760	$98,326,228	$98,578,405
Western	$2,771,305	$239,669	$223,894	$4,717,343	$1,903,145	$3,115,295	$3,147,643
Subtotal	**$32,888,335**	**$2,579,376**	**$2,409,606**	**$264,672,336**	**$157,929,282**	**$110,289,825**	**$110,672,651**
Postal and Delivery Services							

Table VIII.C.28. Total Costs of Proposed Standard by Industry Category and Region (2023$)

	One-Time	Periodic Costs Annualized		Annual	Cost Savings	Total Annualized [a]	
		0%	2%			0%	2%
Alaskan	$223,989	$27,487	$25,678	$64,174	$2	$89,319	$91,966
Central	$10,250,664	$1,189,567	$1,111,272	$12,828,157	$4,937,878	$9,034,302	$9,155,164
Eastern	$13,819,885	$1,517,304	$1,417,437	$23,773,311	$11,087,251	$14,219,778	$14,382,377
Pacific	$144,635	$16,201	$15,134	$465,869	$185,834	$296,118	$297,821
Southern	$10,090,918	$1,136,067	$1,061,293	$58,865,833	$34,096,163	$25,892,369	$26,011,207
Western	$5,829,356	$736,437	$687,966	$9,319,823	$3,668,631	$6,307,770	$6,376,742
Subtotal	**$40,359,447**	**$4,623,062**	**$4,318,780**	**$105,317,166**	**$53,975,760**	**$55,839,656**	**$56,315,277**
Recreation and Amusement							
Alaskan	$210,864	$20,358	$19,018	$57,466	$3	$80,585	$83,055
Central	$9,811,950	$843,376	$787,866	$17,877,387	$7,852,494	$11,090,426	$11,204,934
Eastern	$15,803,455	$1,264,869	$1,181,617	$39,502,426	$19,982,691	$21,226,567	$21,410,624
Pacific	$200,532	$15,892	$14,846	$963,577	$406,550	$578,670	$581,005
Southern	$10,826,402	$823,464	$769,265	$122,043,421	$73,576,662	$49,631,746	$49,757,665
Western	$8,194,447	$700,718	$654,598	$18,758,186	$8,218,151	$11,429,552	$11,525,169
Subtotal	**$45,047,650**	**$3,668,678**	**$3,427,212**	**$199,202,463**	**$110,036,551**	**$94,037,545**	**$94,562,450**
Sanitation and Waste Removal							
Alaskan	$33,469	$2,039	$1,905	$9,981	$7	$13,525	$13,912
Central	$1,117,336	$84,368	$78,815	$3,783,722	$1,935,236	$1,968,656	$1,981,649
Eastern	$1,797,476	$120,671	$112,729	$8,449,281	$4,735,129	$3,905,966	$3,926,808
Pacific	$29,262	$1,783	$1,666	$305,303	$153,166	$155,241	$155,580
Southern	$1,367,533	$87,530	$81,769	$26,837,577	$16,888,684	$10,094,399	$10,110,239
Western	$831,250	$58,708	$54,844	$3,257,159	$1,581,133	$1,765,022	$1,774,672
Subtotal	**$5,176,326**	**$355,099**	**$331,727**	**$42,643,022**	**$25,293,354**	**$17,902,810**	**$17,962,860**
Telecommunications							
Alaskan	$64,849	$5,117	$4,780	$21,032	$14	$28,014	$28,769
Central	$3,579,895	$311,005	$290,535	$12,308,820	$6,509,796	$6,188,114	$6,229,906
Eastern	$5,274,999	$425,661	$397,645	$25,792,488	$14,993,199	$11,369,355	$11,430,805
Pacific	$59,652	$4,637	$4,332	$544,081	$280,645	$269,865	$270,559
Southern	$4,687,346	$373,919	$349,308	$79,412,836	$50,846,902	$29,072,061	$29,126,648
Western	$2,724,734	$260,838	$243,670	$9,652,087	$4,891,989	$5,058,656	$5,090,561
Subtotal	**$16,391,476**	**$1,381,178**	**$1,290,271**	**$127,731,345**	**$77,522,545**	**$51,986,066**	**$52,177,248**
Temporary Help Services							
Alaskan	$16,876	$1,220	$1,139	$4,988	$4	$6,794	$6,990
Central	$9,875,319	$230,862	$215,667	$51,592,972	$28,479,694	$24,123,896	$24,236,673
Eastern	$13,317,760	$325,305	$303,894	$112,624,291	$69,170,634	$44,817,963	$44,970,108
Pacific	$285,783	$3,117	$2,912	$4,508,995	$2,418,741	$2,119,144	$2,122,393

Table VIII.C.28. Total Costs of Proposed Standard by Industry Category and Region (2023$)

	One-Time	Periodic Costs Annualized		Annual	Cost Savings	Total Annualized [a]	
		0%	2%			0%	2%
Southern	$20,047,132	$276,225	$258,044	$713,170,489	$471,523,566	$243,679,259	$243,907,428
Western	$10,232,846	$198,451	$185,389	$61,162,815	$32,737,109	$29,468,836	$29,585,532
Subtotal	**$53,775,715**	**$1,035,180**	**$967,046**	**$943,064,551**	**$604,329,748**	**$344,215,893**	**$344,829,125**
Transportation							
Alaskan	$705,899	$65,875	$61,539	$204,688	$41	$281,825	$290,083
Central	$39,276,702	$4,098,420	$3,828,669	$55,353,625	$22,046,506	$37,644,631	$38,105,890
Eastern	$37,285,875	$3,738,797	$3,492,716	$69,982,708	$32,796,689	$41,288,487	$41,725,758
Pacific	$586,991	$46,755	$43,678	$3,804,184	$1,787,980	$2,079,579	$2,086,415
Southern	$39,677,412	$3,803,184	$3,552,865	$299,605,425	$175,255,496	$128,697,989	$129,162,606
Western	$17,327,009	$2,706,608	$2,528,464	$34,566,152	$15,385,219	$21,184,295	$21,391,375
Subtotal	**$134,859,888**	**$14,459,640**	**$13,507,932**	**$463,516,783**	**$247,271,929**	**$231,176,806**	**$232,762,128**
Utilities							
Alaskan	$148,444	$12,671	$11,837	$56,132	$17	$72,227	$73,959
Central	$7,146,656	$575,888	$537,984	$26,352,196	$13,657,174	$13,467,276	$13,550,526
Eastern	$9,587,651	$712,199	$665,323	$48,962,091	$27,538,893	$22,453,183	$22,564,626
Pacific	$62,534	$6,067	$5,668	$408,852	$201,198	$214,514	$215,247
Southern	$10,044,588	$839,241	$784,004	$157,131,720	$98,366,742	$59,853,362	$59,970,488
Western	$4,579,887	$434,070	$405,500	$16,308,986	$7,985,486	$8,824,896	$8,878,506
Subtotal	**$31,569,760**	**$2,580,136**	**$2,410,316**	**$249,219,978**	**$147,749,511**	**$104,885,457**	**$105,253,352**
Warehousing							
Alaskan	$23,861	$3,648	$3,407	$8,026	$1	$10,776	$11,060
Central	$5,061,913	$533,106	$498,018	$15,543,866	$8,175,173	$7,928,195	$7,987,661
Eastern	$7,009,792	$674,099	$629,731	$29,673,913	$17,101,945	$13,340,358	$13,422,450
Pacific	$61,662	$8,558	$7,994	$251,578	$110,383	$148,218	$148,950
Southern	$6,441,787	$661,753	$618,198	$81,655,479	$52,136,892	$30,228,941	$30,304,551
Western	$4,325,559	$500,559	$467,613	$11,931,088	$5,614,252	$6,799,447	$6,850,443
Subtotal	**$22,924,573**	**$2,381,722**	**$2,224,961**	**$139,063,951**	**$83,138,646**	**$58,455,935**	**$58,725,115**
Non-Core							
Alaskan	$5,182,429	$456,951	$426,875	$1,764,690	$644	$2,327,985	$2,388,511
Central	$391,224,691	$38,434,798	$35,905,088	$868,489,307	$403,322,044	$508,133,212	$512,718,138
Eastern	$667,495,610	$60,452,354	$56,473,487	$2,079,644,665	$1,107,489,644	$1,044,949,817	$1,052,751,986
Pacific	$9,892,196	$891,014	$832,369	$54,062,267	$24,745,067	$30,395,521	$30,511,129
Southern	$450,564,899	$48,351,398	$45,168,995	$3,787,838,223	$2,278,523,483	$1,559,206,369	$1,564,503,073
Western	$371,580,343	$38,699,763	$36,152,613	$906,764,875	$401,438,741	$546,354,145	$550,717,629
Subtotal	**$1,895,940,169**	**$187,286,279**	**$174,959,427**	**$7,698,564,027**	**$4,215,519,623**	**$3,691,367,049**	**$3,713,590,466**
Total							

Table VIII.C.28. Total Costs of Proposed Standard by Industry Category and Region (2023$)

	One-Time	Periodic Costs Annualized		Annual	Cost Savings	Total Annualized [a]	
		0%	2%			0%	2%
Alaskan	$10,459,352	$858,832	$802,306	$3,093,451	$1,069	$4,224,201	$4,346,103
Central	$781,525,250	$67,561,332	$63,114,565	$1,853,564,488	$912,457,660	$1,026,015,486	$1,035,137,646
Eastern	$1,178,819,653	$98,930,485	$92,419,056	$3,799,935,917	$2,079,382,329	$1,848,328,601	$1,862,076,179
Pacific	$17,291,605	$1,442,349	$1,347,416	$103,809,082	$49,156,476	$56,526,001	$56,727,623
Southern	$905,182,777	$80,937,580	$75,610,412	$9,992,060,191	$6,199,237,788	$3,891,434,439	$3,902,010,703
Western	$647,433,093	$63,782,331	$59,584,291	$1,649,953,684	$765,300,091	$955,775,136	$963,363,384
Total	**$3,540,711,730**	**$313,512,910**	**$292,878,045**	**$17,402,416,812**	**$10,005,535,413**	**$7,782,303,863**	**$7,823,661,638**

Source: OSHA estimate.

[a] The total costs with cost savings accounts for the potential labor productivity loss avoided by having more efficient and effective rest breaks required by the proposed standard than are currently taken.

Table VIII.C.29. Total Costs of the Proposed Standard by Provision (2023$)

Provision	One-Time	Periodic Costs Annualized		Annual	Costs Savings	Total Annualized [a]	
		0%	2%			0%	2%
Rule Familiarization	$153,433,817	$0	$0	$0	$0	$15,343,382	$17,081,254
Heat Injury and Illness Prevention Plan	$996,730,462	$0	$0	$173,783,056	$0	$273,456,102	$284,745,597
Identifying Heat Hazards	$71,768,226	$313,512,910	$292,878,045	$367,833,244	$0	$406,361,358	$408,428,047
Requirements at or above the Initial Heat Trigger	$563,572,187	$0	$0	$1,530,484,155	$87,542,404	$1,499,298,970	$1,505,682,286
Requirements at or above the High Heat Trigger	$4,451,329	$0	$0	$14,222,455,144	$9,917,993,009	$4,304,907,268	$4,304,957,686
Heat Illness and Emergency Response and Planning	$276,228,782	$0	$0	$626,032,515	$0	$653,655,393	$656,784,106
Training	$1,474,526,928	$0	$0	$481,828,698	$0	$629,281,391	$645,982,661
Total	**$3,540,711,730**	**$313,512,910**	**$292,878,045**	**$17,402,416,812**	**$10,005,535,413**	**$7,782,303,863**	**$7,823,661,638**

Source: OSHA estimate.

[a] The total costs with cost savings accounts for the potential labor productivity loss avoided by having more effective rest breaks required by the proposed standard than are currently taken.

VI. Sensitivity Analysis.

In this section, OSHA presents the results of five sensitivity analyses where isolated changes were made to the parameter (cost model inputs) assumptions that were used to estimate the total costs of the proposed standard. The methodology and calculations underlying the estimates of the costs are generally linear and additive in nature. Thus, the sensitivity of the results and conclusions of this analysis will generally be proportional to isolated variations of a particular input parameter. For example, if the estimated time that an employee spends in annual training was doubled, the corresponding labor costs would double as well.

OSHA evaluated a series of five such changes in cost input parameters to illustrate how these adjustments would impact the estimated total costs of the proposed standard. The requirements of the proposed standard work collectively to produce the benefit of avoided HRIs and heat-related fatalities. The agency is unable to directly attribute avoided HRIs and heat-related fatalities to any specific provision so is unable to analyze the impact that these isolated changes to parameters might have on benefits.

In the first of five sensitivity tests, OSHA decreased the estimated percentage of buildings with adequate cooling, which is an input into calculating the number of indoor in-scope firms and establishments. For this analysis, OSHA reduced the number of buildings that are cooled under an assumption that all employees work in areas that are adequately cooled only if at least 70 percent of their floorspace cooled (versus the assumption that this condition is met when at least 50 percent of the floorspace is cooled). OSHA used 60 percent of the percentage of buildings with 51 to 99 percent of floorspace cooled according to CBECS data for 2018 plus the percentage of buildings with 100 percent of floorspace cooled to estimate the percentage of establishments that are adequately cooled under this sensitivity analysis. For example, if the percentage of

buildings with 51 to 99 percent of floorspace cooled is 25 percent and the percentage of buildings with 100 percent of floorspace cooled is 50 percent, the estimate used in the primary cost analysis is 75 percent of buildings where all employees work in spaces that are adequately cooled, while the sensitivity analysis assumes that the percentage is 65 percent. Table VIII.C.30. shows that the estimated costs of compliance would increase costs by $585 million annually, or by about 7.5 percent.

In the second sensitivity test, OSHA decreased the estimated non-compliance rates (i.e., assumed higher baseline compliance) for rest breaks at both heat triggers by half. OSHA included this sensitivity test due to uncertainty surrounding the assumptions regarding the current provision of rest breaks by employers for non-heat related reasons (e.g., union contracts, existing State laws) that may result in an underestimate of baseline compliance. As a result of this adjustment, estimated annualized total costs decreased by nearly $2.1 billion annually, or approximately 27.0 percent (see table VIII.C.30.).

In the third sensitivity test, OSHA assumed that all employers without an existing HIIPP will opt to use the OSHA provided template to develop their HIIPP, rather than a portion of establishments opting to write a HIIPP from scratch. Table VIII.C.30. shows that this assumption would lower the estimate annualized costs by $7.8 million, or about 0.1 percent.

For the fourth sensitivity analysis, OSHA increased the estimated travel time to rest breaks by one minute for employees working indoors and two minutes for employees working outdoors, thus increasing travel time to 3 minutes for indoor employees and 6 minutes for outdoor employees. As shown in table VIII.C.30., the increase in travel time to rest breaks would increase estimated annualized costs by approximately $1.4 billion, or by about 18.1 percent.

The final sensitivity test looks at the percent of productivity recovered as a result of rest breaks. OSHA has incorporated the potential cost reduction from decreased

worker pacing—offsetting about 70 percent of the labor cost of rest breaks.[80] However, this analysis rests on specific assumptions and is dependent on the extent of the available literature, in which heat and productivity were assessed in different settings with different break policies, but break policies did not vary within the same setting. An alternative calculation, provided in appendix A, suggests that this offset may be even greater—up to 100 percent of the time spent for rest breaks being recovered through improved labor productivity.[81] Assuming that scheduled rest breaks offset pacing 100 percent for workers above the high heat trigger, the cost of this proposed standard would decrease by about $2.5 billion making the total costs around $7.8 – $2.5 = $5.3 billion.

OSHA welcomes input from the public regarding all aspects of this sensitivity analysis, including any data or information regarding the accuracy of the preliminary estimates of compliance costs and benefits and how the estimates of costs may be affected by varying assumptions and methodological approaches.

[80] See Section VIII.C.VI., Sensitivity Analysis for a discussion of potential underestimation of levels of current compliance with the rest break requirements of the proposed standard and the impacts alternative noncompliance rates might have on the estimated costs of the proposed standard.
[81] As described in the discussion of additional unquantified potential benefits, a reduction of pacing from increased rest breaks could potentially increase production and revenue.

Table VIII.C.30. Results from Sensitivity Analyses of Isolated Changes to Cost Model Parameters

Impact variable	OSHA's Primary Estimate	Sensitivity Test Assumption	Impact to Annualized Costs	Percentage Impact to Costs	Adjusted Annualized Costs
Percentage of buildings cooled by industry	Using CBECS data, considered all buildings with at least 51 percent of floorspace cooled as adequately cooled.	Using CBECS data, considered buildings with 70 percent of floorspace cooled as adequately cooled.	$585,344,087	7.48%	$8,409,005,725
Rest break non-compliance rates	As detailed in table VIII.C.3. Rest Break Non-Compliance Rates by State and Territory.	Reduce the rates in table VIII.C.3. Rest Break Non-Compliance Rates by State and Territory by 50 percent (i.e., assume higher baseline compliance).	-$2,113,058,097	-27.01%	$5,710,603,541
Percentage of establishments without existing HIIPP that will use OSHA template	90 percent of all employers with more than 10 employees, all employers with 10 or less employees.	100% of all employers	-$7,832,568	-0.10%	$7,815,829,070
Travel time to/from rest break area	2 minutes for indoor and 4 minutes for outdoor	3 minutes for indoor and 6 minutes for outdoor	$1,418,460,548	18.13%	$9,242,122,186
Recovered break time through improved productivity	~70% of break time offset by increased productivity	100% of break time offset by increased productivity	$2,500,000,000		$5,300,000,000

Source: OSHA estimate.

D. Economic Feasibility.

I. Introduction.

As explained in Section II., Pertinent Legal Authority, to demonstrate that a standard is economically feasible, "OSHA must construct a reasonable estimate of compliance costs and demonstrate a reasonable likelihood that these costs will not threaten the existence or competitive structure of an industry, even if it does portend disaster for some marginal firms." *Lead I*, 647 F.2d at 1272. OSHA standards therefore satisfy the economic feasibility criterion so long as they do not cause massive economic dislocations within a particular industry or imperil the very existence of the industry. *Lead II*, 939 F.2d at 980; see also *Asbestos I*, 499 F.2d. at 478.

In this feasibility analysis, when OSHA speaks of the costs of complying with the proposed standard as a percent of revenues, it is referring to the costs of complying with 29 CFR 1910.148 for the subset of those establishments that will incur obligations under the proposed standard, as opposed to the costs as a percent of *all* establishments in an industry, whether they are directly affected or not. This avoids underestimating the average per-establishment cost used in the feasibility analysis, even while it may overstate the impact on the industry as a whole. Based on the analysis below, OSHA preliminarily concludes that the proposed standard is economically feasible.

II. OSHA's Screening Test for Economic Feasibility.

To determine whether a standard is economically feasible, OSHA typically begins by using a screening test to determine whether the costs of the standard are beneath the threshold level at which the economic viability of an affected industry might be threatened. The screening test is a revenue test. While there is no firm rule on which to base the threshold, OSHA generally considers a standard to be economically feasible for an affected industry when the annualized costs of compliance are less than one percent of annual revenues for the average establishment in an industry that incurs an obligation.

The one-percent revenue threshold is intentionally set at a low level so that OSHA can confidently assert that the standard is economically feasible for industries that are below the threshold (i.e., industries for which the costs of compliance are less than one percent of annual revenues). To put the one percent threshold into perspective, across the wide swath of affected industries, prices (and therefore revenues), particularly in the recent past, are generally observed to change by considerably more than one percent per year.[82,83]

Another and less reliable screening test that OSHA traditionally used to consider whether a standard is economically feasible for an affected industry is whether the costs of compliance are less than ten percent of annual profits for the average establishment (see, e.g., OSHA's economic analysis of its 2016 *Occupational Exposure to Respirable Crystalline Silica* (Silica) rulemaking, 81 FR 16286, 16533 (Mar. 25, 2016); upheld in *N. Am.'s Bldg. Trades Unions v. OSHA*, 878 F.3d 271, 300 (D.C. Cir., 2017)). The ten-percent profit test was intended to be at a sufficiently low level to allow OSHA to identify industries that might require further examination. Specifically, the profit screening was primarily used to alert OSHA to potential impacts on industries where demand does not allow for ready absorption of new costs (e.g., industries with foreign competition where the American firms would incur costs that their foreign competitors would not because they are not subject to OSHA requirements). In addition, setting the threshold for the profit test low provided an additional basis for concluding that the standard would be economically feasible for industries below that threshold, without further evaluation. OSHA notes that this profit screen relied on accounting profit

[82] For data on Consumer Price Index (CPI) changes over time, see BLS's CPI website at *https://www.bls.gov/cpi/*.
[83] For data on Producer Price Index (PPI) changes over time, see BLS's PPI website at *https://www.bls.gov/ppi/*.

(revenues minus explicit costs) versus the superior profit measurement of economic profit (revenues minus explicit costs minus implicit costs).

For this proposed standard, OSHA has discontinued the use of its profit screening test for the following reasons. First, OSHA has been virtually alone among Federal agencies in consistently using a profitability test (comparing costs to profits) as part of its regulatory impact analyses. The agency could find no evidence that other Federal regulatory agencies are being asked to examine feasibility based on profits. OSHA infers that the silence on the use of the profitability test among all other Federal regulatory bodies implies that the revenue test is sufficient. Even OSHA's sister agency, the Mine Safety and Health Administration (MSHA), does not rely on a profitability test despite very similar statutory language that also requires an economic feasibility determination for its regulations.[84]

Secondly, eliminating the profit test avoids OSHA's reliance on published IRS corporate net income data that lack transparency, comprehensive coverage within industries, and statistical reliability for industries where sample sizes may be statistically inadequate. Furthermore, because firms typically have an incentive to minimize their tax burden, it is reasonable to expect that some of the reported accounting data may have been strategically adjusted to reduce reported profits and their associated tax implications. Business profits are much more likely to reflect such strategic accounting than business revenues. It is therefore unsurprising that OSHA is the lone outlier by including profit screens in its economic analysis. As the Environmental Protection Agency (EPA) noted in its economic impact analysis supporting the *National Air Emission Standards for Hazardous Air Pollutants: Halogenated Solvent Cleaning* (72 FR

[84] The Mine Act instructs the Secretary to "set standards which most adequately assure on the basis of the best available evidence that no miner will suffer material impairment of health or functional capacity." 30 U.S.C. 811(a)(6)(A). It goes on to say that "[i]n addition to the attainment of the highest degree of health and safety protection for the miner, other considerations shall be . . . the feasibility of the standards."

25138 (May 3, 2007))[85], when explaining its reliance on a "sales test" (revenue) and rejecting the use of industry profits as part of its determination of the impact of its regulation on small businesses, "revenues or sales data is commonly available data for entities normally impacted by EPA regulations and profits data normally made available is often not the true profits earned by firms due to accounting and tax considerations." EPA also noted that "firms and entities often have ways available in the tax code to reduce their reported profits; thus, using reported profits may lead to an overestimate of the economic impact of a regulation to an affected firm or entity and their consumers." OSHA is aware of no other publicly available source of business income data.

Even to the extent that firms are not manipulating profit data for tax purposes, profit data are often not accurately aligned with a firm's financial status for purposes of evaluating the economic impact of an OSHA standard. For example, a firm that had already invested a significant amount of capital to voluntarily adopt all of the controls proposed by OSHA's standard could show only marginal profit after accounting for those expenses, suggesting that it would be economically infeasible for that firm to comply with OSHA's standard. Yet, in reality, its ability to comply with OSHA's standard could not be questioned because compliance had already been accomplished.

OSHA is required to make its determinations on the best available evidence, and OSHA's experience has been that the profit screen has amounted to little more than a distraction that unhelpfully flags industries for time-consuming analyses, while not actually aiding the agency in identifying industries for which standards would be economically infeasible. For example, the profit screen can produce the unhelpful result of flagging industries with significant numbers of nonprofit or not-for-profit organizations, as well as failing (at least for tax purposes) enterprises reporting negative

[85] Available at *https://www.epa.gov/sites/default/files/2020-07/documents/halogenated-solvent_eia_neshap_final_05-2007.pdf.*

profits. The revenue screen is obviously more useful for evaluating the economic impact of the standard on such entities.

Another example of the inefficiency of the profit screen is that it often requires OSHA to manipulate data to adjust for the underlying limitations of the profit data sources to perform the screening analysis at all. If significant adjustments are necessary, the result becomes less meaningful. As a case in point, this proposed standard would affect nineteen 4-digit NAICS industries in the Agriculture, Forestry, Fishing and Hunting sector (NAICS 11). No profit data are available at the 4-digit level for any of the 19 industries, and, since 2013, about half of the profit data at the 3-digit level are missing. OSHA's traditional process for adjusting data to perform the profit screen is to substitute data from the next highest level of NAICS codes (focusing on a broader swath of industries). In order for OSHA to include these industries in a profit screen for this rulemaking, OSHA would have had to apply the 2-digit profit rate to all 19 industries, which are as different as logging and aquaculture with the result potentially flagging economic distress for one industry that is actually the result of more drastic economic problems in an entirely different industry (e.g., flagging impacts on aquaculture that would actually result from a decrease in logging profits).

OSHA also notes that it gathers additional information about potential economic impacts directly from small not-for-profit entities and small businesses as part of its compliance with the Small Business Regulatory Enforcement Fairness Act (SBREFA), discussed in more detail later in this analysis. OSHA is one of only a handful of agencies required to engage in this process, which along with the opportunity for public comment on proposed standards and the accompanying economic analysis, provides an additional avenue for the agency to identify potential significant economic impact not flagged via the revenue screen. Avoiding the red herrings produced by the profit screen allows the

agency to focus its resources on areas where the best evidence indicates that a standard may truly pose economic feasibility issues for an industry.

Third, compounding underlying issues with profit reporting is the reality that current IRS data are measurably different and inferior to pre-2013 IRS profit data because the more recent data are presented at a more aggregated level (e.g., at the 2-digit rather than 6-digit NAICS level). These changes to the IRS data make them incompatible with performing this type of screening analysis. Up to this point, where OSHA presented a profit screening analysis, the agency was relying on data from 2003 through 2013. At this point, it is difficult to assume that profit data from those years are meaningfully representative of current industry activity. Accordingly, revenues are a more accurate measure than profits for evaluating economic feasibility and those data are regularly collected and reported by agencies such as the Census Bureau. Therefore, the appropriate economic feasibility test will be the revenue test for most or all covered industries.

OSHA judges that the revenue test can stand alone in playing the signaling role that it has long served in tandem with the profit screen, given the latter's increasing unreliability. That is, a standard is not necessarily judged economically infeasible for the industries that do not pass the initial revenue screening test (i.e., those for which the costs of compliance with the standard are one percent or more of annual revenues) nor did previous OSHA analyses declare a standard infeasible based on one or more industries failing the profit screening test. Instead, OSHA normally views industries failing one or both tests as requiring additional examination as to whether the standard would be economically feasible (see *N. Am.'s Bldg. Trades Unions v. OSHA*, 878 F.3d at 297). OSHA therefore conducts further analysis of the industries that "fail" the screening tests to evaluate whether the standard would threaten the existence or competitive structure of those industries (see *United Steelworkers of Am., AFL-CIO-CLC v. Marshall*, 647 F.2d 1189, 1272 (D.C. Cir. 1980)) and the agency will continue to do so for industries that fail

the revenue screening test. There are fluctuations of prices over time with a general inflationary long-term trend upward, and they include effects such as the pass-through of costs and modifications in tax accounting procedures. Using the cost-to-profit test has never led to the conclusion that a standard will eliminate an industry or significantly alter its competitive structure, and as described above, that test is increasingly limited given the lack of data available. Instead, the revenue test is sufficient to signal to OSHA where it should look more carefully at one or more industries to assess feasibility.

III. Time Parameters for Analysis.

OSHA's economic analyses almost always measure the costs of a standard on an annual basis, conducting the screening tests by measuring the cost of the standard against the annual revenues for a given industry. One year is typically the minimum period for evaluating the status of a business; for example, most business filings for tax or financial purposes are annual in nature.

Some compliance costs are up-front costs and others are spread over the duration of compliance with the standard; regardless, the costs of the standard overall will not typically be incurred or absorbed by businesses all at once. For example, the initial capital costs for equipment that will be used over many years are typically addressed through installments over a year or more to leverage loans or payment options to allow more time to marshal revenue and minimize impacts on reserves.

This proposed standard would include permanent requirements to protect employees from hazards of heat stress in the workplace. Thus, for this proposed standard, OSHA has based its analysis of economic feasibility on annual costs and revenues. As noted earlier in this feasibility analysis, this is consistent with OSHA's typical methodology for analyzing economic feasibility (e.g., OSHA's final Silica rule, 81 FR 16533).

IV. Data Used for the Feasibility Screening Test.

OSHA presents the estimated costs of complying with this proposed standard in *Costs of Compliance* (Section VIII.C., Costs of Compliance) and table VIII.D.1. in this section presents a summary of those costs, including average cost per establishment and total annual costs, by 4-digit NAICS code. OSHA relies on these estimated costs in its examination of feasibility, using the test described above.

Most revenue numbers used to determine cost-to-revenue ratios were obtained from the 2017 SUSB (Census Bureau, 2021a). This is the most current information available from this source, which OSHA considers to be the best available source of revenue data for U.S. businesses. OSHA adjusted these figures to 2023 dollars using the Bureau of Economic Analysis's GDP deflator (BEA, n.d.), which is OSHA's standard source for inflation and deflation analysis (See Section VIII.C., Costs of Compliance for a full discussion of data sources and methodology). For industries that are unavailable in the SUSB dataset, OSHA sourced revenue data from a variety of other sources. These industries are listed below, along with the alternative sources and methods for estimating annual revenues.

Agriculture: As most agricultural industries are not included in the SUSB dataset,[86] OSHA used the Department of Agriculture's 2017 Census of Agriculture (USDA, 2017) to derive estimates of annual revenues. Specifically, OSHA used industry-level estimates of "total sales" from chapter 1, table 75 "Summary by North American Industry Classification System" to represent annual revenues. Since these "total sales" data are combined for Aquaculture (NAICS 1125) and Other Animal Production (NAICS 1129), OSHA based NAICS 1125 revenues on NOAA Fisheries' Aquaculture website, which estimated U.S. aquaculture production at $1.5 billion (NOAA, 2023a). For NAICS

[86] The NAICS industries that were estimated using this method are Oilseed and Grain Farming (111100), Vegetable and Melon Farming (111200), Fruit and Nut Tree Farming (111300), Greenhouse, Nursery, and Floriculture (111400), Other Crop Farming (111900), Cattle Ranch and Farming (112100), Hog and Pig Farming (112200), Poultry and Egg Production (112300), Sheep and Goat Farming (112400), Aquaculture (112500), and Other Animal Production (112900).

1129, OSHA subtracted this $1.5 billion from the Agriculture Census "total sales" estimate for NAICS 1125 and 1129. OSHA adjusted these figures to 2023 dollars using the BEA's GDP deflator.

Local Government: OSHA relied on data from three alternative sources for local government estimates. To estimate total receipts for local government entities, OSHA first estimated the average annual receipts per resident by State. The estimate was equal to the ratio of total local government receipts in the datasets found in the Census Bureau's 2021 Annual Survey of State and Local Government Finances (Census Bureau, 2023a) to the total population served in the GUS dataset. OSHA then multiplied the population associated with each government entity captured in the GUS with the ratio from step one to arrive at an estimate of total annual receipts per government entity.

State Government: OSHA used the State government revenues estimated in the Census Bureau's 2021 Annual Survey of State and Local Government Finances (Census Bureau, 2023a) to estimate annual receipts for State governments. For U.S. territories, OSHA used point estimates from other sources (American Samoa Department of Commerce, 2021; Guam Governor's Office, 2024; CNMI Department of Commerce, 2017; Financial Oversight and Management Board for Puerto Rico, 2023; USVI's Governor's Office, 2024). OSHA adjusted these figures to 2023 dollars using the BEA's GDP deflator.

Rail Transportation,[87] Postal Service, and Insurance and Employee Benefit Funds: A small subset of non-agricultural industries are also unavailable in the SUSB dataset. These industries are Rail Transportation (NAICS 4821), Postal and Delivery

[87] The FRA has promulgated regulations requiring the use of environmental controls to address heat hazards in three specific, limited contexts: non-steam-powered locomotives purchased or remanufactured after June 8, 2012 (49 CFR 229.119(g)), camp cars (49 CFR 228.313(c)), and certain on-track roadway maintenance machines (49 CFR 214.505(a)). OSHA's standard would apply to the working conditions of railroad employees in all other contexts, including within trains and machinery not covered by these regulations and during all outdoor work.

Services (NAICS 4911), and Insurance and Employment Benefit Funds (NAICS 5251). The economic data estimates for these three industries were derived from the Quarterly Census of Employment and Wages (QCEW) collected by the Bureau of Labor Statistics (BLS). While the QCEW does not present revenue data, it does include total annual wages by industry and State. OSHA used the ratio of receipts to wages from the SUSB dataset for corresponding sector-level data (e.g., the ratio applied to wage data for NAICS 5251 is based on receipts and wage data for sector 52 in the SUSB dataset) to convert the 2022 QCEW wage data (BLS, 2023f) into annual receipts by industry and State.

A large percentage of the costs of this proposed standard are variable costs because they depend primarily on the number and types of employees at an establishment. While fixed cost can be more limiting in terms of options for businesses, most of the costs of this standard are not fixed. Instead, most of the compliance costs vary with the level and type of output and employment at an establishment.

In general, "[w]hen an industry is subjected to a higher cost, it does not simply swallow it; it raises its price and reduces its output, and in this way shifts a part of the cost to its consumers and a part to its suppliers." *Am. Dental Ass'n v. Sec'y of Labor*, 984 F.2d 823, 829 (7th Cir., 1993). Increases in prices in industries with elastic demand typically result in reduced quantity demanded, but rarely eliminate all demand for the product. Increases in costs can also be passed along, but with a likely reduction in output.

A reduction in output could happen in a variety of ways: individual establishments could reduce their level of service or production, both of which take the form of a reduction of employee hours; some marginal establishments could close; or in the case of an industry with high turnover of establishments, new entry could be delayed until demand equals supply. In many cases, a decrease in overall output for an industry will be a combination of all three kinds of reductions. The primary means of achieving

the reduction in output most likely depends on the rate of turnover of establishments in the industry and on the form that the costs of the regulation take.

There are two situations typically mentioned when an industry subject to regulatory costs might be unable to pass those costs on: (1) foreign competition not subject to the regulation; or (2) domestic competition from other firms or other industries, not subject to the regulation, that produce goods or services that are close substitutes. Otherwise, when all affected domestic industries are covered by a standard and foreign businesses must also comply with the standard or are unable to compete effectively, the ability of a competing industry to offer a substitute product at a lower price is greatly diminished.

V. Factors that Indicate the Ability to Absorb or Pass on the Costs of the Proposed Standard.

As discussed above, when all establishments in an affected industry are covered by and required to comply with a standard, none of the competitors gain any economic advantage from the standard and the ability of a competitor to offer a substitute product or service at a lower price is greatly diminished. OSHA believes this is the case for the industries covered by the proposed standard. The scope of proposed 29 CFR 1910.148 is broad. The proposed standard applies, with certain exceptions, to each setting where any employee is exposed to heat above a specified threshold, with the result that if an employer enters such a setting, it must comply with the standard. Hence, given the proposed standard's broad applicability, any employer in a particular industry, including domestic competitors providing similar services or goods, would equally be subject to the proposed standard. This negates the potential for substitution by an industry not subject to the standard.

In addition, and as discussed below, OSHA has concluded that many employers that provide services affected by the proposed standard are generally not subject to

international competition (e.g., personal services, such as child care, healthcare services and healthcare support services, and building support services like landscaping and maintenance) because they must be performed domestically. Thus, for those industries, competition from foreign entities that would not also be subject to this proposed standard and its related costs is not a factor.

Finally, while OSHA has attempted to quantify the more obvious cost savings associated with compliance with the proposed standard, in terms of a wage cost offset from increased labor productivity, there are more subtle benefits to reducing heat stress, which suggests that the actual net costs of the proposed standard will be lower than the cost estimates in Section VIII.C., Costs of Compliance used to demonstrate economic feasibility. These cost savings are difficult to quantify and include increased labor supply and decreased disutility to employees. For additional discussion of this issue, see Section VIII.D., Benefits. The economic advantages of increasing the retention of employees by reducing peak heat stressors has been noted in numerous articles, and while difficult to quantify, would tend to counteract the relatively more obvious costs of intervention (e.g., Glaser et al., 2022).

VI. Economic Feasibility Screening Analysis.

This section summarizes OSHA's economic feasibility findings for specific industries covered by the proposed standard. As stated previously, the agency has historically used the two screening tests (costs less than one percent of revenue and costs less than ten percent of profit) as an initial indicator of economic feasibility; however, as discussed earlier, OSHA has discontinued use of the profit screening test because of its serious flaws. In this section, OSHA identifies and discusses the industries that fall above the threshold level for the revenue screening test. OSHA also identifies and discusses industries where small and very small industries fall above the threshold.

A. Economic Feasibility Screening Analysis: All Establishments.

Table VIII.D.1. shows that for the majority of industries, as defined by covered NAICS codes, the cost-to-revenue ratios are below OSHA's screening threshold of one percent, with an average cost for all 298 affected industries of 0.04 percent of revenues. This means that if the average firm needed to absorb the costs of the standard (rather than passing the costs through to other parties), this would amount to an additional four cent burden on $100 of revenue and suggests that compliance with this proposed standard would be feasible for all of these industries.

Five of the 298 industries are estimated to have costs equal to or greater than one percent of revenues. They are all in either agriculture or in-person health care or social assistance services. Two agricultural industries, Sheep and Goat Farming (NAICS 1124) and Other Animal Production (NAICS 1129) were found to have costs above one percent of revenues among affected establishments. Three health care and social assistance industries, Individual and Family Services (NAICS 6241), Vocational Rehabilitation Services (NAICS 6243), and Child Care Services (NAICS 6244) were also found to have costs above one percent of revenues.

Some industries, such as agriculture, would be expected to have relatively large impacts under the proposed standard, due to the prevalence of outdoor work. Nonetheless, the costs of their compliance with the proposed standard would not generally be expected to exceed one percent of revenues when all cost offsets (e.g., current practices to address heat hazards, productivity gains outside of rest breaks) are considered, based on available empirical evidence. For example, the Fair Food Program in Florida (Rivero and Uzcategui, 2024), which encompassed a number of labor benefits (e.g., wage bonuses) in addition to heat stress protection, resulted in price increases of

only one extra cent per pound of tomatoes[88], for a total average price of about $2 per pound,[89] to cover the cost of the protections and benefits to employees. This suggests that the net cost of robust heat illness protections may be less than 0.5 percent of revenues in an industry and geographic region that would be most significantly affected by the proposed standard. Sheep and Goat Farming (NAICS 1124) and Other Animal Production (NAICS 1129), which both have costs greater than one percent of revenues, are both heavily weighted to very small family-owned farms (USDA, 2019). Due to a Congressional budget rider, OSHA is not able to expend funds on enforcement activities for small farms. Only about 5 percent of sheep and goat farms are something other than family-owned farms (i.e., partnerships or corporations). The data for other animal production and aquaculture farms are combined and reported as a single industry. For those two industries combined, 10 percent of farms are something other than family-owned farms. Given the economies of scale necessary for aquaculture, it's likely that these account for more of the corporate farms in the combined Other Animal Production and Aquaculture data, meaning more farms in NAICS 1129 may be family-owned farms than appear to be in the combined data. Based on the 2017 Census of Agriculture (USDA, 2019), about 12,000 of about 93,000 total sheep and goat farms have hired labor and those have on average 2 hired laborers. For other animal production and aquaculture combined, about 41,000 farms out of about 222,000 total farms report having hired labor and have on average 3 hired laborers. Based on the size and organization of these farms, and because a longstanding appropriations rider generally prevents OSHA from enforcing its standards against most small farm operations with 10 or fewer employees, it is unlikely OSHA would enforce the proposed standard in those industries.

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[88] This measure is an increase in price, not costs. The pass through of costs could be less than 100 percent due to competition. However, since a portion of the one-cent premium is used to pay a worker bonus, one can infer that the increase in cost of compliance is likely less than one-cent and that pass-through of costs to firms is greater than 100 percent.

[89] As of December 2023, *https://fred.stlouisfed.org/series/APU0000712311*).

Aside from the issues discussed previously, the agency believes some of these industries are unlikely to have as large of a cost as a percentage of revenue as presented, in part due to inflexibility in the cost analysis regarding the amount of time spent outside in heat in a nondiscretionary manner. For example, even if the assumption that employees in healthcare or child care services spend a large percentage of their time outside is realistic under normal circumstances, these employees would likely limit their time outside in high heat situations if only to protect those in their care. This is also true in livestock industries that have existing recommendations for shade and shelter for livestock under extreme heat conditions.[90] If the costs of complying with this proposed standard were onerous, limiting employee exposure to the outdoors during times of extreme heat would be a costless method to comply with the standard and could possibly result in these employers being fully exempt from the standard (e.g., if the employer limited employee's outdoor exposure to meet the exemption for short duration employee exposure). OSHA believes that these five industries have estimated costs that exceed one percent of revenue as a result of data limitations, rather than a real finding of infeasibility. Therefore, OSHA has preliminarily determined that the proposed rule is economically feasible.

The agency welcomes public comment on what the likely practical effects of the proposed standard would be in these various industries. To the extent commenters believe the proposed standard poses an issue of economic feasibility, the agency welcomes comment on how the proposed standard should be modified to achieve greater feasibility.

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[90] USDA guidance for the livestock industry identifies provision of shelter, increased shade, and altering plans based on heat exposure (https://www.climatehubs.usda.gov/approach/manage-livestock-cope-warmer-and-drier-conditions). Similarly, South Dakota State University Extension recommends provision of shade during the day, minimization, or avoidance of unnecessary animal work during hot time periods, and adequate ventilation and air movement for indoor animal housing (https://extension.sdstate.edu/heat-stress-small-ruminants).

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
1111	Oilseed and Grain Farming	19,259	$22,566,188	$1,172	$1,039,788	0.11%
1112	Vegetable and Melon Farming	2,635	$13,812,142	$5,242	$1,435,990	0.37%
1113	Fruit and Tree Nut Farming	7,247	$20,428,950	$2,819	$887,377	0.32%
1114	Greenhouse, Nursery, and Floriculture Production	3,362	$17,437,825	$5,186	$922,741	0.56%
1119	Other Crop Farming	12,848	$22,027,652	$1,714	$334,120	0.51%
1121	Cattle Ranching and Farming	24,349	$41,972,826	$1,724	$884,209	0.19%
1122	Hog and Pig Farming	1,491	$3,582,128	$2,402	$3,692,579	0.07%
1123	Poultry and Egg Production	2,904	$6,619,341	$2,279	$3,595,687	0.06%
1124	Sheep and Goat Farming	1,995	$3,420,215	$1,714	$109,499	1.57%
1125	Aquaculture	208	$895,579	$4,301	$1,415,210	0.30%
1129	Other Animal Production	6,404	$11,346,005	$1,772	$143,632	1.23%
1131	Timber Tract Operations	498	$726,511	$1,459	$2,701,023	0.05%
1132	Forest Nurseries and Gathering of Forest Products	168	$179,247	$1,067	$1,164,036	0.09%
1133	Logging	8,084	$7,860,331	$972	$1,692,869	0.06%
1141	Fishing	2,473	$1,185,393	$479	$1,188,497	0.04%
1142	Hunting and Trapping	351	$374,292	$1,066	$799,221	0.13%
1151	Support Activities for Crop Production	5,049	$7,698,282	$1,525	$3,457,291	0.04%
1152	Support Activities for Animal Production	4,765	$3,734,295	$784	$724,524	0.11%
1153	Support Activities for Forestry	1,788	$1,775,204	$993	$1,311,774	0.08%
2111	Oil and Gas Extraction	6,382	$23,921,221	$3,748	$43,886,186	0.01%
2131	Support Activities for Mining	13,313	$79,841,646	$5,997	$7,972,536	0.08%
2211	Electric Power Generation, Transmission and Distribution	11,101	$80,690,106	$7,269	$45,828,657	0.02%
2212	Natural Gas Distribution	2,497	$12,578,004	$5,037	$40,786,387	0.01%
2213	Water, Sewage and Other Systems	4,879	$11,985,242	$2,456	$3,542,449	0.07%
2361	Residential Building Construction	173,182	$124,444,236	$719	$2,401,784	0.03%
2362	Nonresidential Building Construction	43,061	$97,309,378	$2,260	$13,006,470	0.02%
2371	Utility System Construction	19,159	$112,079,119	$5,850	$9,895,873	0.06%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
2372	Land Subdivision	4,943	$3,549,637	$718	$2,247,710	0.03%
2373	Highway, Street, and Bridge Construction	9,752	$43,581,038	$4,469	$15,724,180	0.03%
2379	Other Heavy and Civil Engineering Construction	4,324	$11,738,493	$2,715	$6,787,322	0.04%
2381	Foundation, Structure, and Building Exterior Contractors	93,258	$168,622,817	$1,808	$2,354,331	0.08%
2382	Building Equipment Contractors	184,768	$342,792,872	$1,855	$2,724,810	0.07%
2383	Building Finishing Contractors	116,519	$136,463,298	$1,171	$1,425,684	0.08%
2389	Other Specialty Trade Contractors	69,751	$97,414,741	$1,397	$2,689,361	0.05%
3111	Animal Food Manufacturing	895	$2,550,666	$2,850	$35,255,690	0.01%
3112	Grain and Oilseed Milling	369	$2,281,901	$6,192	$106,536,918	0.01%
3113	Sugar and Confectionery Product Manufacturing	941	$3,360,910	$3,574	$17,901,036	0.02%
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	916	$6,966,483	$7,605	$43,442,236	0.02%
3115	Dairy Product Manufacturing	801	$5,315,596	$6,640	$76,548,651	0.01%
3116	Animal Slaughtering and Processing	1,742	$28,278,302	$16,233	$72,789,500	0.02%
3117	Seafood Product Preparation and Packaging	270	$1,229,069	$4,561	$29,356,549	0.02%
3118	Bakeries and Tortilla Manufacturing	5,847	$16,243,920	$2,778	$6,816,984	0.04%
3119	Other Food Manufacturing	1,887	$9,779,813	$5,183	$33,613,908	0.02%
3121	Beverage Manufacturing	4,528	$9,124,037	$2,015	$14,142,707	0.01%
3122	Tobacco Manufacturing	69	$773,005	$11,285	$262,563,987	0.00%
3131	Fiber, Yarn, and Thread Mills	136	$2,067,055	$15,199	$31,396,792	0.05%
3132	Fabric Mills	386	$2,777,269	$7,204	$18,720,390	0.04%
3133	Textile and Fabric Finishing and Fabric Coating Mills	402	$1,843,098	$4,591	$10,606,110	0.04%
3141	Textile Furnishings Mills	818	$3,870,400	$4,734	$9,794,328	0.05%
3149	Other Textile Product Mills	2,022	$3,442,371	$1,702	$2,702,841	0.06%
3151	Apparel Knitting Mills	89	$523,876	$5,920	$6,382,954	0.09%
3152	Cut and Sew Apparel Manufacturing	2,480	$4,006,111	$1,616	$2,064,640	0.08%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
3159	Apparel Accessories and Other Apparel Manufacturing	286	$574,129	$2,011	$2,548,686	0.08%
3161	Leather and Hide Tanning and Finishing	78	$101,034	$1,304	$7,624,471	0.02%
3162	Footwear Manufacturing	112	$773,050	$6,902	$8,295,065	0.08%
3169	Other Leather and Allied Product Manufacturing	364	$444,901	$1,222	$2,105,457	0.06%
3211	Sawmills and Wood Preservation	1,634	$7,765,268	$4,752	$12,001,150	0.04%
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	670	$5,091,443	$7,605	$19,759,596	0.04%
3219	Other Wood Product Manufacturing	4,904	$16,287,680	$3,321	$5,998,996	0.06%
3221	Pulp, Paper, and Paperboard Mills	173	$6,568,365	$37,967	$235,901,294	0.02%
3222	Converted Paper Product Manufacturing	1,787	$12,244,762	$6,854	$34,990,870	0.02%
3231	Printing and Related Support Activities	12,693	$14,738,174	$1,161	$3,996,639	0.03%
3241	Petroleum and Coal Products Manufacturing	1,022	$8,724,306	$8,541	$267,378,536	0.00%
3251	Basic Chemical Manufacturing	1,144	$11,393,676	$9,964	$108,368,479	0.01%
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	681	$8,148,929	$11,966	$91,947,879	0.01%
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	440	$1,670,914	$3,798	$28,466,636	0.01%
3254	Pharmaceutical and Medicine Manufacturing	1,166	$12,270,203	$10,528	$109,652,940	0.01%
3255	Paint, Coating, and Adhesive Manufacturing	873	$4,187,636	$4,800	$29,510,337	0.02%
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	1,102	$5,589,291	$5,072	$37,391,152	0.01%
3259	Other Chemical Product and Preparation Manufacturing	1,093	$4,806,806	$4,398	$23,897,452	0.02%
3261	Plastics Product Manufacturing	5,149	$35,819,947	$6,957	$22,658,441	0.03%
3262	Rubber Product Manufacturing	880	$6,058,076	$6,888	$21,611,316	0.03%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
3271	Clay Product and Refractory Manufacturing	550	$2,002,058	$3,640	$8,078,807	0.05%
3272	Glass and Glass Product Manufacturing	815	$4,007,533	$4,917	$15,793,703	0.03%
3273	Cement and Concrete Product Manufacturing	4,404	$13,765,912	$3,126	$7,785,632	0.04%
3274	Lime and Gypsum Product Manufacturing	118	$725,364	$6,173	$26,805,595	0.02%
3279	Other Nonmetallic Mineral Product Manufacturing	1,585	$4,779,209	$3,016	$8,864,633	0.03%
3311	Iron and Steel Mills and Ferroalloy Manufacturing	268	$5,962,845	$22,291	$201,642,290	0.01%
3312	Steel Product Manufacturing from Purchased Steel	318	$3,034,850	$9,559	$38,589,534	0.02%
3313	Alumina and Aluminum Production and Processing	210	$2,605,926	$12,409	$61,726,946	0.02%
3314	Nonferrous Metal (except Aluminum) Production and Processing	389	$3,035,679	$7,804	$61,261,580	0.01%
3315	Foundries	796	$5,296,856	$6,654	$20,840,709	0.03%
3321	Forging and Stamping	1,141	$4,199,802	$3,682	$14,958,369	0.02%
3322	Cutlery and Handtool Manufacturing	558	$1,274,207	$2,286	$9,193,550	0.02%
3323	Architectural and Structural Metals Manufacturing	6,472	$23,411,603	$3,618	$8,360,234	0.04%
3324	Boiler, Tank, and Shipping Container Manufacturing	740	$4,557,414	$6,163	$24,162,652	0.03%
3325	Hardware Manufacturing	304	$1,285,814	$4,230	$16,750,859	0.03%
3326	Spring and Wire Product Manufacturing	555	$1,725,936	$3,110	$9,533,258	0.03%
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	11,346	$16,998,778	$1,498	$3,557,493	0.04%
3328	Coating, Engraving, Heat Treating, and Allied Activities	2,761	$7,251,052	$2,626	$5,616,834	0.05%
3329	Other Fabricated Metal Product Manufacturing	3,063	$12,570,102	$4,104	$12,315,179	0.03%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,422	$10,297,500	$7,242	$32,127,400	0.02%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
3332	Industrial Machinery Manufacturing	1,534	$4,564,312	$2,976	$12,175,393	0.02%
3333	Commercial and Service Industry Machinery Manufacturing	939	$3,136,561	$3,340	$15,121,049	0.02%
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	842	$7,964,382	$9,459	$29,965,620	0.03%
3335	Metalworking Machinery Manufacturing	3,159	$5,185,713	$1,642	$6,125,519	0.03%
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	441	$3,614,996	$8,197	$51,409,099	0.02%
3339	Other General Purpose Machinery Manufacturing	2,903	$13,233,407	$4,559	$19,613,189	0.02%
3341	Computer and Peripheral Equipment Manufacturing	449	$841,625	$1,877	$19,085,845	0.01%
3342	Communications Equipment Manufacturing	614	$2,801,459	$4,563	$31,095,928	0.01%
3343	Audio and Video Equipment Manufacturing	227	$293,740	$1,294	$6,807,492	0.02%
3344	Semiconductor and Other Electronic Component Manufacturing	1,900	$8,118,846	$4,273	$27,994,372	0.02%
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	2,520	$10,704,689	$4,248	$31,086,340	0.01%
3346	Manufacturing and Reproducing Magnetic and Optical Media	204	$198,879	$977	$4,335,534	0.02%
3351	Electric Lighting Equipment Manufacturing	501	$1,444,609	$2,886	$13,083,478	0.02%
3352	Household Appliance Manufacturing	125	$1,066,209	$8,530	$45,138,353	0.02%
3353	Electrical Equipment Manufacturing	995	$5,832,098	$5,861	$21,618,940	0.03%
3359	Other Electrical Equipment and Component Manufacturing	977	$4,726,132	$4,840	$22,536,250	0.02%
3361	Motor Vehicle Manufacturing	122	$1,085,733	$8,899	$454,487,339	0.00%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
3362	Motor Vehicle Body and Trailer Manufacturing	944	$8,246,263	$8,740	$29,205,076	0.03%
3363	Motor Vehicle Parts Manufacturing	2,425	$27,059,128	$11,161	$61,631,308	0.02%
3364	Aerospace Product and Parts Manufacturing	826	$12,167,578	$14,731	$93,792,988	0.02%
3365	Railroad Rolling Stock Manufacturing	104	$1,429,522	$13,812	$63,611,383	0.02%
3366	Ship and Boat Building	721	$11,788,451	$16,361	$21,809,920	0.08%
3369	Other Transportation Equipment Manufacturing	408	$1,037,801	$2,547	$15,117,084	0.02%
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	5,083	$13,274,090	$2,611	$4,297,730	0.06%
3372	Office Furniture (including Fixtures) Manufacturing	1,767	$5,200,805	$2,943	$7,971,335	0.04%
3379	Other Furniture Related Product Manufacturing	366	$1,792,138	$4,903	$15,572,532	0.03%
3391	Medical Equipment and Supplies Manufacturing	5,090	$13,095,541	$2,573	$10,884,255	0.02%
3399	Other Miscellaneous Manufacturing	8,780	$13,579,420	$1,547	$4,017,213	0.04%
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	2,351	$26,489,257	$11,269	$45,407,480	0.02%
4232	Furniture and Home Furnishing Merchant Wholesalers	1,298	$9,523,083	$7,336	$10,625,767	0.07%
4233	Lumber and Other Construction Materials Merchant Wholesalers	1,736	$13,456,090	$7,749	$13,371,930	0.06%
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	3,513	$25,485,899	$7,255	$20,295,064	0.04%
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	958	$8,692,950	$9,072	$27,671,464	0.03%
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	2,879	$28,074,222	$9,752	$27,451,825	0.04%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
4237	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers	1,951	$13,236,652	$6,783	$11,557,780	0.06%
4238	Machinery, Equipment, and Supplies Merchant Wholesalers	5,776	$58,234,641	$10,082	$11,596,411	0.09%
4239	Miscellaneous Durable Goods Merchant Wholesalers	3,188	$16,166,409	$5,071	$9,310,978	0.05%
4241	Paper and Paper Product Merchant Wholesalers	967	$8,226,081	$8,507	$19,885,243	0.04%
4242	Drugs and Druggists' Sundries Merchant Wholesalers	1,019	$14,966,530	$14,683	$110,821,278	0.01%
4243	Apparel, Piece Goods, and Notions Merchant Wholesalers	1,534	$8,083,432	$5,269	$13,145,411	0.04%
4244	Grocery and Related Product Merchant Wholesalers	3,517	$45,101,982	$12,823	$34,945,484	0.04%
4245	Farm Product Raw Material Merchant Wholesalers	613	$4,961,179	$8,089	$41,951,216	0.02%
4246	Chemical and Allied Products Merchant Wholesalers	1,223	$9,926,609	$8,115	$23,780,447	0.03%
4247	Petroleum and Petroleum Products Merchant Wholesalers	638	$6,705,416	$10,506	$203,610,923	0.01%
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	451	$11,640,093	$25,813	$43,026,015	0.06%
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	2,852	$20,258,440	$7,103	$15,167,514	0.05%
4251	Wholesale Trade Agents and Brokers	3,957	$15,142,900	$3,827	$21,159,691	0.02%
4411	Automobile Dealers	7,943	$70,381,781	$8,860	$26,031,796	0.03%
4412	Other Motor Vehicle Dealers	2,484	$10,727,937	$4,319	$6,684,856	0.06%
4413	Automotive Parts, Accessories, and Tire Retailers	10,382	$38,063,251	$3,666	$2,310,332	0.16%
4441	Building Material and Supplies Dealers	10,300	$26,774,594	$2,599	$5,880,598	0.04%
4442	Lawn and Garden Equipment and Supplies Retailers	3,493	$10,491,710	$3,003	$3,918,834	0.08%
4451	Grocery and Convenience Retailers	16,712	$111,429,709	$6,668	$8,142,684	0.08%
4452	Specialty Food Retailers	4,575	$10,190,815	$2,227	$2,565,311	0.09%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
4453	Beer, Wine, and Liquor Retailers	6,050	$7,676,768	$1,269	$2,103,423	0.06%
4491	Furniture and Home Furnishings Retailers	9,532	$20,849,798	$2,187	$3,437,969	0.06%
4492	Electronics and Appliance Retailers	5,359	$13,310,629	$2,484	$3,870,143	0.06%
4551	Department Stores	892	$11,243,234	$12,610	$17,685,253	0.07%
4552	Warehouse Clubs, Supercenters, and Other General Merchandise Retailers	9,875	$55,995,417	$5,670	$12,141,433	0.05%
4561	Health and Personal Care Retailers	17,607	$26,342,201	$1,496	$4,568,247	0.03%
4571	Gasoline Stations	18,856	$34,130,245	$1,810	$5,062,894	0.04%
4572	Fuel Dealers	1,393	$2,870,053	$2,061	$4,568,306	0.05%
4581	Clothing and Clothing Accessories Retailers	16,339	$44,247,522	$2,708	$2,473,681	0.11%
4582	Shoe Retailers	4,397	$9,190,469	$2,090	$2,227,506	0.09%
4583	Jewelry, Luggage, and Leather Goods Retailers	4,259	$6,611,743	$1,552	$2,704,423	0.06%
4591	Sporting Goods, Hobby, and Musical Instrument Retailers	7,353	$16,879,497	$2,296	$3,294,022	0.07%
4592	Book Retailers and News Dealers	1,515	$3,229,542	$2,131	$2,950,989	0.07%
4593	Florists	2,383	$4,426,367	$1,857	$1,442,716	0.13%
4594	Office Supplies, Stationery, and Gift Retailers	5,104	$10,013,108	$1,962	$2,084,249	0.09%
4595	Used Merchandise Retailers	3,668	$7,796,516	$2,126	$1,521,114	0.14%
4599	Other Miscellaneous Retailers	8,050	$15,263,208	$1,896	$2,640,719	0.07%
4811	Scheduled Air Transportation	1,901	$25,658,803	$13,497	$89,545,214	0.02%
4812	Nonscheduled Air Transportation	1,825	$4,628,067	$2,535	$11,544,951	0.02%
4821	Rail Transportation	119	$124,334	$1,041	$2,215,217	0.05%
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	877	$5,042,806	$5,750	$36,316,671	0.02%
4832	Inland Water Transportation	476	$3,118,127	$6,552	$11,566,749	0.06%
4841	General Freight Trucking	64,907	$89,062,119	$1,372	$3,024,850	0.05%
4842	Specialized Freight Trucking	42,255	$50,978,497	$1,206	$2,422,016	0.05%
4851	Urban Transit Systems	782	$1,541,702	$1,972	$5,727,178	0.03%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
4852	Interurban and Rural Bus Transportation	670	$1,142,712	$1,705	$3,183,166	0.05%
4853	Taxi and Limousine Service	6,647	$7,550,221	$1,136	$2,114,168	0.05%
4854	School and Employee Bus Transportation	3,712	$6,449,362	$1,737	$2,931,452	0.06%
4855	Charter Bus Industry	1,069	$1,792,372	$1,677	$3,278,126	0.05%
4859	Other Transit and Ground Passenger Transportation	4,351	$3,709,249	$852	$1,757,646	0.05%
4861	Pipeline Transportation of Crude Oil	649	$1,410,922	$2,174	$13,170,788	0.02%
4862	Pipeline Transportation of Natural Gas	1,812	$4,248,289	$2,345	$15,487,431	0.02%
4869	Other Pipeline Transportation	580	$1,250,571	$2,156	$14,063,673	0.02%
4871	Scenic and Sightseeing Transportation, Land	617	$1,320,235	$2,139	$2,100,659	0.10%
4872	Scenic and Sightseeing Transportation, Water	1,554	$3,274,995	$2,108	$1,392,280	0.15%
4879	Scenic and Sightseeing Transportation, Other	268	$510,004	$1,901	$2,851,407	0.07%
4881	Support Activities for Air Transportation	5,046	$22,255,588	$4,410	$5,491,720	0.08%
4882	Support Activities for Rail Transportation	1,293	$4,921,648	$3,806	$4,754,766	0.08%
4883	Support Activities for Water Transportation	2,258	$11,495,850	$5,092	$8,269,227	0.06%
4884	Support Activities for Road Transportation	10,553	$8,555,879	$811	$1,051,046	0.08%
4885	Freight Transportation Arrangement	18,079	$29,423,164	$1,627	$3,691,452	0.04%
4889	Other Support Activities for Transportation	1,434	$1,669,460	$1,165	$1,708,634	0.07%
4911	Postal Service	25,465	$28,299,988	$1,111	$5,242,980	0.02%
4921	Couriers and Express Delivery Services	8,360	$24,629,329	$2,946	$9,114,393	0.03%
4922	Local Messengers and Local Delivery	3,780	$3,385,960	$896	$1,707,066	0.05%
4931	Warehousing and Storage	14,274	$58,725,115	$4,114	$2,766,853	0.15%
5121	Motion Picture and Video Industries	3,012	$16,428,008	$5,454	$5,083,819	0.11%
5122	Sound Recording Industries	489	$1,147,515	$2,346	$4,484,294	0.05%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
5131	Newspaper, Periodical, Book, and Directory Publishers	3,052	$20,020,700	$6,559	$11,229,220	0.06%
5132	Software Publishers	1,821	$13,284,155	$7,296	$25,213,904	0.03%
5161	Radio and Television Broadcasting Stations	778	$9,163,332	$11,786	$8,807,054	0.13%
5162	Media Streaming Distribution Services, Social Networks, and Other Media Networks and Content Providers	533	$6,637,578	$12,460	$44,140,119	0.03%
5171	Wired and Wireless Telecommunications (except Satellite)	7,811	$49,672,322	$6,360	$12,522,782	0.05%
5174	Satellite Telecommunications	59	$491,286	$8,376	$14,838,437	0.06%
5178	All Other Telecommunications	358	$2,013,640	$5,620	$9,959,665	0.06%
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	2,409	$13,757,855	$5,712	$11,018,831	0.05%
5192	Web Search Portals, Libraries, Archives, and Other Information Services	611	$1,902,061	$3,111	$6,745,774	0.05%
5221	Depository Credit Intermediation	16,260	$66,680,457	$4,101	$5,815,480	0.07%
5222	Nondepository Credit Intermediation	6,274	$23,451,028	$3,738	$10,353,450	0.04%
5223	Activities Related to Credit Intermediation	3,968	$13,782,701	$3,473	$5,998,640	0.06%
5231	Securities and Commodity Contracts Intermediation and Brokerage	3,942	$12,199,622	$3,095	$10,423,406	0.03%
5232	Securities and Commodity Exchanges	4	$62,437	$13,904	$411,532,288	0.00%
5239	Other Financial Investment Activities	10,124	$23,123,395	$2,284	$5,472,042	0.04%
5241	Insurance Carriers	4,350	$35,116,961	$8,073	$74,913,679	0.01%
5242	Agencies, Brokerages, and Other Insurance Related Activities	20,264	$50,123,045	$2,474	$2,715,515	0.09%
5251	Insurance and Employee Benefit Funds	236	$527,154	$2,237	$3,562,001	0.06%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
5259	Other Investment Pools and Funds	123	$255,212	$2,079	$2,004,745	0.10%
5311	Lessors of Real Estate	17,809	$50,853,115	$2,855	$2,394,282	0.12%
5312	Offices of Real Estate Agents and Brokers	16,673	$36,947,635	$2,216	$1,136,243	0.20%
5313	Activities Related to Real Estate	13,274	$53,336,543	$4,018	$1,215,258	0.33%
5321	Automotive Equipment Rental and Leasing	2,256	$15,749,238	$6,981	$4,088,904	0.17%
5322	Consumer Goods Rental	2,693	$10,999,021	$4,085	$1,173,984	0.35%
5323	General Rental Centers	420	$1,665,083	$3,969	$1,486,508	0.27%
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	2,130	$13,168,084	$6,182	$5,500,482	0.11%
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	377	$1,245,184	$3,303	$19,386,258	0.02%
5411	Legal Services	25,571	$52,480,381	$2,052	$1,941,967	0.11%
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	18,287	$48,179,649	$2,635	$1,396,296	0.19%
5413	Architectural, Engineering, and Related Services	15,623	$174,866,256	$11,193	$3,312,024	0.34%
5414	Specialized Design Services	4,494	$13,137,406	$2,923	$931,984	0.31%
5415	Computer Systems Design and Related Services	19,606	$79,048,499	$4,032	$3,773,095	0.11%
5416	Management, Scientific, and Technical Consulting Services	24,060	$100,628,588	$4,182	$1,787,507	0.23%
5417	Scientific Research and Development Services	2,556	$33,102,069	$12,948	$10,398,760	0.12%
5418	Advertising, Public Relations, and Related Services	5,218	$30,433,443	$5,833	$3,373,336	0.17%
5419	Other Professional, Scientific, and Technical Services	9,861	$64,294,316	$6,520	$1,535,518	0.42%
5511	Management of Companies and Enterprises	7,687	$181,889,901	$23,662	$2,601,094	0.91%
5611	Office Administrative Services	4,694	$13,289,558	$2,831	$2,192,216	0.13%
5612	Facilities Support Services	928	$17,834,897	$19,228	$5,252,912	0.37%
5613	Employment Services	7,276	$344,829,125	$47,393	$8,776,960	0.54%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
5614	Business Support Services	4,372	$13,798,527	$3,156	$2,727,986	0.12%
5615	Travel Arrangement and Reservation Services	3,108	$6,673,364	$2,147	$2,592,365	0.08%
5616	Investigation and Security Services	3,513	$73,921,446	$21,042	$2,971,429	0.71%
5617	Services to Buildings and Dwellings	27,351	$173,828,441	$6,355	$922,181	0.69%
5619	Other Support Services	2,751	$17,358,050	$6,309	$2,809,043	0.22%
5621	Waste Collection	1,605	$5,725,756	$3,567	$5,516,059	0.06%
5622	Waste Treatment and Disposal	358	$2,044,381	$5,704	$6,960,982	0.08%
5629	Remediation and Other Waste Management Services	1,496	$10,192,723	$6,814	$3,165,201	0.22%
6111	Elementary and Secondary Schools	3,291	$40,472,071	$12,297	$4,413,940	0.28%
6112	Junior Colleges	120	$1,194,543	$9,970	$8,501,343	0.12%
6113	Colleges, Universities, and Professional Schools	661	$32,001,201	$48,400	$69,334,614	0.07%
6114	Business Schools and Computer and Management Training	1,248	$2,668,673	$2,138	$1,826,775	0.12%
6115	Technical and Trade Schools	1,228	$4,444,652	$3,619	$1,991,961	0.18%
6116	Other Schools and Instruction	7,639	$17,939,335	$2,348	$592,020	0.40%
6117	Educational Support Services	1,310	$3,196,265	$2,439	$2,241,261	0.11%
6211	Offices of Physicians	9,917	$25,952,877	$2,617	$2,598,098	0.10%
6212	Offices of Dentists	6,017	$16,631,978	$2,764	$1,123,388	0.25%
6213	Offices of Other Health Practitioners	6,967	$15,574,576	$2,235	$650,896	0.34%
6214	Outpatient Care Centers	2,008	$14,460,890	$7,201	$4,256,944	0.17%
6215	Medical and Diagnostic Laboratories	767	$4,775,293	$6,226	$3,788,420	0.16%
6216	Home Health Care Services	1,474	$39,821,728	$27,010	$3,024,173	0.89%
6219	Other Ambulatory Health Care Services	507	$6,057,721	$11,957	$4,132,554	0.29%
6221	General Medical and Surgical Hospitals	245	$65,020,765	$265,020	$218,034,685	0.12%
6222	Psychiatric and Substance Abuse Hospitals	27	$5,602,159	$207,993	$45,105,867	0.46%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	37	$3,694,704	$99,601	$61,909,640	0.16%
6231	Nursing Care Facilities (Skilled Nursing Facilities)	752	$35,736,039	$47,496	$8,679,090	0.55%
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	1,863	$22,918,890	$12,302	$1,273,215	0.97%
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	1,120	$26,868,839	$23,984	$3,060,931	0.78%
6239	Other Residential Care Facilities	227	$4,128,616	$18,174	$1,856,976	0.98%
6241	Individual and Family Services	3,329	$57,309,240	$17,218	$1,658,588	1.04%
6242	Community Food and Housing, and Emergency and Other Relief Services	650	$6,458,493	$9,929	$2,982,906	0.33%
6243	Vocational Rehabilitation Services	328	$7,785,986	$23,739	$2,100,542	1.13%
6244	Child Care Services	3,406	$61,315,616	$18,003	$652,479	2.76%
7111	Performing Arts Companies	4,832	$6,157,218	$1,274	$2,085,725	0.06%
7112	Spectator Sports	2,206	$5,962,390	$2,703	$12,928,871	0.02%
7113	Promoters of Performing Arts, Sports, and Similar Events	4,362	$8,735,781	$2,003	$4,539,819	0.04%
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	2,223	$2,215,936	$997	$2,365,997	0.04%
7115	Independent Artists, Writers, and Performers	15,379	$14,540,701	$945	$848,451	0.11%
7121	Museums, Historical Sites, and Similar Institutions	4,091	$7,846,087	$1,918	$3,102,080	0.06%
7131	Amusement Parks and Arcades	2,347	$15,577,978	$6,639	$5,344,729	0.12%
7132	Gambling Industries	1,638	$3,926,485	$2,398	$9,343,172	0.03%
7139	Other Amusement and Recreation Industries	39,654	$70,323,368	$1,773	$1,310,750	0.14%
7211	Traveler Accommodation	21,598	$63,177,043	$2,925	$5,123,987	0.06%
7212	RV (Recreational Vehicle) Parks and Recreational Camps	2,754	$2,698,715	$980	$1,029,528	0.10%

Table VIII.D.1. Economic Impacts on Establishments Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Establishments	Total Annualized Costs	Average Annualized Cost per Establishment	Average Revenue per Establishment	Costs as % of Revenue
7213	Rooming and Boarding Houses, Dormitories, and Workers' Camps	746	$791,148	$1,061	$994,545	0.11%
7223	Special Food Services	16,532	$29,428,448	$1,780	$1,586,703	0.11%
7224	Drinking Places (Alcoholic Beverages)	14,785	$14,060,549	$951	$739,078	0.13%
7225	Restaurants and Other Eating Places	210,896	$409,134,932	$1,940	$1,274,637	0.15%
8111	Automotive Repair and Maintenance	74,001	$126,236,663	$1,706	$873,479	0.20%
8112	Electronic and Precision Equipment Repair and Maintenance	5,811	$11,875,534	$2,044	$1,945,895	0.11%
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	9,972	$25,065,047	$2,514	$2,202,353	0.11%
8114	Personal and Household Goods Repair and Maintenance	9,830	$12,454,292	$1,267	$559,118	0.23%
8121	Personal Care Services	60,820	$71,616,377	$1,178	$360,641	0.33%
8122	Death Care Services	9,602	$18,086,417	$1,884	$1,109,180	0.17%
8123	Drycleaning and Laundry Services	15,411	$21,745,744	$1,411	$916,522	0.15%
8129	Other Personal Services	21,448	$31,265,564	$1,458	$691,008	0.21%
8131	Religious Organizations	84,819	$139,934,279	$1,650	$975,827	0.17%
8132	Grantmaking and Giving Services	9,147	$11,510,923	$1,258	$7,324,606	0.02%
8133	Social Advocacy Organizations	8,168	$11,803,888	$1,445	$2,343,993	0.06%
8134	Civic and Social Organizations	12,043	$18,907,950	$1,570	$859,416	0.18%
8139	Business, Professional, Labor, Political, and Similar Organizations	26,876	$37,917,962	$1,411	$2,057,484	0.07%
9992	State Government	8	$169,386,525	$20,359,760	$80,797,224,446	0.03%
9993	Local Government	5,172	$504,582,765	$97,561	$64,081,034	0.15%
Total		**2,535,774**	**$7,823,661,638**	**$3,085**	**$7,392,091**	**0.04%**

B. Economic Feasibility Screening Analysis: Small and Very Small Entities.

The preceding discussion focused on the economic viability of each affected industry in its entirety, including entities of all sizes. Even though OSHA has found that the proposed standard does not threaten the economic viability of these industries, the agency also examines whether there is still a possibility that the competitive structure of these industries could be significantly altered. For instance, in some industries, if most or all small firms in that industry would have to close, it could reasonably be concluded that the competitive structure of the industry had been affected by the proposed standard.

To address this possibility, OSHA examines the average compliance costs per affected small entity and very small entity for each industry covered under the final standard. See Section VIII.B., Profile of Affected Industries for a discussion of OSHA's methodology for estimating the number of small and very small entities.

As with its analysis of all establishments, the agency relies on a screening test—costs less than one percent of revenue—to evaluate the impacts on small and very small entities.[91] As with the screening tests for establishments of all sizes, in cases where the small and very small entities in particular industries are above the threshold level for the primary screening test, OSHA will investigate further.

OSHA notes that cost impacts for affected small or very small entities will generally tend to be somewhat higher, on average, than the cost impacts for the average business in those affected industries. That is to be expected. After all, smaller businesses typically suffer from diseconomies of scale in many aspects of their business, leading to lower revenue per dollar of cost and higher average costs. Small businesses are able to overcome these obstacles by providing specialized products and services, offering local

[91] The agency calculates the average per-entity revenues for small and very small entities in each NAICS industry in the same manner that it calculated the average per-establishment revenues for its analysis of all establishments, above.

service and better service, or otherwise creating a market niche for themselves. In a dynamic environment, they also tend to benefit from less institutional inertia. The higher cost impacts for smaller businesses estimated for this standard generally fall within the range observed in other OSHA standards, and OSHA is not aware of any record of major industry failures resulting from those standards.[92] For industries that are below the thresholds for the cost-to-revenue test, the agency concludes that the costs of complying with the proposed standard are unlikely to threaten the survival of small entities or very small entities and are, consequently, unlikely to alter the competitive structure of the affected industries.

As discussed further in Section VIII.F., Initial Regulatory Flexibility Analysis, the agency is required by the Regulatory Flexibility Act to determine whether a proposed standard would likely have a significant economic impact on a substantial number of small entities. As an extension of the feasibility screening analysis, the agency also performed a screening analysis of costs as a percentage of revenues of small entities. Table VIII.D.2. and table VIII.D.3. show that parallel to the previous analysis of costs as percent of average revenues for all establishments, for all but seven (out of 298) of the covered NAICS industries, the cost-to-revenue ratios are generally well below OSHA's screening threshold of one percent, suggesting that compliance with this standard would be feasible for small and very small entities in all of these industries. Since the impact is somewhat higher on average to small entities, two industries, Home Health Care Services (NAICS 6216) and Other Residential Care Facilities (NAICS 6239), had costs marginally above one percent, in addition to the five listed previously for the feasibility screening test for all establishments. A slightly different mix (four of 298) presents for Very Small

[92] For example, OSHA's economic analysis for the agency's 2016 Silica rule showed cost-to-revenue ratios as high as 1.29 percent for small entities and 2.09 percent for very small entities (see OSHA's *Final Economic and Regulatory Flexibility Analysis* for its Silica rule, chapter VI, tables VI-7 and VI-8, pp. VI-87-VI-94, Document ID OSHA-2010-0034-4247, attachment 6).

Entities, the two agriculture industries listed previously and two of the four health care and social service industries, Other Residential Care Facilities (NAICS 6239) and Child Care Services (NAICS 6244) having costs of more than one percent as a percent of revenues.

While the impacts are marginally greater for small entities, the general profile does not differ significantly from the issues with larger entities, suggesting that the proposed standard does not pose unique challenges for small entities. (This result is consistent with the costs being overwhelmingly employee based, as opposed to establishment based (see Section VIII.C., Costs of Compliance)).

Table VIII.D.2. shows that the estimated average cost of complying with the proposed standard for the average small entity in all industries covered by the standard is $1,946 annually, and table VIII.D.3. shows that the estimated average cost of the standard for the average very small entity is $1,178 annually.

The tables further show that for all small entities in covered NAICS industries, the cost-to-revenue ratios are below OSHA's one percent screening threshold, except for the seven industries previously discussed, suggesting that compliance with this proposed standard would be feasible for small entities in these industries.

As is typical with new requirements, the costs will be borne primarily by those businesses that have lagged in implementing safety measures. See *Lead I*, 647 F.2d at 1265 ("'It would appear to be consistent with the purposes of the [OSH] Act to envisage the economic demise of an employer who has lagged behind the rest of the industry in protecting the health and safety of employees and is consequently financially unable to comply with new standards as quickly as other employers.'") (quoting *Indus. Union Dep't, AFL-CIO v. Hodgson*, 499 F.2d 467, 478 (D.C. Cir. 1974)). Indeed, one of the main differentiations between businesses similarly situated in the same industry, where one would be exempt from this proposed standard while the other would not, would be in

situations where one employer has invested in air conditioning that keeps their facility below the heat trigger while the other has forgone those investments. The businesses that have already incurred many of the costs of compliance will presumably be at low risk of going out of business as a result of the standard. Even when small or very small entities in particular industries are above the revenue screening threshold, it would be very unlikely that this proposed standard would result in the alteration of the economic structure of these industries based on the failure of most or all of the small or very small entities in those industries.

Moreover, OSHA has considered input from SBA-defined small entities who participated in the SBREFA process, with regard to the potential provisions of a regulatory framework for a heat standard. OSHA's adjustments to the regulatory framework presented during the panel, along with a set of regulatory alternatives and options drafted and analyzed in response to recommendations from the SBAR Panel, are also discussed in Section VIII.F., Initial Regulatory Flexibility Analysis.

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
1111	Oilseed and Grain Farming	12,511	$13,585,428	$1,086	$759,359	0.14%
1112	Vegetable and Melon Farming	2,127	$9,980,549	$4,693	$1,153,664	0.41%
1113	Fruit and Tree Nut Farming	6,121	$14,284,547	$2,334	$682,745	0.34%
1114	Greenhouse, Nursery, and Floriculture Production	2,720	$12,359,299	$4,544	$741,146	0.61%
1119	Other Crop Farming	9,564	$15,497,239	$1,620	$282,465	0.57%
1121	Cattle Ranching and Farming	18,428	$28,781,484	$1,562	$700,078	0.22%
1122	Hog and Pig Farming	1,048	$2,182,612	$2,082	$2,601,611	0.08%
1123	Poultry and Egg Production	2,278	$4,700,946	$2,064	$2,939,009	0.07%
1124	Sheep and Goat Farming	1,548	$2,393,222	$1,546	$88,910	1.74%
1125	Aquaculture	160	$616,482	$3,859	$1,133,734	0.34%
1129	Other Animal Production	4,913	$7,999,112	$1,628	$115,067	1.41%
1131	Timber Tract Operations	442	$439,946	$996	$1,501,147	0.07%
1132	Forest Nurseries and Gathering of Forest Products	150	$152,566	$1,017	$790,399	0.13%
1133	Logging	7,980	$7,648,751	$958	$1,563,286	0.06%
1141	Fishing	2,432	$1,113,045	$458	$853,204	0.05%
1142	Hunting and Trapping	351	$374,292	$1,066	$799,221	0.13%
1151	Support Activities for Crop Production	4,648	$5,853,520	$1,259	$2,707,767	0.05%
1152	Support Activities for Animal Production	4,640	$3,376,198	$728	$506,802	0.14%
1153	Support Activities for Forestry	1,658	$1,398,749	$844	$1,111,045	0.08%
2111	Oil and Gas Extraction	5,307	$16,476,736	$3,105	$26,579,145	0.01%
2131	Support Activities for Mining	10,921	$43,981,568	$4,027	$3,821,423	0.11%
2211	Electric Power Generation, Transmission and Distribution	2,058	$28,171,559	$13,690	$76,221,412	0.02%
2212	Natural Gas Distribution	418	$3,527,573	$8,436	$70,106,856	0.01%
2213	Water, Sewage and Other Systems	3,668	$7,573,926	$2,065	$1,410,992	0.15%
2361	Residential Building Construction	171,099	$106,947,179	$625	$1,421,852	0.04%
2362	Nonresidential Building Construction	40,735	$62,520,995	$1,535	$6,719,320	0.02%
2371	Utility System Construction	16,774	$34,191,049	$2,038	$3,633,655	0.06%
2372	Land Subdivision	4,805	$3,170,977	$660	$1,877,172	0.04%
2373	Highway, Street, and Bridge Construction	8,285	$17,087,777	$2,062	$6,724,608	0.03%
2379	Other Heavy and Civil Engineering Construction	4,056	$6,569,839	$1,620	$3,024,764	0.05%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
2381	Foundation, Structure, and Building Exterior Contractors	91,279	$125,277,109	$1,372	$1,699,487	0.08%
2382	Building Equipment Contractors	177,612	$233,824,679	$1,316	$1,621,258	0.08%
2383	Building Finishing Contractors	114,496	$106,453,318	$930	$1,078,107	0.09%
2389	Other Specialty Trade Contractors	68,126	$72,672,079	$1,067	$1,929,027	0.06%
3111	Animal Food Manufacturing	636	$1,601,425	$2,520	$24,357,224	0.01%
3112	Grain and Oilseed Milling	250	$1,211,561	$4,854	$62,037,403	0.01%
3113	Sugar and Confectionery Product Manufacturing	868	$2,204,453	$2,539	$9,556,299	0.03%
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	743	$3,725,663	$5,016	$25,690,434	0.02%
3115	Dairy Product Manufacturing	588	$2,637,411	$4,484	$49,929,979	0.01%
3116	Animal Slaughtering and Processing	1,456	$12,280,924	$8,438	$38,292,294	0.02%
3117	Seafood Product Preparation and Packaging	221	$902,567	$4,087	$22,008,470	0.02%
3118	Bakeries and Tortilla Manufacturing	5,471	$11,517,147	$2,105	$3,818,211	0.06%
3119	Other Food Manufacturing	1,655	$5,268,917	$3,183	$16,374,321	0.02%
3121	Beverage Manufacturing	4,226	$6,542,557	$1,548	$8,758,819	0.02%
3122	Tobacco Manufacturing	58	$515,881	$8,848	$182,294,825	0.00%
3131	Fiber, Yarn, and Thread Mills	102	$1,037,014	$10,139	$19,374,286	0.05%
3132	Fabric Mills	345	$1,937,288	$5,609	$12,945,642	0.04%
3133	Textile and Fabric Finishing and Fabric Coating Mills	378	$1,346,267	$3,565	$7,871,921	0.05%
3141	Textile Furnishings Mills	769	$2,410,151	$3,134	$5,547,861	0.06%
3149	Other Textile Product Mills	1,981	$2,870,758	$1,449	$2,012,712	0.07%
3152	Cut and Sew Apparel Manufacturing	1,485	$1,708,817	$1,151	$907,132	0.13%
3159	Apparel Accessories and Other Apparel Manufacturing	279	$488,329	$1,750	$1,772,440	0.10%
3161	Leather and Hide Tanning and Finishing	75	$78,767	$1,048	$6,384,614	0.02%
3162	Footwear Manufacturing	102	$410,499	$4,029	$5,074,485	0.08%
3211	Sawmills and Wood Preservation	1,425	$5,001,937	$3,510	$7,582,835	0.05%
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	169	$1,273,144	$7,533	$21,682,868	0.03%
3219	Other Wood Product Manufacturing	4,412	$11,586,726	$2,626	$4,072,371	0.06%
3221	Pulp, Paper, and Paperboard Mills	35	$855,082	$24,193	$136,863,576	0.02%
3222	Converted Paper Product Manufacturing	1,264	$6,774,484	$5,360	$24,890,031	0.02%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3231	Printing and Related Support Activities	12,027	$11,573,349	$962	$2,522,782	0.04%
3241	Petroleum and Coal Products Manufacturing	464	$3,199,326	$6,895	$177,980,216	0.00%
3251	Basic Chemical Manufacturing	642	$4,655,288	$7,251	$78,530,261	0.01%
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	530	$4,077,855	$7,695	$52,682,176	0.01%
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	355	$1,140,904	$3,217	$18,940,264	0.02%
3254	Pharmaceutical and Medicine Manufacturing	925	$5,779,821	$6,251	$51,766,648	0.01%
3255	Paint, Coating, and Adhesive Manufacturing	705	$2,479,397	$3,516	$16,249,794	0.02%
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	1,002	$3,477,371	$3,470	$17,908,986	0.02%
3259	Other Chemical Product and Preparation Manufacturing	872	$2,542,871	$2,916	$12,165,378	0.02%
3261	Plastics Product Manufacturing	4,134	$19,980,060	$4,833	$13,921,131	0.03%
3262	Rubber Product Manufacturing	699	$3,192,709	$4,565	$12,772,546	0.04%
3271	Clay Product and Refractory Manufacturing	463	$1,199,726	$2,590	$5,587,274	0.05%
3272	Glass and Glass Product Manufacturing	706	$1,989,379	$2,819	$6,976,531	0.04%
3273	Cement and Concrete Product Manufacturing	2,173	$8,394,899	$3,863	$8,676,117	0.04%
3274	Lime and Gypsum Product Manufacturing	74	$303,318	$4,126	$15,209,592	0.03%
3279	Other Nonmetallic Mineral Product Manufacturing	1,369	$3,198,469	$2,336	$5,186,460	0.05%
3311	Iron and Steel Mills and Ferroalloy Manufacturing	191	$2,633,059	$13,753	$115,596,140	0.01%
3312	Steel Product Manufacturing from Purchased Steel	246	$1,720,852	$6,991	$28,374,263	0.02%
3313	Alumina and Aluminum Production and Processing	155	$1,282,335	$8,290	$35,439,130	0.02%
3314	Nonferrous Metal (except Aluminum) Production and Processing	309	$1,616,110	$5,227	$39,316,152	0.01%
3315	Foundries	691	$2,989,596	$4,329	$11,281,321	0.04%
3321	Forging and Stamping	991	$2,784,200	$2,810	$10,193,180	0.03%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3322	Cutlery and Handtool Manufacturing	529	$928,777	$1,755	$5,517,119	0.03%
3323	Architectural and Structural Metals Manufacturing	5,974	$16,517,707	$2,765	$5,735,883	0.05%
3324	Boiler, Tank, and Shipping Container Manufacturing	589	$2,689,023	$4,567	$12,577,513	0.04%
3325	Hardware Manufacturing	272	$770,518	$2,836	$8,866,155	0.03%
3326	Spring and Wire Product Manufacturing	492	$1,152,112	$2,340	$6,269,990	0.04%
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	11,032	$15,208,419	$1,379	$2,901,748	0.05%
3328	Coating, Engraving, Heat Treating, and Allied Activities	2,521	$5,835,961	$2,315	$4,178,955	0.06%
3329	Other Fabricated Metal Product Manufacturing	2,806	$7,766,243	$2,767	$7,493,462	0.04%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,247	$5,944,680	$4,766	$18,417,556	0.03%
3332	Industrial Machinery Manufacturing	425	$1,030,865	$2,425	$10,195,646	0.02%
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	699	$3,921,041	$5,609	$15,601,508	0.04%
3335	Metalworking Machinery Manufacturing	3,010	$4,202,594	$1,396	$4,357,322	0.03%
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	337	$1,582,741	$4,698	$25,365,617	0.02%
3339	Other General Purpose Machinery Manufacturing	1,762	$5,979,770	$3,394	$12,034,903	0.03%
3341	Computer and Peripheral Equipment Manufacturing	415	$490,089	$1,182	$8,911,705	0.01%
3342	Communications Equipment Manufacturing	547	$1,256,142	$2,294	$13,522,113	0.02%
3343	Audio and Video Equipment Manufacturing	219	$262,564	$1,198	$5,604,208	0.02%
3344	Semiconductor and Other Electronic Component Manufacturing	1,680	$4,552,187	$2,709	$13,079,398	0.02%
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	2,157	$4,626,878	$2,145	$12,820,769	0.02%
3352	Household Appliance Manufacturing	101	$332,021	$3,290	$14,304,913	0.02%
3353	Electrical Equipment Manufacturing	852	$2,906,501	$3,411	$10,715,020	0.03%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3359	Other Electrical Equipment and Component Manufacturing	752	$2,497,573	$3,319	$12,404,672	0.03%
3361	Motor Vehicle Manufacturing	23	$51,856	$2,260	$58,221,416	0.00%
3362	Motor Vehicle Body and Trailer Manufacturing	803	$4,874,596	$6,071	$15,741,094	0.04%
3363	Motor Vehicle Parts Manufacturing	1,978	$13,487,337	$6,817	$32,394,740	0.02%
3364	Aerospace Product and Parts Manufacturing	646	$3,977,519	$6,160	$29,941,829	0.02%
3365	Railroad Rolling Stock Manufacturing	74	$567,108	$7,707	$33,655,605	0.02%
3366	Ship and Boat Building	658	$7,118,392	$10,818	$14,164,896	0.08%
3369	Other Transportation Equipment Manufacturing	392	$641,075	$1,635	$6,718,062	0.02%
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	4,766	$9,401,064	$1,972	$2,859,010	0.07%
3372	Office Furniture (including Fixtures) Manufacturing	1,690	$3,989,090	$2,360	$5,125,287	0.05%
3379	Other Furniture Related Product Manufacturing	326	$1,166,170	$3,581	$8,591,445	0.04%
3391	Medical Equipment and Supplies Manufacturing	4,621	$7,495,312	$1,622	$4,733,183	0.03%
3399	Other Miscellaneous Manufacturing	8,582	$11,161,673	$1,301	$2,660,648	0.05%
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	1,544	$11,511,623	$7,456	$8,053,146	0.09%
4232	Furniture and Home Furnishing Merchant Wholesalers	1,077	$5,781,729	$5,367	$5,828,655	0.09%
4233	Lumber and Other Construction Materials Merchant Wholesalers	993	$5,631,821	$5,671	$6,885,143	0.08%
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	2,259	$10,168,859	$4,501	$5,929,082	0.08%
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	709	$4,763,004	$6,715	$13,288,617	0.05%
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	1,907	$11,364,290	$5,960	$8,540,329	0.07%
4237	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers	1,026	$5,820,745	$5,674	$6,361,789	0.09%
4238	Machinery, Equipment, and Supplies Merchant Wholesalers	4,033	$29,834,160	$7,398	$5,737,517	0.13%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4239	Miscellaneous Durable Goods Merchant Wholesalers	2,831	$10,561,663	$3,731	$5,222,434	0.07%
4241	Paper and Paper Product Merchant Wholesalers	717	$3,784,639	$5,277	$5,821,550	0.09%
4242	Drugs and Druggists' Sundries Merchant Wholesalers	662	$4,340,575	$6,561	$10,574,055	0.06%
4243	Apparel, Piece Goods, and Notions Merchant Wholesalers	386	$1,344,807	$3,483	$5,167,182	0.07%
4244	Grocery and Related Product Merchant Wholesalers	2,662	$15,934,090	$5,986	$10,630,078	0.06%
4245	Farm Product Raw Material Merchant Wholesalers	325	$2,641,457	$8,119	$23,756,996	0.03%
4246	Chemical and Allied Products Merchant Wholesalers	809	$4,315,458	$5,336	$8,980,738	0.06%
4247	Petroleum and Petroleum Products Merchant Wholesalers	376	$3,206,820	$8,522	$61,864,570	0.01%
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	326	$3,172,050	$9,724	$13,306,719	0.07%
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	2,124	$10,353,521	$4,876	$5,895,079	0.08%
4251	Wholesale Trade Agents and Brokers	3,749	$9,368,912	$2,499	$12,764,272	0.02%
4411	Automobile Dealers	6,500	$37,276,607	$5,735	$15,961,277	0.04%
4412	Other Motor Vehicle Dealers	955	$3,490,111	$3,656	$5,414,403	0.07%
4441	Building Material and Supplies Dealers	544	$1,021,683	$1,877	$2,831,193	0.07%
4451	Grocery and Convenience Retailers	6,886	$22,913,996	$3,328	$3,311,379	0.10%
4452	Specialty Food Retailers	1,180	$2,429,585	$2,059	$1,053,778	0.20%
4811	Scheduled Air Transportation	727	$10,339,037	$14,225	$97,899,634	0.01%
4812	Nonscheduled Air Transportation	1,637	$3,179,136	$1,942	$6,496,273	0.03%
4821	Rail Transportation	113	$78,448	$697	$1,132,927	0.06%
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	606	$2,154,113	$3,553	$16,994,169	0.02%
4832	Inland Water Transportation	410	$1,791,814	$4,371	$6,386,189	0.07%
4841	General Freight Trucking	55,843	$50,365,637	$902	$1,458,914	0.06%
4842	Specialized Freight Trucking	39,386	$41,886,506	$1,063	$1,812,364	0.06%
4851	Urban Transit Systems	513	$590,618	$1,151	$2,151,325	0.05%
4852	Interurban and Rural Bus Transportation	488	$896,937	$1,837	$2,488,321	0.07%
4853	Taxi and Limousine Service	6,453	$7,243,177	$1,122	$862,937	0.13%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4854	School and Employee Bus Transportation	2,232	$3,191,204	$1,430	$2,019,525	0.07%
4855	Charter Bus Industry	978	$1,507,466	$1,541	$2,813,587	0.05%
4859	Other Transit and Ground Passenger Transportation	3,856	$3,185,344	$826	$1,343,491	0.06%
4861	Pipeline Transportation of Crude Oil	70	$347,281	$4,984	$28,045,336	0.02%
4862	Pipeline Transportation of Natural Gas	59	$90,847	$1,528	$15,269,599	0.01%
4869	Other Pipeline Transportation	71	$269,120	$3,788	$22,870,110	0.02%
4871	Scenic and Sightseeing Transportation, Land	572	$1,034,717	$1,808	$1,542,634	0.12%
4872	Scenic and Sightseeing Transportation, Water	1,479	$2,781,692	$1,881	$961,471	0.20%
4879	Scenic and Sightseeing Transportation, Other	229	$354,470	$1,551	$1,442,518	0.11%
4881	Support Activities for Air Transportation	3,639	$7,427,615	$2,041	$2,726,627	0.07%
4882	Support Activities for Rail Transportation	494	$1,414,555	$2,861	$3,694,856	0.08%
4883	Support Activities for Water Transportation	1,852	$6,207,901	$3,353	$4,619,864	0.07%
4884	Support Activities for Road Transportation	9,012	$6,993,625	$776	$1,019,225	0.08%
4885	Freight Transportation Arrangement	12,925	$18,974,056	$1,468	$2,467,206	0.06%
4889	Other Support Activities for Transportation	1,387	$1,669,460	$1,203	$1,765,588	0.07%
4921	Couriers and Express Delivery Services	3,724	$12,926,412	$3,471	$9,170,589	0.04%
4922	Local Messengers and Local Delivery	3,431	$3,012,249	$878	$1,312,866	0.07%
4931	Warehousing and Storage	9,681	$56,004,514	$5,785	$3,692,460	0.16%
5121	Motion Picture and Video Industries	2,568	$7,638,794	$2,975	$1,544,741	0.19%
5122	Sound Recording Industries	466	$946,190	$2,032	$1,914,032	0.11%
5174	Satellite Telecommunications	46	$165,892	$3,602	$3,473,723	0.10%
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	1,352	$3,731,170	$2,759	$2,821,642	0.10%
5221	Depository Credit Intermediation	1,562	$21,857,409	$13,995	$15,334,364	0.09%
5222	Nondepository Credit Intermediation	1,085	$3,521,500	$3,245	$2,825,317	0.11%
5223	Activities Related to Credit Intermediation	1,822	$4,068,120	$2,232	$1,274,881	0.18%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5232	Securities and Commodity Exchanges	1	$26,178	$39,745	$753,808,884	0.01%
5239	Other Financial Investment Activities	1,542	$3,322,810	$2,154	$3,014,962	0.07%
5241	Insurance Carriers	724	$7,767,572	$10,729	$64,751,762	0.02%
5242	Agencies, Brokerages, and Other Insurance Related Activities	18,002	$37,871,610	$2,104	$884,543	0.24%
5251	Insurance and Employee Benefit Funds	161	$187,816	$1,164	$860,458	0.14%
5259	Other Investment Pools and Funds	122	$253,899	$2,075	$1,915,830	0.11%
5311	Lessors of Real Estate	13,445	$32,370,835	$2,408	$1,498,519	0.16%
5312	Offices of Real Estate Agents and Brokers	14,553	$27,775,521	$1,909	$848,299	0.22%
5313	Activities Related to Real Estate	10,787	$33,316,314	$3,088	$865,500	0.36%
5321	Automotive Equipment Rental and Leasing	567	$2,987,344	$5,267	$2,647,455	0.20%
5322	Consumer Goods Rental	1,185	$5,301,598	$4,475	$1,093,599	0.41%
5323	General Rental Centers	318	$1,344,257	$4,222	$1,436,198	0.29%
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	1,171	$5,466,318	$4,667	$3,114,198	0.15%
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	315	$671,532	$2,130	$3,900,891	0.05%
5411	Legal Services	23,897	$49,298,948	$2,063	$1,105,731	0.19%
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	15,652	$36,586,403	$2,338	$715,353	0.33%
5413	Architectural, Engineering, and Related Services	12,833	$75,874,312	$5,913	$1,482,804	0.40%
5414	Specialized Design Services	4,402	$11,949,232	$2,715	$783,080	0.35%
5415	Computer Systems Design and Related Services	16,220	$39,798,676	$2,454	$1,363,070	0.18%
5416	Management, Scientific, and Technical Consulting Services	22,491	$62,683,511	$2,787	$917,797	0.30%
5417	Scientific Research and Development Services	2,115	$15,224,604	$7,199	$5,734,418	0.13%
5418	Advertising, Public Relations, and Related Services	4,587	$16,632,694	$3,626	$1,610,062	0.23%
5419	Other Professional, Scientific, and Technical Services	8,774	$45,327,608	$5,166	$1,037,261	0.50%
5511	Management of Companies and Enterprises	932	$7,466,268	$8,009	$7,794,296	0.10%
5611	Office Administrative Services	4,204	$10,143,593	$2,413	$1,807,749	0.13%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5612	Facilities Support Services	296	$3,898,123	$13,148	$4,474,249	0.29%
5613	Employment Services	3,752	$42,559,048	$11,344	$2,963,924	0.38%
5614	Business Support Services	3,342	$5,943,802	$1,778	$1,306,752	0.14%
5615	Travel Arrangement and Reservation Services	1,972	$3,129,421	$1,587	$1,663,607	0.10%
5616	Investigation and Security Services	2,773	$25,002,454	$9,018	$1,245,244	0.72%
5617	Services to Buildings and Dwellings	26,019	$112,901,810	$4,339	$671,194	0.65%
5619	Other Support Services	2,399	$7,136,600	$2,975	$1,533,830	0.19%
5621	Waste Collection	1,078	$2,523,921	$2,342	$3,245,312	0.07%
5622	Waste Treatment and Disposal	181	$743,227	$4,112	$3,879,488	0.11%
5629	Remediation and Other Waste Management Services	1,259	$6,361,525	$5,055	$2,114,365	0.24%
6111	Elementary and Secondary Schools	2,856	$34,194,636	$11,975	$4,338,191	0.28%
6112	Junior Colleges	61	$567,155	$9,272	$7,096,235	0.13%
6113	Colleges, Universities, and Professional Schools	178	$641,408	$3,603	$3,148,365	0.11%
6114	Business Schools and Computer and Management Training	1,150	$2,051,773	$1,785	$1,184,543	0.15%
6115	Technical and Trade Schools	1,020	$3,125,752	$3,063	$1,475,233	0.21%
6116	Other Schools and Instruction	7,124	$15,777,099	$2,215	$471,098	0.47%
6117	Educational Support Services	1,184	$2,055,225	$1,736	$994,278	0.17%
6211	Offices of Physicians	7,538	$16,396,965	$2,175	$1,557,548	0.14%
6212	Offices of Dentists	5,517	$15,448,753	$2,800	$1,107,348	0.25%
6213	Offices of Other Health Practitioners	5,985	$13,236,859	$2,212	$610,067	0.36%
6214	Outpatient Care Centers	799	$6,631,683	$8,303	$3,531,393	0.24%
6215	Medical and Diagnostic Laboratories	326	$1,639,918	$5,023	$2,880,366	0.17%
6216	Home Health Care Services	1,021	$21,196,909	$20,756	$1,947,504	1.07%
6219	Other Ambulatory Health Care Services	290	$2,399,519	$8,280	$2,122,696	0.39%
6221	General Medical and Surgical Hospitals	58	$3,146,213	$54,588	$31,988,544	0.17%
6222	Psychiatric and Substance Abuse Hospitals	10	$1,136,474	$118,967	$26,840,059	0.44%
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	6	$408,435	$64,547	$24,345,151	0.27%
6231	Nursing Care Facilities (Skilled Nursing Facilities)	377	$15,692,040	$41,623	$7,737,051	0.54%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	454	$12,424,041	$27,345	$2,746,969	1.00%
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	779	$13,425,442	$17,232	$2,104,725	0.82%
6239	Other Residential Care Facilities	136	$3,155,732	$23,216	$2,165,006	1.07%
6241	Individual and Family Services	2,496	$39,826,256	$15,956	$1,571,030	1.02%
6242	Community Food and Housing, and Emergency and Other Relief Services	480	$5,254,947	$10,949	$2,633,784	0.42%
6243	Vocational Rehabilitation Services	172	$4,469,310	$25,964	$2,335,393	1.11%
6244	Child Care Services	2,687	$51,565,482	$19,189	$676,561	2.84%
7111	Performing Arts Companies	4,679	$5,483,031	$1,172	$1,560,279	0.08%
7112	Spectator Sports	2,011	$2,409,683	$1,198	$2,328,568	0.05%
7113	Promoters of Performing Arts, Sports, and Similar Events	4,046	$5,398,753	$1,334	$2,099,056	0.06%
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	2,119	$2,111,109	$996	$1,445,877	0.07%
7115	Independent Artists, Writers, and Performers	15,342	$14,460,165	$942	$835,413	0.11%
7121	Museums, Historical Sites, and Similar Institutions	3,845	$6,836,964	$1,778	$2,394,793	0.07%
7131	Amusement Parks and Arcades	1,742	$3,288,557	$1,888	$1,040,189	0.18%
7132	Gambling Industries	1,000	$2,273,300	$2,272	$5,012,918	0.05%
7139	Other Amusement and Recreation Industries	34,659	$51,264,046	$1,479	$1,051,729	0.14%
7211	Traveler Accommodation	17,375	$32,853,003	$1,891	$2,184,689	0.09%
7212	RV (Recreational Vehicle) Parks and Recreational Camps	2,543	$2,405,045	$946	$991,813	0.10%
7213	Rooming and Boarding Houses, Dormitories, and Workers' Camps	687	$741,076	$1,079	$930,215	0.12%
7223	Special Food Services	7,295	$8,312,585	$1,139	$857,031	0.13%
7224	Drinking Places (Alcoholic Beverages)	14,383	$13,061,680	$908	$663,521	0.14%
7225	Restaurants and Other Eating Places	157,253	$276,972,590	$1,761	$1,144,923	0.15%
8111	Automotive Repair and Maintenance	62,789	$100,273,474	$1,597	$798,630	0.20%

Table VIII.D.2. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	8,982	$14,997,313	$1,670	$1,261,858	0.13%
8114	Personal and Household Goods Repair and Maintenance	9,417	$11,449,589	$1,216	$455,661	0.27%
8121	Personal Care Services	52,932	$64,529,881	$1,219	$346,123	0.35%
8122	Death Care Services	6,955	$13,214,986	$1,900	$1,130,650	0.17%
8123	Drycleaning and Laundry Services	13,051	$16,733,433	$1,282	$564,862	0.23%
8129	Other Personal Services	16,792	$22,209,398	$1,323	$509,230	0.26%
8131	Religious Organizations	83,837	$126,171,312	$1,505	$722,894	0.21%
8132	Grantmaking and Giving Services	7,839	$8,889,289	$1,134	$3,473,007	0.03%
8133	Social Advocacy Organizations	6,903	$8,993,435	$1,303	$1,442,084	0.09%
8134	Civic and Social Organizations	11,030	$15,706,906	$1,424	$697,379	0.20%
8139	Business, Professional, Labor, Political, and Similar Organizations	25,710	$33,664,444	$1,309	$1,384,987	0.09%
9993	Local Government	4,846	$132,114,558	$27,261	$17,292,921	0.16%
Total		**1,985,235**	**$3,863,384,856**	**$1,946**	**$2,403,819**	**0.08%**

Source: OSHA estimate.

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
1111	Oilseed and Grain Farming	7,184	$6,027,437	$839	$609,184	0.14%
1112	Vegetable and Melon Farming	1,227	$3,233,900	$2,636	$705,291	0.37%
1113	Fruit and Tree Nut Farming	3,060	$4,119,361	$1,346	$384,931	0.35%
1114	Greenhouse, Nursery, and Floriculture Production	1,545	$4,149,308	$2,686	$513,448	0.52%
1119	Other Crop Farming	5,537	$6,434,964	$1,162	$198,860	0.58%
1121	Cattle Ranching and Farming	10,474	$11,742,592	$1,121	$523,461	0.21%
1122	Hog and Pig Farming	585	$921,175	$1,575	$2,022,974	0.08%
1123	Poultry and Egg Production	1,356	$2,018,022	$1,488	$2,264,037	0.07%
1124	Sheep and Goat Farming	856	$968,612	$1,131	$59,994	1.89%
1125	Aquaculture	91	$239,911	$2,630	$875,290	0.30%
1129	Other Animal Production	2,806	$3,272,814	$1,166	$88,841	1.31%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
1131	Timber Tract Operations	429	$403,940	$942	$1,293,445	0.07%
1132	Forest Nurseries and Gathering of Forest Products	144	$104,419	$725	$679,386	0.11%
1133	Logging	7,530	$6,292,246	$836	$1,170,494	0.07%
1141	Fishing	2,416	$1,100,212	$455	$667,346	0.07%
1142	Hunting and Trapping	331	$292,626	$885	$619,029	0.14%
1151	Support Activities for Crop Production	4,102	$3,213,003	$783	$1,530,220	0.05%
1152	Support Activities for Animal Production	4,531	$2,962,939	$654	$405,439	0.16%
1153	Support Activities for Forestry	1,534	$1,037,673	$676	$765,904	0.09%
2111	Oil and Gas Extraction	4,571	$6,341,178	$1,387	$2,574,156	0.05%
2131	Support Activities for Mining	8,845	$14,462,495	$1,635	$937,066	0.17%
2211	Electric Power Generation, Transmission and Distribution	832	$2,254,730	$2,709	$13,316,386	0.02%
2212	Natural Gas Distribution	267	$546,792	$2,049	$10,690,728	0.02%
2213	Water, Sewage and Other Systems	3,468	$5,937,995	$1,712	$850,747	0.20%
2361	Residential Building Construction	167,394	$90,561,837	$541	$1,043,976	0.05%
2362	Nonresidential Building Construction	34,810	$32,498,908	$934	$2,948,013	0.03%
2371	Utility System Construction	13,929	$14,564,718	$1,046	$1,657,874	0.06%
2372	Land Subdivision	4,615	$2,626,758	$569	$1,167,179	0.05%
2373	Highway, Street, and Bridge Construction	6,251	$5,486,633	$878	$2,619,746	0.03%
2379	Other Heavy and Civil Engineering Construction	3,581	$3,418,173	$954	$1,444,677	0.07%
2381	Foundation, Structure, and Building Exterior Contractors	83,470	$72,226,262	$865	$936,942	0.09%
2382	Building Equipment Contractors	161,684	$141,354,524	$874	$847,521	0.10%
2383	Building Finishing Contractors	108,028	$74,449,281	$689	$653,438	0.11%
2389	Other Specialty Trade Contractors	62,342	$43,480,559	$697	$1,039,609	0.07%
3111	Animal Food Manufacturing	377	$349,776	$928	$5,316,620	0.02%
3112	Grain and Oilseed Milling	130	$273,983	$2,115	$22,940,721	0.01%
3113	Sugar and Confectionery Product Manufacturing	652	$541,708	$831	$1,163,232	0.07%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	441	$532,718	$1,207	$3,760,308	0.03%
3115	Dairy Product Manufacturing	337	$456,581	$1,353	$9,285,097	0.01%
3116	Animal Slaughtering and Processing	996	$872,620	$876	$2,401,951	0.04%
3117	Seafood Product Preparation and Packaging	129	$107,828	$838	$3,136,053	0.03%
3118	Bakeries and Tortilla Manufacturing	4,379	$4,017,779	$918	$635,675	0.14%
3119	Other Food Manufacturing	1,111	$1,075,034	$968	$2,724,529	0.04%
3121	Beverage Manufacturing	3,429	$2,263,370	$660	$1,398,536	0.05%
3122	Tobacco Manufacturing	32	$42,411	$1,311	$6,587,893	0.02%
3131	Fiber, Yarn, and Thread Mills	60	$75,096	$1,254	$2,191,371	0.06%
3132	Fabric Mills	192	$233,984	$1,217	$3,435,732	0.04%
3133	Textile and Fabric Finishing and Fabric Coating Mills	263	$271,517	$1,031	$1,915,018	0.05%
3141	Textile Furnishings Mills	630	$573,335	$910	$780,741	0.12%
3149	Other Textile Product Mills	1,705	$1,270,778	$745	$614,109	0.12%
3151	Apparel Knitting Mills	54	$66,320	$1,228	$1,443,320	0.09%
3152	Cut and Sew Apparel Manufacturing	2,095	$1,429,596	$682	$637,842	0.11%
3159	Apparel Accessories and Other Apparel Manufacturing	236	$188,102	$796	$619,537	0.13%
3161	Leather and Hide Tanning and Finishing	61	$42,671	$698	$2,839,687	0.02%
3162	Footwear Manufacturing	75	$123,351	$1,655	$2,193,374	0.08%
3169	Other Leather and Allied Product Manufacturing	302	$187,558	$621	$626,299	0.10%
3211	Sawmills and Wood Preservation	1,006	$1,185,132	$1,179	$1,727,380	0.07%
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	264	$633,617	$2,400	$4,044,768	0.06%
3219	Other Wood Product Manufacturing	3,327	$3,257,167	$979	$1,053,722	0.09%
3221	Pulp, Paper, and Paperboard Mills	27	$376,078	$13,794	$93,208,301	0.01%
3222	Converted Paper Product Manufacturing	559	$893,086	$1,597	$4,579,693	0.03%
3231	Printing and Related Support Activities	10,124	$5,790,603	$572	$693,094	0.08%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3241	Petroleum and Coal Products Manufacturing	244	$494,702	$2,027	$28,484,143	0.01%
3251	Basic Chemical Manufacturing	277	$556,651	$2,011	$21,892,698	0.01%
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	226	$335,765	$1,485	$6,835,167	0.02%
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	229	$350,781	$1,534	$7,269,726	0.02%
3254	Pharmaceutical and Medicine Manufacturing	546	$603,519	$1,106	$3,960,913	0.03%
3255	Paint, Coating, and Adhesive Manufacturing	448	$542,317	$1,211	$3,140,147	0.04%
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	704	$655,288	$931	$2,390,628	0.04%
3259	Other Chemical Product and Preparation Manufacturing	579	$723,101	$1,250	$3,072,599	0.04%
3261	Plastics Product Manufacturing	2,192	$2,911,100	$1,328	$2,782,966	0.05%
3262	Rubber Product Manufacturing	382	$557,177	$1,459	$2,487,702	0.06%
3271	Clay Product and Refractory Manufacturing	328	$323,850	$989	$1,473,179	0.07%
3272	Glass and Glass Product Manufacturing	539	$546,405	$1,014	$1,791,588	0.06%
3273	Cement and Concrete Product Manufacturing	1,336	$1,655,935	$1,240	$2,456,404	0.05%
3274	Lime and Gypsum Product Manufacturing	51	$122,726	$2,409	$7,351,270	0.03%
3279	Other Nonmetallic Mineral Product Manufacturing	1,006	$1,149,905	$1,143	$1,653,776	0.07%
3311	Iron and Steel Mills and Ferroalloy Manufacturing	103	$218,406	$2,121	$6,567,240	0.03%
3312	Steel Product Manufacturing from Purchased Steel	121	$265,350	$2,191	$7,339,261	0.03%
3313	Alumina and Aluminum Production and Processing	82	$262,328	$3,197	$12,497,676	0.03%
3314	Nonferrous Metal (except Aluminum) Production and Processing	178	$278,430	$1,566	$8,757,990	0.02%
3315	Foundries	391	$547,296	$1,398	$2,192,210	0.06%
3321	Forging and Stamping	556	$557,664	$1,003	$2,020,339	0.05%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3322	Cutlery and Handtool Manufacturing	373	$259,248	$695	$1,107,327	0.06%
3323	Architectural and Structural Metals Manufacturing	4,125	$4,085,887	$991	$1,456,833	0.07%
3324	Boiler, Tank, and Shipping Container Manufacturing	300	$423,339	$1,409	$3,917,337	0.04%
3325	Hardware Manufacturing	186	$153,954	$828	$1,511,537	0.05%
3326	Spring and Wire Product Manufacturing	298	$292,858	$983	$1,589,842	0.06%
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	8,812	$6,785,989	$770	$910,823	0.08%
3328	Coating, Engraving, Heat Treating, and Allied Activities	1,740	$1,753,611	$1,008	$985,271	0.10%
3329	Other Fabricated Metal Product Manufacturing	1,998	$2,026,136	$1,014	$1,910,855	0.05%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	776	$880,986	$1,135	$2,303,225	0.05%
3332	Industrial Machinery Manufacturing	951	$827,287	$870	$1,790,885	0.05%
3333	Commercial and Service Industry Machinery Manufacturing	602	$467,902	$777	$1,741,883	0.04%
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	409	$485,787	$1,186	$2,390,594	0.05%
3335	Metalworking Machinery Manufacturing	2,174	$1,503,816	$692	$1,172,111	0.06%
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	186	$279,911	$1,504	$4,514,698	0.03%
3339	Other General Purpose Machinery Manufacturing	1,576	$1,782,884	$1,131	$2,828,012	0.04%
3341	Computer and Peripheral Equipment Manufacturing	317	$181,009	$570	$2,040,422	0.03%
3342	Communications Equipment Manufacturing	374	$275,245	$735	$2,213,015	0.03%
3343	Audio and Video Equipment Manufacturing	180	$98,831	$548	$1,509,740	0.04%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3344	Semiconductor and Other Electronic Component Manufacturing	991	$740,401	$747	$1,810,399	0.04%
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1,411	$961,637	$682	$2,280,952	0.03%
3346	Manufacturing and Reproducing Magnetic and Optical Media	158	$80,247	$509	$869,333	0.06%
3351	Electric Lighting Equipment Manufacturing	321	$290,904	$906	$2,228,223	0.04%
3352	Household Appliance Manufacturing	73	$67,216	$915	$1,907,392	0.05%
3353	Electrical Equipment Manufacturing	543	$585,477	$1,078	$2,265,967	0.05%
3359	Other Electrical Equipment and Component Manufacturing	530	$775,438	$1,462	$4,923,782	0.03%
3361	Motor Vehicle Manufacturing	72	$42,019	$586	$8,079,095	0.01%
3362	Motor Vehicle Body and Trailer Manufacturing	462	$571,401	$1,237	$2,128,388	0.06%
3363	Motor Vehicle Parts Manufacturing	1,140	$1,248,555	$1,096	$2,450,442	0.04%
3364	Aerospace Product and Parts Manufacturing	368	$569,759	$1,550	$4,750,992	0.03%
3365	Railroad Rolling Stock Manufacturing	32	$104,712	$3,303	$12,137,746	0.03%
3366	Ship and Boat Building	446	$605,519	$1,357	$1,347,324	0.10%
3369	Other Transportation Equipment Manufacturing	321	$258,348	$804	$1,487,253	0.05%
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	4,244	$3,437,887	$810	$718,130	0.11%
3372	Office Furniture (including Fixtures) Manufacturing	1,162	$1,046,524	$901	$1,149,394	0.08%
3379	Other Furniture Related Product Manufacturing	216	$288,388	$1,337	$2,340,433	0.06%
3391	Medical Equipment and Supplies Manufacturing	3,950	$2,735,349	$693	$758,887	0.09%
3399	Other Miscellaneous Manufacturing	7,399	$5,215,239	$705	$801,390	0.09%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	1,257	$4,993,354	$3,973	$3,303,747	0.12%
4232	Furniture and Home Furnishing Merchant Wholesalers	910	$3,110,498	$3,417	$2,854,446	0.12%
4233	Lumber and Other Construction Materials Merchant Wholesalers	785	$2,505,110	$3,193	$3,557,039	0.09%
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	1,916	$5,577,568	$2,912	$2,405,983	0.12%
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	556	$2,106,984	$3,790	$6,228,340	0.06%
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	1,576	$5,580,492	$3,542	$3,369,434	0.11%
4237	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers	816	$2,636,524	$3,230	$2,796,763	0.12%
4238	Machinery, Equipment, and Supplies Merchant Wholesalers	3,312	$15,267,247	$4,610	$2,896,468	0.16%
4239	Miscellaneous Durable Goods Merchant Wholesalers	2,551	$6,358,104	$2,492	$2,832,277	0.09%
4241	Paper and Paper Product Merchant Wholesalers	610	$2,004,758	$3,287	$2,995,604	0.11%
4242	Drugs and Druggists' Sundries Merchant Wholesalers	563	$1,888,913	$3,356	$4,020,123	0.08%
4243	Apparel, Piece Goods, and Notions Merchant Wholesalers	1,248	$3,098,845	$2,483	$2,808,295	0.09%
4244	Grocery and Related Product Merchant Wholesalers	2,242	$7,359,247	$3,283	$4,893,717	0.07%
4245	Farm Product Raw Material Merchant Wholesalers	266	$1,240,969	$4,671	$11,316,686	0.04%
4246	Chemical and Allied Products Merchant Wholesalers	676	$2,375,082	$3,516	$5,030,093	0.07%
4247	Petroleum and Petroleum Products Merchant Wholesalers	263	$1,242,062	$4,718	$20,772,751	0.02%
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	243	$763,626	$3,147	$3,176,806	0.10%
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	1,870	$6,010,140	$3,215	$2,900,974	0.11%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4251	Wholesale Trade Agents and Brokers	3,577	$7,395,194	$2,068	$8,758,811	0.02%
4411	Automobile Dealers	4,702	$9,420,631	$2,004	$3,255,236	0.06%
4412	Other Motor Vehicle Dealers	1,853	$4,518,777	$2,439	$2,697,277	0.09%
4413	Automotive Parts, Accessories, and Tire Retailers	4,859	$11,159,040	$2,297	$1,134,410	0.20%
4441	Building Material and Supplies Dealers	5,693	$7,059,545	$1,240	$1,614,974	0.08%
4442	Lawn and Garden Equipment and Supplies Retailers	2,502	$5,016,485	$2,005	$1,498,082	0.13%
4451	Grocery and Convenience Retailers	10,521	$16,794,972	$1,596	$1,054,320	0.15%
4452	Specialty Food Retailers	3,551	$5,729,397	$1,613	$900,891	0.18%
4453	Beer, Wine, and Liquor Retailers	5,163	$5,975,343	$1,157	$1,325,671	0.09%
4491	Furniture and Home Furnishings Retailers	6,010	$8,962,736	$1,491	$1,223,523	0.12%
4492	Electronics and Appliance Retailers	3,217	$4,908,069	$1,525	$1,030,417	0.15%
4551	Department Stores	148	$190,770	$1,287	$1,621,586	0.08%
4552	Warehouse Clubs, Supercenters, and Other General Merchandise Retailers	2,556	$3,419,681	$1,338	$842,471	0.16%
4561	Health and Personal Care Retailers	7,776	$9,533,570	$1,226	$1,791,759	0.07%
4571	Gasoline Stations	10,327	$15,498,593	$1,501	$2,804,858	0.05%
4572	Fuel Dealers	649	$1,060,755	$1,635	$2,693,189	0.06%
4581	Clothing and Clothing Accessories Retailers	5,967	$8,712,135	$1,460	$698,207	0.21%
4582	Shoe Retailers	1,010	$1,421,801	$1,408	$1,020,151	0.14%
4583	Jewelry, Luggage, and Leather Goods Retailers	2,976	$3,898,966	$1,310	$1,079,268	0.12%
4591	Sporting Goods, Hobby, and Musical Instrument Retailers	5,150	$7,074,290	$1,374	$864,136	0.16%
4592	Book Retailers and News Dealers	774	$988,633	$1,278	$744,295	0.17%
4593	Florists	2,213	$3,540,277	$1,600	$494,498	0.32%
4594	Office Supplies, Stationery, and Gift Retailers	3,317	$4,621,207	$1,393	$627,443	0.22%
4595	Used Merchandise Retailers	2,352	$3,240,613	$1,378	$608,402	0.23%
4599	Other Miscellaneous Retailers	5,911	$8,732,908	$1,477	$1,042,423	0.14%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4811	Scheduled Air Transportation	278	$293,355	$1,054	$3,080,504	0.03%
4812	Nonscheduled Air Transportation	1,285	$1,286,819	$1,001	$2,040,509	0.05%
4821	Rail Transportation	96	$51,361	$536	$399,619	0.13%
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	455	$544,184	$1,196	$2,200,414	0.05%
4832	Inland Water Transportation	323	$453,643	$1,403	$1,350,810	0.10%
4841	General Freight Trucking	51,643	$37,499,799	$726	$861,013	0.08%
4842	Specialized Freight Trucking	35,020	$26,650,522	$761	$892,912	0.09%
4851	Urban Transit Systems	373	$312,637	$839	$839,880	0.10%
4852	Interurban and Rural Bus Transportation	332	$422,567	$1,274	$833,268	0.15%
4853	Taxi and Limousine Service	5,931	$6,596,898	$1,112	$473,725	0.23%
4854	School and Employee Bus Transportation	1,444	$1,578,496	$1,093	$381,438	0.29%
4855	Charter Bus Industry	663	$764,143	$1,152	$976,121	0.12%
4859	Other Transit and Ground Passenger Transportation	3,097	$2,381,262	$769	$514,988	0.15%
4861	Pipeline Transportation of Crude Oil	27	$34,499	$1,282	$5,687,521	0.02%
4862	Pipeline Transportation of Natural Gas	59	$90,847	$1,528	$15,269,599	0.01%
4869	Other Pipeline Transportation	29	$37,586	$1,288	$4,867,763	0.03%
4871	Scenic and Sightseeing Transportation, Land	474	$570,363	$1,203	$670,486	0.18%
4872	Scenic and Sightseeing Transportation, Water	1,385	$2,109,958	$1,524	$589,761	0.26%
4879	Scenic and Sightseeing Transportation, Other	208	$272,900	$1,311	$812,572	0.16%
4881	Support Activities for Air Transportation	2,961	$3,481,748	$1,176	$1,058,641	0.11%
4882	Support Activities for Rail Transportation	315	$430,553	$1,366	$1,603,240	0.09%
4883	Support Activities for Water Transportation	1,396	$1,914,888	$1,372	$1,256,551	0.11%
4884	Support Activities for Road Transportation	8,222	$6,121,945	$745	$687,092	0.11%
4885	Freight Transportation Arrangement	11,283	$15,674,157	$1,389	$1,583,872	0.09%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4889	Other Support Activities for Transportation	1,202	$1,095,829	$912	$799,155	0.11%
4921	Couriers and Express Delivery Services	3,125	$2,811,195	$900	$843,986	0.11%
4922	Local Messengers and Local Delivery	2,990	$2,455,403	$821	$741,162	0.11%
4931	Warehousing and Storage	3,555	$3,599,514	$1,012	$1,301,304	0.08%
5121	Motion Picture and Video Industries	2,383	$4,673,631	$1,962	$903,851	0.22%
5122	Sound Recording Industries	445	$780,716	$1,754	$660,025	0.27%
5131	Newspaper, Periodical, Book, and Directory Publishers	1,936	$4,503,697	$2,326	$816,692	0.28%
5132	Software Publishers	1,057	$2,023,518	$1,915	$1,268,517	0.15%
5161	Radio and Television Broadcasting Stations	370	$1,470,235	$3,969	$662,207	0.60%
5162	Media Streaming Distribution Services, Social Networks, and Other Media Networks and Content Providers	235	$560,991	$2,388	$1,346,479	0.18%
5171	Wired and Wireless Telecommunications (except Satellite)	942	$1,900,994	$2,018	$1,249,302	0.16%
5174	Satellite Telecommunications	40	$86,847	$2,157	$1,745,466	0.12%
5178	All Other Telecommunications	287	$502,736	$1,753	$1,126,736	0.16%
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	1,112	$2,196,650	$1,976	$1,171,961	0.17%
5192	Web Search Portals, Libraries, Archives, and Other Information Services	468	$867,704	$1,853	$507,510	0.37%
5221	Depository Credit Intermediation	637	$1,709,643	$2,682	$1,711,700	0.16%
5222	Nondepository Credit Intermediation	1,654	$3,919,691	$2,369	$1,191,143	0.20%
5223	Activities Related to Credit Intermediation	1,718	$3,212,716	$1,870	$758,941	0.25%
5231	Securities and Commodity Contracts Intermediation and Brokerage	1,349	$2,298,865	$1,704	$1,235,568	0.14%
5232	Securities and Commodity Exchanges	0	$19,633	$39,745	$753,808,884	0.01%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5239	Other Financial Investment Activities	6,852	$11,878,438	$1,734	$1,247,480	0.14%
5241	Insurance Carriers	499	$1,011,256	$2,025	$3,600,269	0.06%
5242	Agencies, Brokerages, and Other Insurance Related Activities	17,366	$34,184,872	$1,968	$575,155	0.34%
5251	Insurance and Employee Benefit Funds	197	$166,858	$849	$198,788	0.43%
5259	Other Investment Pools and Funds	112	$200,679	$1,786	$1,085,641	0.16%
5311	Lessors of Real Estate	12,961	$26,616,095	$2,054	$1,090,656	0.19%
5312	Offices of Real Estate Agents and Brokers	14,379	$25,261,103	$1,757	$700,221	0.25%
5313	Activities Related to Real Estate	10,077	$22,407,861	$2,224	$584,901	0.38%
5321	Automotive Equipment Rental and Leasing	482	$1,447,641	$3,004	$1,018,247	0.29%
5322	Consumer Goods Rental	1,039	$3,003,692	$2,891	$609,218	0.47%
5323	General Rental Centers	284	$865,973	$3,049	$969,539	0.31%
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	949	$2,282,588	$2,404	$1,447,107	0.17%
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	285	$476,238	$1,669	$3,054,162	0.05%
5411	Legal Services	22,852	$45,807,442	$2,005	$747,237	0.27%
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	14,754	$29,735,652	$2,015	$425,212	0.47%
5413	Architectural, Engineering, and Related Services	11,568	$42,680,149	$3,690	$796,165	0.46%
5414	Specialized Design Services	4,322	$10,844,535	$2,509	$651,156	0.39%
5415	Computer Systems Design and Related Services	15,074	$30,869,789	$2,048	$699,158	0.29%
5416	Management, Scientific, and Technical Consulting Services	21,484	$48,439,074	$2,255	$605,529	0.37%
5417	Scientific Research and Development Services	1,662	$4,503,806	$2,709	$1,184,901	0.23%
5418	Advertising, Public Relations, and Related Services	4,240	$11,597,282	$2,735	$972,915	0.28%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5419	Other Professional, Scientific, and Technical Services	8,042	$31,055,715	$3,862	$718,191	0.54%
5511	Management of Companies and Enterprises	622	$1,694,619	$2,724	$2,000,475	0.14%
5611	Office Administrative Services	3,518	$5,423,804	$1,542	$785,494	0.20%
5612	Facilities Support Services	157	$441,128	$2,817	$1,344,810	0.21%
5613	Employment Services	2,522	$4,435,122	$1,758	$862,254	0.20%
5614	Business Support Services	2,939	$3,932,901	$1,338	$637,724	0.21%
5615	Travel Arrangement and Reservation Services	1,846	$2,452,247	$1,328	$1,145,290	0.12%
5616	Investigation and Security Services	2,305	$7,402,537	$3,212	$568,222	0.57%
5617	Services to Buildings and Dwellings	24,202	$62,022,534	$2,563	$441,221	0.58%
5619	Other Support Services	2,194	$4,403,819	$2,007	$960,942	0.21%
5621	Waste Collection	893	$1,162,660	$1,301	$1,262,504	0.10%
5622	Waste Treatment and Disposal	140	$316,092	$2,251	$1,725,940	0.13%
5629	Remediation and Other Waste Management Services	1,086	$3,133,580	$2,885	$1,098,195	0.26%
6111	Elementary and Secondary Schools	1,169	$3,475,761	$2,973	$637,302	0.47%
6112	Junior Colleges	29	$111,992	$3,817	$2,336,262	0.16%
6113	Colleges, Universities, and Professional Schools	119	$231,971	$1,952	$1,512,355	0.13%
6114	Business Schools and Computer and Management Training	1,062	$1,591,435	$1,498	$755,854	0.20%
6115	Technical and Trade Schools	841	$1,646,426	$1,959	$687,422	0.28%
6116	Other Schools and Instruction	6,476	$11,488,813	$1,774	$332,175	0.53%
6117	Educational Support Services	1,096	$1,574,151	$1,437	$604,768	0.24%
6211	Offices of Physicians	6,908	$12,269,746	$1,776	$960,870	0.18%
6212	Offices of Dentists	5,290	$13,513,854	$2,555	$948,924	0.27%
6213	Offices of Other Health Practitioners	5,695	$10,110,019	$1,775	$447,256	0.40%
6214	Outpatient Care Centers	536	$1,544,461	$2,879	$989,325	0.29%
6215	Medical and Diagnostic Laboratories	265	$717,035	$2,703	$1,182,302	0.23%
6216	Home Health Care Services	653	$2,917,046	$4,468	$518,702	0.86%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
6219	Other Ambulatory Health Care Services	209	$655,184	$3,137	$797,038	0.39%
6221	General Medical and Surgical Hospitals	4	$20,164	$5,297	$10,704,238	0.05%
6222	Psychiatric and Substance Abuse Hospitals	1	$60,072	$40,967	$15,140,669	0.27%
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	2	$89,129	$45,058	$23,112,360	0.19%
6231	Nursing Care Facilities (Skilled Nursing Facilities)	97	$299,181	$3,092	$1,138,055	0.27%
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	246	$1,184,615	$4,820	$495,389	0.97%
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	523	$2,224,552	$4,252	$439,078	0.97%
6239	Other Residential Care Facilities	83	$513,007	$6,216	$469,247	1.32%
6241	Individual and Family Services	1,805	$7,386,994	$4,092	$424,361	0.96%
6242	Community Food and Housing, and Emergency and Other Relief Services	334	$1,555,480	$4,659	$990,632	0.47%
6243	Vocational Rehabilitation Services	81	$345,131	$4,262	$566,673	0.75%
6244	Child Care Services	2,132	$20,144,880	$9,448	$290,434	3.25%
7111	Performing Arts Companies	4,171	$4,129,821	$990	$787,860	0.13%
7112	Spectator Sports	1,794	$1,430,879	$797	$1,258,295	0.06%
7113	Promoters of Performing Arts, Sports, and Similar Events	3,604	$3,665,186	$1,017	$1,122,492	0.09%
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	2,047	$2,033,576	$993	$1,093,566	0.09%
7115	Independent Artists, Writers, and Performers	15,202	$14,251,524	$937	$787,943	0.12%
7121	Museums, Historical Sites, and Similar Institutions	3,149	$3,311,160	$1,051	$608,424	0.17%
7131	Amusement Parks and Arcades	1,354	$1,316,414	$972	$516,918	0.19%
7132	Gambling Industries	744	$922,020	$1,239	$1,354,532	0.09%

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
7139	Other Amusement and Recreation Industries	28,297	$22,821,999	$807	$483,584	0.17%
7211	Traveler Accommodation	12,993	$15,574,139	$1,199	$877,297	0.14%
7212	RV (Recreational Vehicle) Parks and Recreational Camps	2,293	$1,620,981	$707	$721,900	0.10%
7213	Rooming and Boarding Houses, Dormitories, and Workers' Camps	654	$651,616	$996	$650,782	0.15%
7223	Special Food Services	6,293	$4,826,527	$767	$453,753	0.17%
7224	Drinking Places (Alcoholic Beverages)	12,801	$9,231,321	$721	$450,393	0.16%
7225	Restaurants and Other Eating Places	117,267	$109,738,307	$936	$537,890	0.17%
8111	Automotive Repair and Maintenance	64,015	$85,582,777	$1,337	$646,006	0.21%
8112	Electronic and Precision Equipment Repair and Maintenance	4,843	$7,081,340	$1,462	$555,490	0.26%
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	8,375	$11,158,572	$1,332	$842,857	0.16%
8114	Personal and Household Goods Repair and Maintenance	9,205	$10,159,719	$1,104	$380,439	0.29%
8121	Personal Care Services	50,363	$59,103,771	$1,174	$267,441	0.44%
8122	Death Care Services	6,418	$9,445,610	$1,472	$854,725	0.17%
8123	Drycleaning and Laundry Services	12,190	$12,520,561	$1,027	$353,835	0.29%
8129	Other Personal Services	15,818	$15,920,372	$1,006	$339,338	0.30%
8131	Religious Organizations	76,718	$98,017,873	$1,278	$417,227	0.31%
8132	Grantmaking and Giving Services	7,573	$8,483,782	$1,120	$2,705,446	0.04%
8133	Social Advocacy Organizations	6,199	$6,958,994	$1,123	$816,788	0.14%
8134	Civic and Social Organizations	10,249	$12,512,391	$1,221	$479,271	0.25%
8139	Business, Professional, Labor, Political, and Similar Organizations	23,841	$28,061,383	$1,177	$819,457	0.14%
9993	Local Government	1,922	$4,052,837	$2,109	$1,111,959	0.19%
Total		**1,847,745**	**$2,177,399,776**	**$1,178**	**$987,455**	**0.12%**

Table VIII.D.3. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue

Source: OSHA estimate.

E. Benefits.

I. Introduction.

OSHA's proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings is a crucial step towards ensuring the health, safety, and well-being of employees with occupational exposure to hazardous heat. Compliance with this standard is projected to yield substantial health and safety benefits, primarily through the reduction of occupational non-fatal heat-related injuries and illnesses (HRIs) and heat-related fatalities. These include severe conditions such as heat stroke, which can be fatal if not promptly treated, and heat exhaustion, which can lead to more serious complications if ignored. To estimate the health and safety benefits of this standard, OSHA has conducted an analysis of data on workplace incidents involving exposure to heat. In this section, OSHA will first present the available BLS data on HRIs and heat-related fatalities. After that, there is a discussion of underreporting issues surrounding these data which leads to a presentation of OSHA's underreporting adjusted count of HRIs and heat-related fatalities. Even with this adjustment, there remains a great deal of uncertainty surrounding the extent of underreporting, other parameters used in this estimation of health and safety benefits, as well as additional potential benefits, all of which the agency discusses next in an uncertainty analysis. Finally, this section includes a sensitivity analysis that calculates the potential benefits of this standard assuming different parameters to demonstrate the range of potential quantifiable benefits.

II. Fatal and Non-Fatal Heat-Related Injuries and Illnesses.

OSHA estimated the potential benefits of the proposed standard by determining the number of HRIs and heat-related fatalities that could be prevented through its provisions. This estimation was based on data regarding occupational fatalities and HRIs resulting from exposure to environmental heat. OSHA conducted this analysis using data from the BLS Injuries, Illnesses, and Fatalities (IIF) program. The IIF program collects

data annually through two major surveys: the Census of Fatal Occupational Injuries (CFOI) and the Survey of Occupational Injuries and Illnesses (SOII). OSHA identified the number of heat-related fatalities and HRIs by searching BLS' CFOI and SOII databases for incidents captured under BLS event or exposure classification code 531 – Exposure to Environmental Heat.

A. Heat-Related Fatalities.

The CFOI, a Federal/State cooperative program, aims to provide accurate, comprehensive, and timely information on occupational fatalities. According to the CFOI data, between 1992 and 2022, there were 1,042 fatal cases due to employee exposure to environmental heat (BLS, 2024c). As depicted in table VIII.E.1., while the annual number of heat-related fatalities has fluctuated over this 31-year period, a gradual increasing trend in the annual average is evident.

Table VIII.E.1. Occupational Fatalities: Exposure to Environmental Heat, All Ownerships, U.S., 1992-2022

Year	Number of Fatalities
1992	12
1993	22
1994	28
1995	35
1996	18
1997	22
1998	34
1999	35
2000	21
2001	24
2002	40
2003	29
2004	18
2005	47
2006	44
2007	32
2008	27
2009	35
2010	40
2011	61
2012	31
2013	34
2014	18
2015	37

Table VIII.E.1. Occupational Fatalities: Exposure to Environmental Heat, All Ownerships, U.S., 1992-2022

Year	Number of Fatalities
2016	39
2017	32
2018	49
2019	43
2020	56
2021	36
2022	43
Total Fatalities	**1,042**

Source: BLS, 2024c.

To assess recent trends, OSHA focused its analysis on heat-related fatalities between 2011 and 2022. Over this 12-year timeframe, BLS CFOI data reported a total of 479 work-related fatalities from exposure to environmental heat, an average of 40 fatalities per year. OSHA also evaluated the fatality counts by industry. Due to BLS publication guidelines, some industry-level estimates were not publishable, denoted by dashes in the BLS tables. OSHA used the BLS data to estimate the number of fatalities by industry for those cases. OSHA used four steps to estimate the number of industry fatalities in years with undisclosed BLS data.

First, OSHA reviewed the total annual number of heat-related fatalities in all industries, comparing this total to the sum of annual total fatalities in private industry and government. In all cases where the sum of the fatalities in the two categories did not match the total annual fatalities, one of the categories had an undisclosed annual fatality count. Therefore, OSHA assumed that the fatality count for the undisclosed estimate was equal to the difference between total annual fatalities and the fatalities in the published estimate (total for private industry or government). For example, in 2020, the total number of fatalities in all industries was 56, the total number of fatalities in private industry was 52, and the total in government was undisclosed. OSHA estimated that the number of heat-related fatalities in government was equal to the difference, four.

Second, OSHA reviewed the total heat-related deaths in all private industry and compared to the sum of heat-related fatalities in private goods-producing industries and

private service-producing industries combined. Since these two groups cover all private industry, the numbers are expected to be equal. In 2019–2022, the data for both categories (goods-producing and service-providing) was undisclosed. OSHA estimated the number of fatalities for both categories for 2019–2022. Using the data from 2011–2018, OSHA divided the average percentage of heat-related private industry fatalities that were attributable to each group, estimating that 63 percent of private industry fatalities were in goods-producing industries and the remaining 37 percent were in service-producing industries. In each of the four years with undisclosed data, OSHA estimated the total fatalities in goods-producing and service-providing industries by multiplying each percentage by the total number of private industry annual heat-related fatalities. For example, in 2019, OSHA estimates that 63 percent of the private industry fatalities, 25.3 fatalities, are in goods-producing industries.

Next, OSHA reviewed the super-sectors within private goods-producing and private service-providing industries, comparing the total annual fatalities in each category to the sum of the annual fatalities of the lower, more detailed underlying super-sectors.[93] In years where the comparison showed a mismatch due to undisclosed data, OSHA estimated the data for the undisclosed super-sectors by distributing the difference between the total annual fatalities and the sum of fatalities in the underlying super-sectors across the super-sectors with undisclosed data. More specifically, the estimate for these undisclosed super-sectors was set equal to the difference described above multiplied by the percentage of non-fatal heat-related incidents[94] by super-sector. This percentage is calculated by the estimate of average annual heat-related non-fatal injuries and illnesses

[93] The underlying super-sectors of Goods-Producing Industries are Natural Resources and Mining (includes agriculture), Construction, and Manufacturing. The underlying super-sectors within Service-Providing industries are Trade, Transportation, and Utilities; Information; Financial Activities; Professional and Business Services; Education and Health Services; Leisure and Hospitality; and Other Services.
[94] The percentage of total domain-level non-fatal heat-related incidents by super-sector was calculated using the SOII data from 2011–2022, described in more detail in section VIII.E.II.B., below.

within the super-sector divided by the average total number of heat-related incidents in the category in which it belongs (i.e., goods-producing or service-providing).

Finally, OSHA examined the annual fatality counts for government and used a different method to estimate fatalities due to the differences in scope between SOII and CFOI.[95] For each year, OSHA calculated the difference between the total annual heat-related fatalities in government and the sum of annual fatality counts by all government ownership types (Federal, State, and local). OSHA assumed this difference represents the number of fatalities for ownership types with undisclosed yearly estimates. OSHA evenly distributed the difference across all government ownerships with undisclosed estimates for that year. For example, in 2020 there were four total heat-related fatalities in all government. Since none of the government ownership types had disclosed estimates, OSHA estimated that local, State, and Federal Government had 1.3 (4/3) fatalities each. Table VIII.E.2. presents the total estimated fatality counts for 2011 to 2022 by industry groups.

Further analysis of the data revealed that an estimated 88.1 percent or 422 of these fatalities occurred within private industry, while 11.9 percent or 57 fatalities were recorded in Federal, State, and local governments. Within the private industry, the Goods Producing industries accounted for 262 of these estimated fatalities, with Construction accounting for 162 of the incidents within that sector. Natural Resources and Mining (which includes agriculture) and Manufacturing accounted for 52 and 49 of the estimated fatalities within the Goods-Producing industries respectively. Additionally, 160 of the 422 fatalities in private industry occurred in the Service-Providing industries, which includes super-sectors such as Trade, Transportation and Utilities, Leisure and Hospitality, and Professional and Business Services. Professional and Business Services (this NAICS super-sector can include disparate occupations, including janitors, material

[95] SOII excludes Federal Government ownership and CFOI does not.

movers, groundskeeping workers, office clerks, security guards, architects, accountants, engineers, general managers, waste collectors, and lawyers) made up nearly 45 percent of all fatalities within the Service Providing industries, accounting for 71 of the 160 fatalities within this group. These findings are detailed below in table VIII.E.2., illustrating the distribution of fatalities across different sectors and industries.

Table VIII.E.2. Estimated Occupational Fatalities by Industry: Exposure to Environmental Heat, Number and Percent, All Ownerships, U.S., 2011-2022

Industry	Estimated Total Number of Fatalities	Percent of Total Fatalities
Total Injuries Fatalities	**479**	
Private Industry [a]	422	88.1
Goods Producing Industries[b][c]	262	54.8
Natural Resources and Mining	52	10.8
Construction	162	33.7
Manufacturing	49	10.3
Service Providing Industries [b][c]	160	33.3
Trade, Transportation and Utilities	45	9.4
Information	7	1.4
Financial Activities	5	1.0
Professional and Business Services	71	14.8
Education and Health Services	7	1.4
Leisure and Hospitality	15	3.2
Other Services	10	2.0
Government [a][d]	57	11.9
Federal Government	26	5.5
State Government	10	2.1
Local Government	21	4.3

Source: OSHA derived estimates based on BLS, 2024c.
[a] OSHA estimated years with undisclosed data using the difference between total annual fatalities and the sum of private industry and government fatalities.
[b] OSHA estimated years with undisclosed estimates for goods-producing industry totals and service-providing industry totals by comparing the annual sum of both categories to the total annual private industry fatalities and adjusting for the average percentage of private industries that fall within each category.

[c] For years with undisclosed data in the underlying super-sectors within these categories, OSHA estimated the number of fatalities by multiplying the number of fatalities unaccounted for in the published data by a ratio of the non-fatal heat-related injuries and illnesses for the super-sector
[d] Estimates for the three different government ownership codes with annual undisclosed data were estimated by distributing the residual between the total annual government fatalities and the sum of published fatalities at the more detailed government ownership level, evenly across all government ownership types with undisclosed estimates.

B. Non-Fatal Heat-Related Injuries and Illnesses (HRIs).

The BLS SOII is a Federal/State cooperative program that publishes estimates on non-fatal occupational injuries and illnesses, including HRIs. From 2011 to 2022, SOII recorded a total of 39,450 HRIs that required days away from work, averaging 3,288 HRIs per year (BLS, 2023b; BLS, 2023g; and BLS, 2023h). As detailed in table VIII.E.3., 35.8 percent of these HRIs required only one day away from work to recover after the incident, 21.5 percent required two days, and 23.9 percent needed three to five days. The remaining 18.8 percent of cases needed six or more days away from work for recovery from injuries and illnesses caused by exposure to environmental heat.

Table VIII.E.3. Non-Fatal Occupational Injuries and Illnesses Requiring Days Away From Work: Exposure to Environmental Heat, Number and Percent, All Ownerships, U.S., 2011 - 2022

	Number of Non-Fatal Injuries and Illnesses	**Percent of Total Non-Fatal Injuries and Illnesses**
Total Non-Fatal Injuries and Illnesses:	**39,450**	
Number of days away from work:		
Cases involving 1 day	14,130	35.8
Cases involving 2 days	8,500	21.5
Cases involving 3-5 days	9,440	23.9
Cases involving 6-10 days	3,660	9.3
Cases involving 11-20 days	1,760	4.5
Cases involving 21-30 days	480	1.2
Cases involving 31 or more days	1,500	3.8
Median days away from work [a]	2	

Source: OSHA calculations based on BLS, 2023b; BLS, 2023g; and BLS, 2023h.
Note: Because of rounding and data exclusion of nonclassifiable responses, data may not sum to the totals. Days away from work include those that result in days away from work with or without job transfer or restriction.

Table VIII.E.3. Non-Fatal Occupational Injuries and Illnesses Requiring Days Away From Work: Exposure to Environmental Heat, Number and Percent, All Ownerships, U.S., 2011 - 2022

	Number of Non-Fatal Injuries and Illnesses	Percent of Total Non-Fatal Injuries and Illnesses

[a] Median days away from work is the measure used to summarize the varying lengths of absences from work among the cases with days away from work. Half the cases involved more days and half involved less days than a specified median. Median days away from work are represented in actual values.

Table VIII.E.4. details the BLS' SOII estimates of annual incidence rates of HRIs between 2011 and 2022. Over this period, the average estimated annual incidence rate is 3 cases per 100,000 full-time workers for HRIs. This incidence rate indicates the annual frequency of injuries and illnesses due to heat exposure.

Table VIII.E.4. Non-Fatal Occupational Injuries or Illnesses: Exposure to Environmental Heat, Number and Annual Incidence Rates per 100,000 workers, All Ownerships, U.S., 2011-2022

Year	Number of Non-Fatal Injuries or Illnesses	Incidence Rate Per 100,000 Full-Time Workers
2011	4,420	4
2012	4,170	4
2013	3,160	3
2014	2,660	2
2015	2,830	3
2016	4,110	4
2017	3,180	3
2018	3,950	3
2019	3,080	3
2020	2,330	2
2021 & 2022	5,560	2
Total Non-Fatal Injuries and Illnesses, All Ownerships	**39,450**	
Average Non-Fatal Injuries and Illnesses Per Year	**3,288**	**3**

Source: BLS, 2023b; BLS, 2023g; and BLS, 2023h.

Note: Starting with 2021, BLS published data biennially. The number of HRIs reported for 2021 and 2022, is a biennial estimate.

Table VIII.E.5. presents the number of HRIs by industry from 2011 to 2022. Similar to the findings illustrated in table VIII.E.2., table VIII.E.5. demonstrates that the majority of HRIs also occur predominantly within private industry, accounting for 79.9 percent or 31,510 of the 39,450 non-fatal injuries and illnesses. Twenty-one percent of HRIs occurred within State and local governments, accounting for 7,930 of all HRIs. Within private industry, more than half of all recorded HRIs occurred in the Service Providing sector, which accounted for 18,460 of the total 31,510 HRIs recorded. The Trade, Transportation, and Utilities industry (which includes Wholesale Trade, Retail Trade, Transportation and Warehousing, and Utilities) made up 8,010 of HRIs within the Service Providing sector, followed by Professional and Business Services, and Leisure and Hospitality with 4,260, and 1,790 HRIs, respectively. The Goods Producing sector accounted for 13,050 of the total HRIs within private industry, most of which occurred within the Construction and Manufacturing industries, with 6,130 and 5,100 non-fatal cases respectively.

Table VIII.E.5. Non-Fatal Occupational Injuries and Illnesses by Industry: Exposure to Environmental Heat, Number and Percent, All Ownerships, U.S., 2011-2022

Industry	Number of Injuries and Illnesses	Percent of Total Injuries and Illnesses
Total Injuries and Illnesses	**39,450**	
Private Industry	**31,510**	**79.9**
Goods Producing Industries	13,050	33.1
Natural Resources and Mining	1,790	4.5
Agriculture, Forestry, Fishing and Hunting	1,200	3.0
Mining	580	1.5
Construction	6,130	15.5
Manufacturing	5,100	12.9
Service Providing Industries	18,460	46.8
Trade, Transportation and Utilities	8,010	20.3
Wholesale Trade	1,570	4.0
Retail Trade	2,200	5.6

Table VIII.E.5. Non-Fatal Occupational Injuries and Illnesses by Industry: Exposure to Environmental Heat, Number and Percent, All Ownerships, U.S., 2011-2022

Industry	Number of Injuries and Illnesses	Percent of Total Injuries and Illnesses
Transportation and Warehousing	3,900	9.9
Utilities	330	0.8
Information	1,140	2.9
Financial Activities	810	2.1
Finance and Insurance	-	-
Real Estate and Rental and Leasing	680	1.7
Professional and Business Services	4,260	10.8
Professional, Scientific, and Technical Services	120	0.3
Management of Companies and Enterprises	60	0.2
Administrative and support and waste management and remediation services	3,520	8.9
Education and Health Services	1,140	2.9
Educational Services	110	0.3
Healthcare and Social Assistance	1,000	2.5
Leisure and Hospitality	1,790	4.5
Arts, Entertainment, and Recreation	540	1.4
Accommodation and Food Services	1,230	3.1
Other Services	1,250	3.2
Other Services, Except Public Administration	1,250	3.2
Public Administration	-	-
State Government	**1,490**	**3.8**
Local Government	**6,440**	**16.3**

Source: OSHA calculation from BLS, 2023b; BLS, 2023g; and BLS, 2023h.
Note: Because of rounding and data exclusion for detailed categories that did not meet the BLS publication guidelines, data may not sum to the totals. The SOII excludes all work-related fatalities as well as non-fatal work injuries and illnesses to the self-employed, to workers on farms with 10 or fewer employees, to private household workers; to volunteers, and to Federal Government workers.

C. Underreporting.

Based on an analysis of relevant academic literature (discussed in detail in Section V.A., Risk Assessment), OSHA has determined that heat-related occupational fatalities and HRIs are underreported due to (1) employers not being fully compliant with recordkeeping rules, (2) employees not reporting cases to their employers, (3) a lack of

identifying heat as the cause of a heat-related injury or illness, and (4) the scope and inclusion criteria of the various surveillance data.

I. Underreporting of Heat-Related Fatalities.

BLS CFOI is well-regarded as the most complete and authoritative source on fatal workplace injuries and estimates of its magnitude of underreporting of occupational fatalities do not exist. However, there may be factors specific to heat-related fatalities that make CFOI particularly likely to misclassify the cause of death as being due to some other cause. This could mean that heat-related fatalities may be historically excluded from CFOI (e.g., cause of death is listed as cardiac arrest) or listed under another, not heat-specific Occupational Injury and Illness Classification System (OIICS) category (e.g., a worker faints due to heat exposure, falls from a height, and subsequently suffers a fatal traumatic injury). Additionally, as discussed in Section V.A., Risk Assessment, the documentation upon which BLS relies to code occupational fatalities (e.g., death certificates, coroner reports) may have limitations for heat-related fatalities due to the lack of expertise or experience of the individual determining the cause of death and whether the individual witnessed the events preceding the fatality. Therefore, OSHA has preliminarily determined that there is reason to believe that the number of heat-related fatalities in CFOI are undercounted, but precise estimates of this quantification do not exist.

II. OSHA's Underreporting Adjustment – Heat-Related Fatalities.

Heat-related fatalities are often identified in public health surveillance through review of International Classification of Diseases (ICD) codes listed in death certificates, which are known to be limited in their capture of heat as a cause-of-death (Shen et al., 1998). However, epidemiologists have increasingly used statistical techniques to identify

excess deaths attributable to heat, both globally and in the United States, regardless of the cause-of-death listed on the death certificate. A recent study from 2020 estimated that, on average, 5,608 excess deaths were the result of heat each year between 1997 and 2006 in the 297 counties examined (representing approximately 62 percent of the U.S. population) or 9,045 excess deaths per year when extrapolated to the full nation (Weinberger et al., 2020). Estimates for similar time periods using the death certificate approach ranged from 618 to 658 heat-related deaths per year across the U.S. (Xu, 2012; Fowler et al., 2013). This would suggest that nationally heat-related deaths may be 13.7-to-14.6 fold undercounted. However, it is unclear if this ratio could be applied to CFOI estimates of occupational heat-related fatalities, as it is not clear what proportion of these excess deaths occurred among workers. Recent evidence from Mexico indicates that heat-related excess deaths are concentrated among working-age individuals and children (preprint by Wilson et al., 2024). If the same pattern holds in the U.S., then the undercounting estimates above (13.7-14.6) might be understating the magnitude of the undercount for workers. However, another recent study that examined heat-related excess deaths in Europe found that these deaths were predominantly concentrated among individuals over the age of 65 (Ballester et al., 2023). If this pattern were true for the U.S., the undercounting estimates above might be overstating the magnitude of undercounting for workers. These two studies had important differences in methodology (e.g., use of exposure metric, use of observational weather data, and age groups analyzed) and underlying population (e.g., age distribution), and the researchers were not able to characterize work-related deaths. Given that the proportion of work-related deaths among the total estimated excess heat-related deaths in the U.S. is unknown, OSHA did not adjust the ratio derived from comparing Weinberger et al.'s estimates to Xu and Fowler et al.'s counts. Therefore, for this analysis, OSHA estimates that occupational fatalities due to heat are undercounted by a factor of 14. Additional values of the undercount—

both higher and lower—are presented later in this section in a sensitivity analysis. OSHA welcomes comment on the estimates of avoided fatalities, the underreporting adjustment, data sources, and methodologies employed here. The agency welcomes additional studies that OSHA should consider and comment on whether there are more appropriate underreporting factors that should be used to adjust reported fatalities in the final economic analysis.

III. Underreporting of Non-Fatal HRIs.

As discussed in Section V.A., Risk Assessment, researchers and government agencies have long acknowledged the shortcomings of BLS's SOII in accurately estimating all non-fatal occupational injuries and illnesses. One limitation is the scope of cases for which BLS has historically reported enough information to identify HRIs—only those cases involving days away from work.[96] Another limitation of SOII is the reliance on employer-reported data, as research has demonstrated that employers are not always fully compliant with recordkeeping rules. Quantifying the magnitude of the undercounting of SOII is difficult, but comparisons to workers' compensation and other databases provide some context for the potential magnitude of undercounting.

IV. OSHA's Underreporting Adjustment – Non-Fatal HRIs.

The best available estimates of the magnitude of the underreporting of injuries and illnesses comes from a 2014 study funded by BLS that compared State-based surveillance data from California (specifically the Workers' Compensation Information System, data from healthcare facilities across the State, and Doctors' First Reports of Occupational Illness or Injury) to BLS SOII microdata for both carpal tunnel syndrome and amputations from 2007–2008 (Joe et al., 2014). In this study, researchers linked individual cases in each dataset to the corresponding case in other datasets to obtain a

[96] BLS expanded their publication of case and demographic data for injury and illness cases involving days of job transfer or restriction (DJTR) with the introduction of biennial estimates in 2021–2022. (https://www.bls.gov/iif/notices/2022/biennial-estimates.htm).

better estimate of the total number of cases for each outcome occurring in California during this time. They found that the State-based data sources contained 5 times more amputations and 10 times more carpal tunnel syndrome cases than were reported in the BLS SOII data. Joe et al. (2014) also found that about 30 percent of SOII cases were not captured in the State database which suggests that both sources are failing to capture some injuries.

While Joe et al. (2014) was not specific to heat, a more recent study from California compared the number of HRI claims in the State's Workers' Compensation Information System to the estimated number of HRIs reported in BLS SOII for the same years (2009–2017) (Heinzerling et al., 2020). Heinzerling et al. found 3–6 times the number of HRI cases estimated by SOII in the State's workers' compensation database each year. While this study did not match individual cases as was done in Joe et al. (2014), it is reasonable to assume that similar to the findings in that study, some HRIs that were captured by the SOII data were not captured by the State's workers' compensation data. This would mean that there are even more cases in the State database that are not captured in SOII (which would mean the undercount estimate of 3-6 times is an underestimate). It is also possible that the workers' compensation database examined by Heinzerling et al. (2020) is missing HRIs. In Joe et al., 2014, approximately 54–74 percent of cases identified in the healthcare facility data were only found in that dataset and 46 percent of cases identified in the Doctors' First Reports data were found only in that dataset. This suggests that the number of cases Heinzerling et al. (2020) identified in the workers' compensation data that they compared to BLS SOII may itself have been an undercount.

Finally, simply comparing the total number of recorded occupational fatalities annually to the total number of annual recorded non-fatal injuries and illnesses suggests potentially significant underreporting of HRIs. For each occupational death in 2022, there

were about 965 medically consulted work-related injuries (4,695 fatalities to 4,530,000 medically consulted injuries based on data from the National Safety Council (NSC, n.d.)). In 2022, for each occupational fatality, there were about 639 recordable injuries and illnesses (5,486 fatalities to 3.5046 million recordable cases (BLS, 2024c; BLS, 2023b)). This ratio is generally consistent across a number of specific causes or types of occupational fatalities and non-fatal injuries and illnesses. Similarly, for heat-specific cases, a ratio of 1,000 emergency department visits and hospitalizations per 1.4 fatalities was reported in a 2011 analysis by the Florida Department of Health (Florida DOH, 2011; also discussed in Section V.A., Risk Assessment). As such, the ratio of heat-related fatalities to HRIs (about 82 HRIs for every one fatality) from the data that OSHA is relying on for its estimate of benefits indicates an unusually low number of HRIs. Based on the reported number of occupational heat-related fatalities (which OSHA believes, and research supports, is an underestimate) of 40 per year, the expected number of HRIs would be around 38,000 per year versus the 3,288 reported annual HRIs (assuming the relationship between fatalities and non-fatal injuries and illnesses is similar for heat-related fatalities and injuries and illnesses and the all-cause mortality and injury and illness numbers).

Based on these studies, OSHA has preliminary determined that the range of estimates reported in Joe et al. (2014) (i.e., 5–10 times more cases than in the SOII data) are the best available estimates on the magnitude of undercounting of occupational injuries and illnesses by BLS SOII. These values are supported by Heinzerling et al. (2020) which found 3–6 times the number of HRI cases but which had limitations likely leading to an underestimation of the magnitude. OSHA welcomes comment on this adjustment, submission of additional data or studies that would help the agency refine this estimate, and suggestions on alternative methodologies.

V. Underreporting-Adjusted HRIs and Heat-Related Fatalities.

Based on this analysis, OSHA estimates that HRIs are undercounted by a factor of 7.5 (mid-point of 5 and 10) and heat-related fatalities are undercounted by a factor of 14. Applying these factors to BLS' reported 39,450 HRIs and 479 fatalities, OSHA estimates an underreporting adjusted total of 295,875 HRIs and a total of 6,706 heat-related fatalities from 2011 to 2022, an annual average of 24,656 and 559 per year respectively. Additional values of the undercount—both higher and lower—are presented later in this section in a sensitivity analysis.

III. Monetized Health and Safety Benefits.

As explained in Section V.C., Risk Reduction, OSHA has preliminarily determined, based on a review of academic literature on the effectiveness of heat injury and illness prevention methods, that full compliance with this proposed standard would reduce heat-related fatalities by 99.8–100 percent and HRIs by 37–96 percent. For this benefits analysis, OSHA is assuming an effectiveness of 95 percent for fatalities and 65 percent of HRIs. The effect of different assumptions on the outcome of this benefits analysis are discussed below in the sensitivity analysis.

Applying the undercount adjustment to BLS-reported heat-related fatalities and HRIs discussed above by factors of 14 and 7.5 respectively, OSHA estimates that the proposed standard will prevent 531 heat-related fatalities per year (of the estimated 559 fatalities) and 16,027 HRIs per year (of the estimated 24,656 HRIs) under the assumptions of 95 percent effectiveness for heat-related fatalities and 65 percent effectiveness for HRIs[97]. Using the 2022 estimate of the value of a statistical life (VSL) developed by the Department of Transportation (DOT)[98] and converting to 2023 dollars

[97] OSHA assumes that the proposed standard is equally effective at preventing fatalities and HRIs that are currently reported in the economic data and those that are currently unreported. The agency welcomes comment on this assumption.

[98] Available at *https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis* (DOT, 2024). The 2022 estimate was based on a comprehensive 2021 Department of Transportation guidance update, available at *https://www.transportation.gov/sites/dot.gov/files/2021-03/DOT%20VSL%20Guidance%20-%202021%20Update.pdf* (DOT, 2021).

using the GDP deflator (BEA, 2024), $13.77 million, OSHA estimates the monetized benefits from avoided fatal heat-related incidents in the first year would be $7.310 billion. OSHA monetized benefits of avoided HRIs using the midpoint of the range of the value of a statistical injury (VSI) cited in Viscusi and Gentry (2015), converted to 2023 dollars using the GDP deflator, $116,588 per injury.[99] The estimated monetized benefits from avoided HRIs are $1.869 billion per year. Total benefits each year for avoided heat-related fatalities and HRIs are $9.179 billion .

IV. Additional Unquantified Potential Benefits.

OSHA believes the proposed standard may provide several additional potential benefits beyond the avoided direct heat-related fatalities and HRIs captured in the monetized health and safety benefits. These potential benefits include avoided indirect fatal and non-fatal injuries related to heat exposure, increased labor supply, and increased utility for employees. The agency's estimate of monetized health and safety benefits has not incorporated benefits for these factors. The values presented here are shown to demonstrate the potential magnitude of these benefits but are highly uncertain and, therefore, not incorporated into the main quantified estimate of the benefits of this proposed standard.

A. Indirect Fatalities and Non-Fatal Injuries.

As discussed in detail in Section V.A., Risk Assessment, and Section IV., Health Effects, workers face additional risks from working in hot environments other than the direct physical effects of heat on the employee's body. Indirect injuries that are caused by the physiological effects of heat stress, but are not themselves, heat exhaustion or heat stroke (i.e., falling, motor vehicle accidents, etc.). Direct HRIs and fatalities are those

[99] OSHA welcomes comment regarding this VSI estimate and whether it is an appropriate value given that HRIs may be less severe than other injuries and illnesses typically considered in the VSI derivation. The agency welcomes suggestions on alternative VSI estimates for HRIs as well as supporting data, methodologies, or studies that would help the agency refine this estimate.

caused by the effects of heat on the body without the involvement of other factors. The underreporting adjustments in the benefits analysis may not capture or only capture some of the underreporting of indirect HRIs and heat-related fatalities. Researchers have used the natural fluctuations in temperatures to conduct quasi-experimental studies examining the relationship between heat and workers' compensation claims for traumatic injuries (Spector et al., 2016; Calkins et al., 2019; Dillender, 2019; Park et al., 2021; Negrusa et al., 2024). These papers' findings suggest that there may be many workers' compensation claims that are heat-related but not coded as such. For instance, Park et al. (2021) estimated that approximately 20,000 injuries per year in California between 2001 and 2018 were caused by hotter temperatures (relative to "optimal" temperature). For comparison, for a similar time period (2000–2017), Heinzerling et al. (2020) only identified an average of 889 HRI workers' compensation claims per year in California (a 22-fold difference), suggesting that relying on workers' compensation claims for HRIs alone does not capture the higher incidence of injuries of other kinds where heat may have played a role. OSHA has not included a quantified value of potentially avoided indirect heat-related fatalities and non-fatal occupational injuries, but these studies suggest that heat may contribute to additional impacts on employees and that these impacts may be significant. Because of this, the benefits of this proposed standard may be greater than what OSHA estimates in the primary estimate.

If the relationship between directly- and indirectly-caused heat-related non-fatal injuries found in Park et al. (2021) was representative of the true relationship, the number of occupational direct and indirect heat-related non-fatal injuries may be as high as 72,000 annually (based on the BLS-reported annual non-fatal injuries of 3,288 and an estimate of 22 indirect heat-related injuries per 1 direct heat-related injury). Assuming the proposed standard prevented 65 percent of these indirect non-fatal injuries, it might prevent a total of 47,000 indirect non-fatal injuries each year. Monetizing those avoided

injuries would represent about an additional $5.5 billion in benefits (using a VSI of $116,588 per avoided injury). If the relationship between non-fatal injuries and fatalities seen for occupational injuries and fatalities in general of one fatality for every 1,000 injuries holds for these accidents, this means that there might be 72 indirect heat-related fatalities annually.[100] Given that these are caused by different factors besides heat and so may be preventable at lower rates than direct heat-related fatalities, assuming preventability equal to the preventability of non-fatal injuries, this proposed standard might prevent an additional 46 indirect heat-related fatalities annually. Monetized, this would mean additional benefits of $644 million.

B. Worker Disutility and Decreased Labor Supply.

There is a lengthy economic literature that suggests that humans have strong preferences for not being exposed to extreme temperatures. Roback (1982) and Sinha et al. (2018) used revealed preference techniques and found that most people experience non-trivial direct disutility[101] from exposure to extreme temperatures and that they are willing to pay non-trivial amounts to mitigate those exposures where they can. Studies of real world responses to extreme temperatures including Graff Zivin and Neidell (2014) and Rode et al. (2022) found that workers decrease the amount of labor they are willing to supply (i.e., for workers who are able to do so, they will shorten their work day or choose to not work on a certain day) when temperatures are extreme (with a greater decrease in labor supplied when temperatures are extremely hot versus when they are extremely cold) suggesting that workers prefer to forgo wages rather than be exposed to extreme temperatures. In cases where labor markets are imperfectly competitive, workers

[100] This calculation uses a more generalized ratio of occupational injuries to fatalities than those discussed previously based on NSC and BLS data (NSC, n.d.; BLS, 2023b; BLS, 2024c). If the NSC-derived ratio of 965 injuries to one fatality were more accurate, there could be about 75 indirect heat-related fatalities annually. If the BLS-derived ratio of 639 injuries to one fatality were correct, the indirect heat-related fatalities could be around 113 annually.

[101] In economic terms, disutility is the negative or harmful effects of some activity or economic transaction. In economics, individuals are assumed to try to maximize their utility (and conversely minimize their disutility).

might benefit from this proposed standard because they do not have the option to avoid exposure to extreme temperatures, even if they were willing to forgo wages (for more on the implications of imperfect labor market competition for compensating differentials, see, e.g., Burdett and Mortensen, 1998; Sorkin, 2018). While the interventions in this proposed standard will not eliminate the need for work to be performed in hot environments, to the extent that these interventions mitigate some of the physical discomfort caused by heat, employees may experience a decrease in the disutility they face due to working in hot environments.

While an individual's utility or disutility is difficult to measure, Li et al. (2020) found that people expressed a willingness to pay (WTP) between $2.60 and $4.60 per day to avoid a hot day. WTP may not already be satisfied in the labor market as a result of imperfect competition, imperfect information, binding minimum wages, or other features of the market. This is not perfectly analogous to utility but gives a range for the value that individuals place on avoiding excessive heat. Assuming a point estimate of a WTP of $3 per day[102] to mitigate the physical discomfort of working in hot environments, all employees in the scope of this proposed standard receiving heat protections for 30 days on average would equal benefits of $3.236 billion. Employees in many parts of the country work in hot conditions for many more than 30 days, meaning that, if benefits to workers to mitigate the negative physical effects of heat that do not rise to the level of a heat injury or illness were captured and monetized, the benefits of this proposed standard may be even greater than those shown by the monetized safety and health benefits.

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[102] This assumes a value on the lower end of what Li et al. (2020) estimated since this proposed standard will not entirely remove most employees from hot environments. There are arguments to be made that this might be an underestimate for a few reasons. First, people have a higher WTP to avoid very high temperatures so where this proposed standard improves conditions for employees exposed to very high temperatures, their WTP might be higher. Second, those surveyed by Li et al. (2020) were not necessarily workers who were working in high heat. Employee's WTP for heat mitigating measures might be higher than a general individual's WTP to avoid hot days in general since employees have to perform physical labor in those hot environments and because employees have less control over workplace factors like resting, clothing choices, or the ability to stay inside or to relocate somewhere with air conditioning. Finally, those surveyed by Li et al. (2020) may have included nonworking individuals who may have a lower income and therefore a lower WTP than individuals who are working for wages.

Graff Zivin and Neidell (2014) found that workers with high exposure to heat reduced their labor supply by as much as one hour per day when the temperatures were above 85°F.[103] Based on an average loaded hourly wage of $43.60 (the average for all at-risk workers in the scope of the proposed standard), if employees working in the hottest environments (assumed here to be the sum of workers exposed to process heat and outdoor workers) supply 5 additional hours of labor each over the course of a year, they would cumulatively receive additional wages of $3.877 billion. Measures that improve the comfort of employees and reduce the negative physical effects of heat could easily result in the small increase in labor supply discussed here. As mentioned previously, employers benefit when employees produce more so the benefits of increased labor supply would be more than just the increased wages paid to employees—employers' revenue would increase because of increased employee output as well.

V. Uncertainty.

A few factors contribute to uncertainty in the estimates of the benefits of this proposed standard including potential underreporting of heat-related fatalities and HRIs, uncertainty of the effectiveness of the interventions required by the proposed standard, and potential benefits of improved labor productivity.

A. Underreporting.

As discussed earlier, OSHA believes the number of HRIs and heat-related fatalities estimated from the BLS data is likely underestimated compared to the true number of HRIs and heat-related fatalities in the United States. Research suggests that HRIs and heat-related fatalities are underreported in multiple datasets (e.g., BLS CFOI, BLS SOII, workers' compensation claims data, and hospital discharge data). The general underreporting and undercounting of occupational injuries and illnesses has been a topic

[103] Note that this change in labor supply refers to real world effects seen where workers choose to work fewer hours when temperatures are excessively hot or cold (e.g., ending their workday early, choosing to not work on certain days) and is different from the productivity effects of rest breaks discussed elsewhere.

of multiple government reports (e.g., Ruser, 2008; Miller, 2008; GAO, 2009; Wiatrowski, 2014). While there is a good deal of agreement that some level of underreporting exists for occupational injuries and illnesses in general and HRIs specifically, there is uncertainty regarding the magnitude of underreporting. OSHA has adjusted for underreporting of HRIs and heat-related fatalities but there remains a wide range of estimates of underreporting in the research. There still remains a high level of uncertainty in these estimates and the magnitude of underreporting is potentially considerably higher than what OSHA has estimated. If the HRIs were underreported by a factor of 10 rather than 7.5 (which is plausible based on the available evidence) and this proposed standard has the same effectiveness, it could prevent about an additional 11,500 HRIs which could account for an additional $1.342 billion in benefits.

B. Program Effectiveness.

As explained above, for this benefits analysis, OSHA assumes that the proposed standard will be 65 percent effective in curbing HRIs. This topic, the relevant literature, and how the agency arrived at its estimates of the standard's effectiveness are discussed in-depth in Section V.C., Risk Reduction. As discussed previously, OSHA found that the literature on this issue lacks certainty. Few studies included a concurrent control group, rather most studies looked at rates of HRI before and after an intervention in the same group. Studies were generally performed on specific industries, or in specific settings, and the effectiveness of the intervention might be higher or lower than the study average across the firms and employees covered by this rulemaking. Additionally, no study tested an intervention that would exactly match the controls required by the proposed standard. For example, McCarthy et al. (2019) report a 60–90 percent decrease in the odds of HRI among municipal outdoor workers in Texas after a Heat Stress Awareness Program (HSAP) intervention was implemented in 2011. However, this study lacked a control group that received no intervention making it difficult to determine if the reported

effectiveness could be attributed to the intervention. While OSHA assumed the effectiveness of the proposed standard in preventing HRIs to be on the lower end of what McCarthy et al. (2019) found, there is evidence that the effectiveness of heat interventions may be much higher than that (See Section V.C., Risk Reduction, for additional discussion).

If the proposed standard were more effective at preventing heat-related fatalities and HRIs than OSHA estimates in this analysis (and based on available evidence this is plausible, see Section V.C., Risk Reduction) and prevented all fatalities (100 percent versus 95 percent) and 10 percent more HRIs (75 percent versus 65 percent), the proposed standard might prevent 28 more fatalities and about 2,500 more non-fatal injuries and illnesses annually. Monetized, this represents approximately an additional $672 million in benefits.

C. Labor Productivity Losses.

As discussed above in section VIII.E.IV.A., OSHA has preliminarily determined, based on numerous studies, that there are labor productivity losses from working in the heat that can be partially recovered through the provision of rest breaks. However, precisely defining the magnitude of labor productivity losses that could be recuperated under the proposed standard is difficult with the current research available. This analysis rests on specific assumptions and is dependent on the extent of the available literature, in which heat and productivity were assessed in different settings with different break policies, but break policies did not vary within the same setting. OSHA mentions those impacts here, as well, to acknowledge the uncertainty associated with those estimates. This factor is examined in the sensitivity analysis in Section VIII.C. Costs of Compliance (section VIII.C.VI).

VI. Sensitivity Analysis.

OSHA considers the rate of effectiveness of the various measures of this proposed standard a major source of uncertainty in the calculation of benefits. OSHA has compiled a sensitivity analysis to illustrate the range that could depict the benefits estimate. As shown below in table VIII.E.6. for the low estimate, OSHA estimated program effectiveness to be 50 percent for HRIs and 90 percent for heat-related fatalities (as opposed to the primary estimate of 65 percent effectiveness for HRI prevention and 95 percent effectiveness for fatality prevention). For the high estimate, OSHA estimated 100 percent effectiveness for the prevention of both heat-related fatalities and HRIs by the proposed standard (as opposed to the primary estimate of 65 percent effectiveness for HRI prevention and 95 percent effectiveness for fatality prevention).

At the 50 percent level of effectiveness, OSHA calculated monetized benefits of avoided HRIs of $1.437 billion. At the 90 percent level of effectiveness, OSHA calculated monetized benefits of avoided heat-related fatalities of $6.926 billion. Both estimates use the same VSI and VSL discussed above. Total monetized benefits at the 50 and 90 percent level of effectiveness are $8.363 billion per year.

At the 100 percent level of effectiveness, the monetized benefits of avoided HRIs are $2.875 billion per year. The monetized benefits of avoided heat-related fatalities at the same level of effectiveness are $7.696 billion. Both estimates use the same VSI and VSL discussed above. Total monetized benefits per year for the 100 percent level of effectiveness are $10.570 billion.

The sensitivity analysis also looked at the impact on the estimated number of avoided HRIs and heat-related fatalities under different assumptions of underreporting, specifically (1) alternative assumptions for the underreporting related to HRIs, assuming factors of 2 or 10 or no underreporting and (2) alternative assumptions regarding the underreporting of heat-related fatalities, assuming that heat-related fatalities were underreported by factors of 3 or 15 or not underreported at all. The estimated number of

avoided HRIs and avoided heat-related fatalities under these alternative assumptions of underreporting are presented in tables VIII.E.6. and VIII.E.7. with OSHA's primary estimate of effectiveness as well as under the low and high levels of effectiveness discussed above.

Total monetized benefits per year from avoided heat-related fatalities and HRIs under different assumptions of program effectiveness and underreporting are presented in Table VIII.E.8.

Table VIII.E.6. Sensitivity Analysis – HRIs

	Primary Estimate (65 % Effectiveness)	**Low Estimate (50 % Effectiveness)**	**High Estimate (100% Effectiveness)**
Cases – No underreporting adjustment	2,137	1,644	3,288
Cases - Low underreporting (2X)	4,274	3,288	6,575
Cases - High underreporting (10X)	21,369	16,438	32,875
Cases – Primary estimate underreporting (7.5X)	16,027	12,328	24,656
Monetized benefits, no underreporting adjustment	$249,133,988	$191,641,529	$383,283,058
Monetized benefits, low underreporting (2X)	$498,267,975	$383,283,058	$766,566,116
Monetized benefits, high underreporting (10X)	$2,491,339,876	$1,916,415,290	$3,832,830,579
Monetized benefits, OSHA primary estimate underreporting (7.5X)	$1,868,504,907	$1,437,311,467	$2,874,622,934

Source: OSHA estimate.

Table VIII.E.7. Sensitivity Analysis – Heat-Related Fatalities

	Primary Estimate (95% Effectiveness)	**Low Estimate (90% Effectiveness)**	**High Estimate (100% Effectiveness)**
Cases - No underreporting adjustment	37.9	35.9	39.9
Cases – Low underreporting (3X)	113.8	107.8	119.8

Table VIII.E.7. Sensitivity Analysis – Heat-Related Fatalities

	Primary Estimate (95% Effectiveness)	Low Estimate (90% Effectiveness)	High Estimate (100% Effectiveness)
Cases – High underreporting (15X)	568.86	538.92	598.8
Cases – Primary estimate underreporting (14X)	530.936	502.992	558.88
Monetized benefits, no underreporting adjustment underreporting	$522,213,480	$494,728,560	$549,698,400
Monetized benefits, low underreporting (3X)	$1.566,640,440	$1,484,185,680	$1,649,095,200
Monetized benefits, high underreporting (15X)	$7,833,202,200	$7,420,928,400	$8,245,476,000
Monetized benefits, primary estimate underreporting (14X)	$7,310,988,720	$6,926,199,840	$7,695,777,600

Source: OSHA estimate.

Table VIII.E.8. Sensitivity Analysis - Total Estimated Benefits

	Primary Underreporting Estimate	No Underreporting	Low Underreporting	High Underreporting
Monetized Health and Safety Benefits				
Low Effectiveness	$8,363,511,307	$686,370,089	$1,867,468,738	$9,337,343,690
High Effectiveness	$10,570,400,534	$932,981,458	$2,415,661,316	$12,078,306,579
OSHA Primary Estimate Effectiveness	$9,179,493,627	$771,347,468	$2,064,908,415	$10,324,542,076

Source: OSHA estimate.

VII. Conclusion.

Uncertainty as to the magnitude of underreporting and uncertainty as to the effectiveness of the interventions prescribed by this proposed standard create substantial uncertainty in the calculation of monetized benefits. Additional uncertainty is added by the magnitude of labor productivity benefits from the required rest breaks. With the

caveat of multiple areas of uncertainty, OSHA preliminarily concludes that this proposed standard would have an estimated $9.179 billion in total annualized benefits.

F. Initial Regulatory Flexibility Analysis, Small Business Regulatory Enforcement Fairness Act, and Executive Order 13272 (Proper Consideration of Small Entities in Agency Rulemaking).

I. Introduction.

The RFA, 5 U.S.C. 601 et seq., as amended by the Small Business Regulatory Enforcement Fairness Act of 1996, Public Law 104-121 (Mar. 29, 1996), hereafter jointly referred to as the RFA, requires Federal agencies to consider the economic impact of a proposed rulemaking on small entities. The RFA states that whenever a Federal agency is required to publish a general notice of proposed rulemaking, the agency must prepare and make available for public comment an initial regulatory flexibility analysis (IRFA) (5 U.S.C. 603(a)). Pursuant to section 605(b), instead of an IRFA, the head of an agency may certify that the proposed rule will not have a significant economic impact on a substantial number of small entities. A factual basis must support a certification. If the head of an agency makes a certification, the agency shall publish such certification in the *Federal Register* at the time of publication of a general notice of proposed rulemaking or at the time of publication of the final rule (5 U.S.C. 605(b)).

To determine whether OSHA can certify that the proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings will not have a significant economic impact on a substantial number of small entities, OSHA has developed a screening test to consider the minimum threshold effects of the proposed rule on small entities. This screening test is similar in concept to the revenue test used in Section VIII.D., Economic Feasibility, to identify minimum threshold effects to demonstrate economic feasibility. However, for this IRFA the screening test is applied not to all establishments but to small entities (called “small business concerns” by SBA).

OSHA is not able to certify that the proposed rule will not result in a significant economic impact on a substantial number of small entities, thus triggering the need for an IRFA. Under the provisions of the RFA, as amended in 1996, each such analysis shall contain:

1. A description of the reasons why action by the agency is being considered;
2. A succinct statement of the objectives of, and legal basis for, the proposed rule;
3. A description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;
4. A description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities that will be subject to the requirements and the type of professional skills necessary for the preparation of the report or record;
5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the proposed rule; and
6. A description and discussion of any significant alternatives to the proposed rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the proposed rule on small entities, such as:

   (a) The establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities;

   (b) The clarification, consolidation, or simplification of compliance and reporting requirements under the rule for such small entities;

   (c) The use of performance rather than design standards; and

   (d) An exemption from coverage of the rule, or any part thereof, for such small entities (5 U.S.C. 603, 607). The RFA further states that the required elements of the IRFA may be performed in conjunction with or as part of any other agenda or analysis required by any other law if such other analysis satisfies the provisions of

the IRFA (5 U.S.C. 605). The remaining sections of this chapter address each of the components listed above.

II. Initial Regulatory Flexibility Analysis.

A. Description of the Reasons Why Action by the Agency Is Being Considered.

Heat is the leading cause of death among all weather-related phenomena in the United States. Excessive heat exacerbates existing health conditions (e.g., asthma and heart disease) and can cause heat stroke and even death if not treated properly and promptly. Heat-related illnesses are adverse clinical health outcomes that occur due to exposure to heat (e.g., heat exhaustion or heat stroke). A heat-related injury is an injury linked to heat exposure (e.g., a fall that occurred while a person was experiencing dizziness related to heat exposure).

Employees in both outdoor and indoor work settings without adequate climate controls are at risk of hazardous heat exposure, which may lead to heat-related illnesses and injuries (HRIs). Certain heat-generating processes, machinery, and equipment (e.g., hot tar ovens, furnaces) can also cause HRIs when effective cooling measures are not in place. Some groups, such as pregnant employees, may be more likely to experience adverse health effects from heat. In contrast, others are disproportionately employed in work settings with a higher risk of HRI, such as workers of color in essential jobs.

The BLS SOII estimates that there have been 39,450 work-related HRIs involving days away from work between 2011 and 2022, for an average of 3,288 HRIs of this severity occurring per year during this period. Additionally, according to the BLS CFOI, exposure to environmental heat has killed 479 U.S. workers from 2011-2022, with an average of 40 fatalities per year during that period. As explained in Section V.A., Risk Assessment, these statistics likely do not capture the true magnitude and prevalence of heat-related injuries, illnesses, and fatalities. OSHA's estimates of the annual incidents of

heat-related fatalities and HRIs and the number the agency expects will be avoided by this proposed standard can be found in Section VIII.E., Benefits.

OSHA has developed and published recommendations for heat injury and illness prevention. However, in the absence of a Federal standard, multiple States have issued regulations to address heat hazards in the workplace. Five States have enacted laws that aim to protect employees exposed to heat: Minnesota (Minn. R. 5205.0110); California (Cal. Code of Regs. title 8, section 3395); Washington (Wash. Admin. Code sections 296-62-095 through 296-62-09560; 296307-097 through 296-307-09760); Oregon (Or. Admin. R. 437-002-0156; Or. Admin. R. 437004-1131); and Colorado (7 Colo. Code Regs section 1103-15:3).

OSHA has received multiple petitions to promulgate a heat injury and illness prevention standard in recent years, including in 2018 from Public Citizen, on behalf of approximately 130 organizations. Members of Congress have also urged OSHA to initiate rulemaking for a Federal heat standard.

In the *Federal Register*, OSHA published an advance notice of proposed rulemaking (ANPRM) for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings on October 27, 2021 (86 FR 59309). From the ANPRM, OSHA initiated the rulemaking process to consider a heat-related injury and illness prevention standard. The standard would set forth the employer's obligations and the measures necessary to protect employees to reduce the number of HRIs and fatalities more effectively among workers. The goal is to prevent or reduce the number of occupational HRIs and fatalities caused by exposure to hazardous heat.

OSHA has developed potential options for various elements of a heat-specific standard using: stakeholder comments from the ANPRM; academic literature; best practices from State heat-specific standards; recommendations from the National Institute for Occupational Safety and Health (NIOSH) and the National Advisory Committee on

Occupational Safety and Health (NACOSH); and other input from experts, stakeholders, and the public.

As described in the benefits analysis in Section VIII.E., Benefits, OSHA estimates that approximately 559 heat-related fatalities and approximately 24,656 HRIs among employees occur annually. However, as explained in that section, OSHA also believes there remains a great deal of uncertainty surrounding the extent of underreporting and other parameters used in this estimate.

B. Statement of the Objectives of and Legal Basis for the Proposed Rule.

The objective of the proposed standard is to reduce the number of HRIs and fatalities due to exposure to hazardous heat occurring among employees in the course of their work. This objective would be achieved by requiring employers to establish heat injury and illness prevention plans (HIIPPs); identify and monitor heat hazards, provide rest breaks, adequate water, and training; plan for, and be ready to respond to, heat emergencies; and take other steps to ensure that employees can perform their duties safely.

The legal basis for the rulemaking is discussed in depth in Section II., Pertinent Legal Authority. In short, Congress enacted the Occupational Safety and Health (OSH) Act of 1970 (29 U.S.C. 651 et seq.), "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources" (29 U.S.C. 651(b)). To that end, Congress authorized the Secretary of Labor "to set mandatory occupational safety and health standards applicable to businesses affecting interstate commerce" (29 U.S.C. 651(b)(3); see also 29 U.S.C. 655(b)).

The OSH Act imposes several requirements OSHA must satisfy before adopting a safety standard. Among other things, the standard must provide a high degree of employee protection, substantially reduce a significant risk to workers, be technologically feasible, and be economically feasible (see 58 FR 16612, 16614–16 (Mar. 30, 1993); *Int'l*

Union, United Auto., Aerospace & Agric. Implement Workers of Am. v. *OSHA,* 37 F.3d 665, 668–69 (D.C. Cir. 1994)). A standard is technologically feasible if the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that is reasonably expected to be developed (see *Am. Iron and Steel Inst. v. OSHA*, 939 F.2d 975, 980 (D.C. Cir. 1991)). In determining economic feasibility, OSHA must consider the cost of compliance in an industry rather than on individual employers. In its economic analyses, OSHA "must construct a reasonable estimate of compliance costs and demonstrate a reasonable likelihood that these costs will not threaten the existence or competitive structure of an industry, even if it does portend disaster for some marginal firms" (*Am. Iron and Steel Inst.*, 939 F.2d at 980, quoting *United Steelworkers of Am.* v. *Marshall,* 647 F.2d 1189, 1272 (D.C. Cir. 1980)).

C. Description and Estimate of the Number of Small Entities to Which the Proposed Rule Will Apply.

Section VIII.B., Profile of Affected Industries, of this PEA presents OSHA's preliminary analysis of the type and number of small entities to which the proposed rule would apply. To estimate the number of small entities potentially affected by this rulemaking, OSHA used definitions developed by SBA for each sector as well as the definition of a small government and small non-profit entity according to the RFA. OSHA estimates the proposed rule would affect approximately 2.0 million small entities. Across these small entities, roughly 16.2 million employees would be protected by the proposed rule. Table VIII.F.1. presents counts of small and very small entities, establishments, and employees by industry and region.

Table VIII.F.1. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Agriculture, Forestry, and Fishing						
Alaskan	475	478	831	466	466	544

Table VIII.F.1. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Central	24,294	24,322	149,091	15,065	15,065	55,208
Eastern	16,193	16,208	115,421	12,736	12,738	53,826
Pacific	199	199	1,399	138	138	1,082
Southern	26,346	26,377	169,979	17,326	17,331	62,951
Western	16,211	16,268	314,889	10,009	10,012	58,338
Subtotal	**83,717**	**83,853**	**751,608**	**55,739**	**55,750**	**231,950**
Building Materials and Equipment Suppliers						
Alaskan	14	15	216	27	27	202
Central	1,192	1,282	25,975	2,192	2,231	18,113
Eastern	1,999	2,128	40,838	3,358	3,409	27,914
Pacific	38	41	679	52	52	395
Southern	1,814	1,946	34,426	2,855	2,898	23,385
Western	1,509	1,596	28,722	2,311	2,345	18,858
Subtotal	**6,566**	**7,009**	**130,856**	**10,795**	**10,962**	**88,866**
Commercial Kitchens						
Alaskan	509	579	4,603	430	432	1,745
Central	36,119	40,201	472,283	26,822	26,939	130,727
Eastern	65,298	69,963	724,441	51,676	51,830	233,251
Pacific	1,282	1,388	16,812	946	949	4,411
Southern	42,239	47,058	571,817	31,027	31,159	145,802
Western	38,954	43,511	487,920	29,838	30,051	149,486
Subtotal	**184,402**	**202,700**	**2,277,876**	**140,740**	**141,361**	**665,422**
Construction						
Alaskan	2,383	2,400	6,784	2,277	2,279	4,532
Central	158,425	158,752	562,118	147,997	148,028	315,449
Eastern	230,158	230,528	840,221	214,268	214,313	467,181
Pacific	3,308	3,317	15,761	2,986	2,986	8,179
Southern	163,896	164,295	695,987	149,782	149,827	359,212
Western	151,930	152,258	602,318	140,362	140,392	322,939
Subtotal	**710,101**	**711,550**	**2,723,189**	**657,671**	**657,825**	**1,477,491**
Drycleaning and Commercial Laundries						
Alaskan	17	19	95	16	17	69
Central	1,929	2,171	8,814	1,754	1,797	4,391
Eastern	5,626	5,994	17,624	5,330	5,438	10,761
Pacific	39	41	313	32	34	83
Southern	3,087	3,449	12,989	2,843	2,951	7,977
Western	2,352	2,501	8,319	2,214	2,268	5,138
Subtotal	**13,051**	**14,174**	**48,155**	**12,190**	**12,506**	**28,419**
Landscaping and Facilities Support						
Alaskan	105	109	1,938	98	99	860
Central	11,364	11,974	165,112	10,565	10,796	82,930
Eastern	18,330	19,096	270,325	17,103	17,308	131,677
Pacific	223	250	5,027	202	203	2,067
Southern	12,805	13,271	200,425	11,867	11,974	101,006
Western	9,634	9,974	152,217	8,953	9,030	77,219
Subtotal	**52,461**	**54,673**	**795,043**	**48,789**	**49,410**	**395,758**
Maintenance and Repair						
Alaskan	174	186	1,055	174	176	821
Central	19,068	19,653	108,461	19,174	19,344	84,101

Table VIII.F.1. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Eastern	25,688	26,211	144,821	25,704	25,857	113,180
Pacific	304	318	1,926	304	306	1,384
Southern	20,023	20,552	117,782	20,239	20,395	87,092
Western	15,931	16,477	100,556	16,000	16,166	72,908
Subtotal	**81,188**	**83,397**	**474,600**	**81,595**	**82,245**	**359,487**
Manufacturing						
Alaskan	161	180	1,703	141	147	430
Central	28,332	29,454	617,095	20,447	20,529	95,353
Eastern	33,582	34,481	611,009	25,312	25,388	112,950
Pacific	282	288	2,422	248	248	818
Southern	24,499	25,279	450,901	18,822	18,884	83,417
Western	24,347	24,818	337,592	19,945	19,989	76,876
Subtotal	**111,203**	**114,500**	**2,020,722**	**84,915**	**85,185**	**369,844**
Oil and Gas						
Alaskan	53	61	692	29	29	70
Central	2,861	3,003	15,645	2,423	2,443	4,948
Eastern	1,391	1,458	9,518	1,116	1,125	2,497
Pacific	0	0	0	0	0	0
Southern	10,562	11,375	87,027	8,658	8,691	17,744
Western	1,561	1,631	9,034	1,306	1,308	2,807
Subtotal	**16,428**	**17,527**	**121,915**	**13,532**	**13,596**	**28,065**
Postal and Delivery Services						
Alaskan	21	33	34	18	18	26
Central	1,374	1,951	11,199	1,168	1,171	1,544
Eastern	2,238	3,001	18,998	1,899	1,900	2,351
Pacific	25	36	56	20	20	27
Southern	1,965	2,731	17,147	1,709	1,720	2,104
Western	1,533	2,081	17,285	1,302	1,309	1,733
Subtotal	**7,155**	**9,832**	**64,719**	**6,115**	**6,139**	**7,785**
Recreation and Amusement						
Alaskan	258	262	836	243	244	407
Central	9,660	9,978	76,652	8,093	8,131	23,284
Eastern	14,184	14,593	126,221	11,535	11,573	34,163
Pacific	176	182	1,996	131	131	387
Southern	9,058	9,335	79,313	7,510	7,547	22,207
Western	7,620	7,976	68,703	6,226	6,251	18,228
Subtotal	**40,956**	**42,326**	**353,720**	**33,738**	**33,877**	**98,674**
Sanitation and Waste Removal						
Alaskan	17	17	260	16	16	144
Central	598	613	11,803	519	519	5,716
Eastern	908	925	21,423	763	765	8,892
Pacific	13	16	510	10	10	186
Southern	579	600	13,810	481	482	5,650
Western	403	416	10,566	333	334	4,111
Subtotal	**2,517**	**2,586**	**58,372**	**2,120**	**2,125**	**24,699**
Telecommunications						
Alaskan	0	0	0	4	4	18
Central	6	6	28	281	303	1,237
Eastern	11	12	108	370	388	1,356

Table VIII.F.1. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Pacific	0	0	0	2	3	13
Southern	14	16	124	341	361	1,341
Western	14	14	71	271	286	1,089
Subtotal	**46**	**48**	**332**	**1,269**	**1,344**	**5,054**
Temporary Help Services						
Alaskan	3	3	111	2	2	24
Central	746	785	58,271	487	490	4,506
Eastern	1,258	1,305	92,651	845	847	7,409
Pacific	9	10	1,444	5	5	43
Southern	1,001	1,064	81,872	663	666	5,193
Western	734	765	47,601	520	525	3,995
Subtotal	**3,752**	**3,933**	**281,950**	**2,522**	**2,537**	**21,170**
Transportation						
Alaskan	472	551	2,648	402	407	779
Central	35,362	35,967	100,567	32,172	32,196	40,920
Eastern	30,938	31,687	109,558	27,247	27,290	38,381
Pacific	336	378	3,401	248	252	513
Southern	30,063	31,185	121,185	26,656	26,726	38,318
Western	22,303	23,056	77,739	19,941	20,008	26,654
Subtotal	**119,474**	**122,823**	**415,098**	**106,667**	**106,879**	**145,566**
Utilities						
Alaskan	56	86	742	34	37	110
Central	1,169	2,078	18,326	711	760	2,076
Eastern	1,235	2,285	22,667	835	957	2,177
Pacific	12	25	105	9	9	28
Southern	2,393	3,494	28,343	1,911	1,960	4,049
Western	1,279	1,717	11,810	1,067	1,103	3,123
Subtotal	**6,144**	**9,686**	**81,995**	**4,568**	**4,826**	**11,564**
Warehousing						
Alaskan	21	22	126	10	10	17
Central	2,193	3,078	70,279	732	753	1,639
Eastern	2,820	3,920	105,756	1,034	1,051	2,412
Pacific	42	51	449	8	8	34
Southern	2,570	3,800	87,420	965	975	2,066
Western	2,035	2,888	67,352	806	820	1,817
Subtotal	**9,681**	**13,759**	**331,382**	**3,555**	**3,618**	**7,985**
Non-Core						
Alaskan	1,503	1,582	14,497	1,594	1,620	5,729
Central	109,785	114,774	1,251,037	117,012	117,910	428,271
Eastern	175,885	181,593	1,867,095	189,755	190,941	648,153
Pacific	2,738	2,857	22,687	2,818	2,851	9,578
Southern	133,234	138,262	1,099,714	147,342	148,376	508,465
Western	113,249	117,242	1,000,087	122,703	123,582	423,075
Subtotal	**536,394**	**556,310**	**5,255,118**	**581,225**	**585,280**	**2,023,270**
Total						
Alaskan	6,241	6,582	37,172	5,982	6,031	16,526
Central	444,478	460,042	3,722,756	407,614	409,405	1,300,411
Eastern	627,742	645,388	5,138,694	590,884	593,119	1,898,531
Pacific	9,027	9,397	74,988	8,161	8,205	29,227

Table VIII.F.1. Profile of Small and Very Small Affected Entities, Establishments, and Employees, by Core Industry and Region

Region	Small (SBA/RFA)			Very Small (<20)		
	Entities	Establishments	Employees	Entities	Establishments	Employees
Southern	486,148	504,089	3,870,261	450,999	452,925	1,477,979
Western	411,599	425,189	3,342,781	384,105	385,778	1,268,393
Total	**1,985,235**	**2,050,685**	**16,186,651**	**1,847,745**	**1,855,463**	**5,991,068**

Source: OSHA, based on BLS 2023c; Census Bureau, 2021a; Census Bureau, 2023a;Census Bureau, 2023d; SBA, 2023; USDA, 2019; and USFA, 2023.
Note: Due to rounding, figures in the columns and rows may not sum to the totals shown.

E. Description of the Projected Reporting, Recordkeeping, and Other Compliance Requirements of the Proposed Rule.

OSHA calculates costs for small entities, as defined by SBA (SBA, 2023) and the RFA, and for "very small" entities, defined by OSHA as those with fewer than 20 employees, in each industry. To estimate costs for these small and very small entities, OSHA first calculates for each 4-digit NAICS industry and State combination, the average one-time cost per establishment, average annual cost per establishment, average one-time cost per employee, and average annual cost per employee for each provision. Since OSHA assumes the indoor work area hazard evaluation is completed every five years, average per-establishment and average per-employee costs are taken for the corresponding cost items. OSHA then multiplies these estimates by the number of small, affected establishments or affected employees at small establishments to derive one-time and annual costs for each provision of the proposed standard. One-time costs are annualized to determine total annualized costs by provision of the proposed standard. This same methodology is applied to the very small business analysis.

Table VIII.F.2. below shows across all provisions of the proposed rule, that small entities are estimated to incur annualized costs of approximately $3.9 billion for 2.0 million entities while 1.8 million very small entities are estimated to incur annualized costs of about $2.2 billion. The costs by provision are shown below while the detailed discussion of the unit costs, other parameters, and methodology are included in Section VIII.C., Costs of Compliance. Requirements at or above the high heat trigger (which includes requirements for rest breaks) are the most expensive provision for small entities, accounting for almost half of overall costs. The second most expensive provision of this proposed rule for small entities is the requirements at or above the initial heat trigger provision, which accounts for about 12.5 percent of costs overall.

Table VIII.F.2. Total Costs of the Proposed Heat Injury and Illness Prevention Standard by Provision for Small Entities (2023$)

Provision	One-Time	Periodic Costs Annualized		Annual	Costs Savings	Total Annualized [a]	
		0%	2%			0%	2%
Rule Familiarization	$126,197,841	$0	$0	$0	$0	$12,619,784	$14,049,167
Heat Injury and Illness Prevention Plan	$797,869,328	$0	$0	$142,832,518	$0	$222,619,451	$231,656,540
Identifying Heat Hazards	$51,433,925	$216,486,243	$202,237,502	$270,810,603	$0	$297,602,620	$299,050,963
Requirements at or above the Initial Heat Trigger	$257,883,589	$0	$0	$651,324,232	$35,815,071	$641,297,520	$644,218,446
Requirements at or above the High Heat Trigger	$3,616,156	$0	$0	$6,173,098,461	$4,288,986,520	$1,884,473,557	$1,884,514,515
Heat Illness and Emergency Response and Planning	$203,967,646	$0	$0	$459,558,305	$0	$479,955,069	$482,265,315
Training	$822,601,053	$0	$0	$216,052,591	$0	$298,312,696	$307,629,910
Total	**$2,263,569,538**	**$216,486,243**	**$202,237,502**	**$7,913,676,711**	**$4,324,801,590**	**$3,836,880,698**	**$3,863,384,856**

Source: OSHA.

[a] The total costs with cost savings accounts for the potential labor productivity loss avoided by having more efficient and effective rest breaks required by the proposed standard than are currently taken.

Table VIII.F.3. Total Costs of the Proposed Heat Injury and Illness Prevention Standard by Provision for Very Small Entities (2023$)

Provision	One-Time	Periodic Costs Annualized		Annual	Costs Savings	Total Annualized [a]	
		0%	2%			0%	2%
Rule Familiarization	$114,091,454	$0	$0	$0	$0	$11,409,145	$12,701,405
Heat Injury and Illness Prevention Plan	$722,235,085	$0	$0	$129,326,342	$0	$201,549,851	$209,730,267
Identifying Heat Hazards	$48,640,027	$188,281,796	$175,889,421	$254,469,418	$0	$278,161,601	$279,465,502
Requirements at or above the Initial Heat Trigger	$123,616,262	$0	$0	$252,006,494	$13,475,322	$250,892,798	$252,292,941
Requirements at or above the High Heat Trigger	$2,654,923	$0	$0	$2,476,140,705	$1,705,554,474	$770,851,723	$770,881,794
Heat Illness and Emergency	$192,369,277	$0	$0	$433,352,739	$0	$452,589,667	$454,768,543

Table VIII.F.3. Total Costs of the Proposed Heat Injury and Illness Prevention Standard by Provision for Very Small Entities (2023$)

Provision	One-Time	Periodic Costs Annualized		Annual	Costs Savings	Total Annualized [a]	
		0%	2%			0%	2%
Response and Planning							
Training	$609,255,824	$0	$0	$129,732,988	$0	$190,658,570	$197,559,323
Total	**$1,812,663,317**	**$188,281,796**	**$175,889,421**	**$3,682,138,934**	**$1,719,029,797**	**$2,163,203,649**	**$2,184,487,809**

Source: OSHA.

[a] The total costs with cost savings accounts for the potential labor productivity loss avoided by having more efficient and effective rest breaks required by the proposed standard than are currently taken.

Table VIII.F.4. presents the average costs per small entity, while table VIII.F.5. presents the average costs per very small entity. On average, nearly 2.0 million small entities are estimated to incur costs of $1,950 annually to comply with the proposed standard. Fishing (NAICS 1141) are estimated to have the lowest costs of compliance of the covered small entities—$461 on average annually to comply with the proposed rule. The small entities with the largest costs, Psychiatric and Substance Abuse Hospitals (NAICS 6222), would spend an estimated $118,974 annually to comply with the proposed standard.

On average, about 1.8 million very small entities are estimated to incur costs of $1,182 annually to comply with the proposed standard. The smallest average costs per very small entity are incurred by Fishing (NAICS 1141)—estimated to be $459 on average annually to comply with the proposed standard. The highest average costs for very small establishments are incurred by Specialty (except Psychiatric and Substance Abuse) Hospitals (NAICS 6223) and are estimated to be about $45,066 annually.

The potential small entity impacts of the proposed rule were derived based on the methodology detailed in Section VIII.D., Economic Feasibility. Table VIII.F.5. shows that, while small entities in most industries are estimated to have costs that are well below one percent of revenue, a few are estimated to experience costs that exceed one percent of revenues. Costs as a percentage of revenues for these entities vary from less than 0.01 percent for Tobacco Manufacturing (NAICS 3122) and Petroleum and Coal Products Manufacturing (NAICS 3241) to 2.84 percent for Child Care Services (NAICS 6244). Note that the costs in these tables were annualized using a 2 percent discount rate. The impacts for very small entities can be seen in table VIII.F.6.

As with the small entity impact analysis, the very small entity impact analysis shows that, in the majority of industries, the average impacts per entity are well below the

one percent threshold. Impacts range from 0.01 percent for a few industries such as Petroleum and Coal Products Manufacturing (NAICS 3241), and Motor Vehicle.

As discussed in depth in Section VIII.D., Economic Feasibility, the agency believes some of the estimated impact in some of these industries is likely overstated, due to inflexibility in the cost analysis regarding the amount of time spent outside in heat in a nondiscretionary manner. For example, even if the assumption that these employees spend a large percentage of their time outside is realistic under normal circumstances, childcare providers and in-person health care providers would likely limit their time outside in high heat situations if only to protect those in their care. If the costs of complying with this proposed standard were onerous, limiting employee exposure to the outdoors during times of extreme heat would be a costless method to comply with the standard and could possibly result in these employers being fully exempt from the standard (e.g., if the employer limited employee's outdoor exposure to meet the exemption for short duration employee exposure). OSHA's cost estimates did not take changes in employee scheduling into account and therefore may have overestimated costs to employers whose employees have discretion regarding the amount of time they spend outside.

NAICS 1124 Sheep and Goat Farming and NAICS 1129 Other Animal Production are both heavily weighted to very small family-owned farms (USDA, 2019). Due to a Congressional budget rider, OSHA is not able to expend funds on enforcement activities for small farms. Only about 5 percent of sheep and goat farms and 12 percent of combined Other Animal Production and Aquaculture are something other than family-owned farms (i.e., partnerships or corporations). (Given the economies of scale necessary for aquaculture, it's likely that these account for more of the corporate farms in the combined Other Animal Production and Aquaculture data meaning more farms in NAICS 1129 may be family-owned farms than appear to be in the combined data.) Based on the

Census of Agriculture, about 20,000 of about 79,000 total sheep and goat farms have hired labor and those have 2 hired laborers on average. For other animal production and aquaculture combined, about 35,000 farms out of about 190,000 total farms report having hired labor and have an average of 3.5 hire laborers. Based on the size and organization of these farms, it is unlikely OSHA would be enforcing this standard on those industries so they would not incur compliance costs. OSHA welcomes feedback on this analysis of the impact on small and very small entities

The costs of this proposed standard are largely employee-based and the agency has not found there to be feasibility concerns for entities of any size. Therefore, the agency believes that including large non-profits in the profile of SBA/RFA defined small entities would not alter the findings of the Initial Regulatory Flexibility Analysis. OSHA welcomes comment regarding the inclusion of large non-profits in the profile of SBA/RFA defined small entities.

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
1111	Oilseed and Grain Farming	12,511	$13,585,428	$1,086	$759,359	0.14%
1112	Vegetable and Melon Farming	2,127	$9,980,549	$4,693	$1,153,664	0.41%
1113	Fruit and Tree Nut Farming	6,121	$14,284,547	$2,334	$682,745	0.34%
1114	Greenhouse, Nursery, and Floriculture Production	2,720	$12,359,299	$4,544	$741,146	0.61%
1119	Other Crop Farming	9,564	$15,497,239	$1,620	$282,465	0.57%
1121	Cattle Ranching and Farming	18,428	$28,781,484	$1,562	$700,078	0.22%
1122	Hog and Pig Farming	1,048	$2,182,612	$2,082	$2,601,611	0.08%
1123	Poultry and Egg Production	2,278	$4,700,946	$2,064	$2,939,009	0.07%
1124	Sheep and Goat Farming	1,548	$2,393,222	$1,546	$88,910	1.74%
1125	Aquaculture	160	$616,482	$3,859	$1,133,734	0.34%
1129	Other Animal Production	4,913	$7,999,112	$1,628	$115,067	1.41%
1131	Timber Tract Operations	442	$439,946	$996	$1,501,147	0.07%
1132	Forest Nurseries and Gathering of Forest Products	150	$152,566	$1,017	$790,399	0.13%
1133	Logging	7,980	$7,648,751	$958	$1,563,286	0.06%
1141	Fishing	2,432	$1,113,045	$458	$853,204	0.05%
1142	Hunting and Trapping	351	$374,292	$1,066	$799,221	0.13%
1151	Support Activities for Crop Production	4,648	$5,853,520	$1,259	$2,707,767	0.05%
1152	Support Activities for Animal Production	4,640	$3,376,198	$728	$506,802	0.14%
1153	Support Activities for Forestry	1,658	$1,398,749	$844	$1,111,045	0.08%
2111	Oil and Gas Extraction	5,307	$16,476,736	$3,105	$26,579,145	0.01%
2131	Support Activities for Mining	10,921	$43,981,568	$4,027	$3,821,423	0.11%
2211	Electric Power Generation, Transmission and Distribution	2,058	$28,171,559	$13,690	$76,221,412	0.02%
2212	Natural Gas Distribution	418	$3,527,573	$8,436	$70,106,856	0.01%
2213	Water, Sewage and Other Systems	3,668	$7,573,926	$2,065	$1,410,992	0.15%
2361	Residential Building Construction	171,099	$106,947,179	$625	$1,421,852	0.04%
2362	Nonresidential Building Construction	40,735	$62,520,995	$1,535	$6,719,320	0.02%
2371	Utility System Construction	16,774	$34,191,049	$2,038	$3,633,655	0.06%
2372	Land Subdivision	4,805	$3,170,977	$660	$1,877,172	0.04%
2373	Highway, Street, and Bridge Construction	8,285	$17,087,777	$2,062	$6,724,608	0.03%
2379	Other Heavy and Civil Engineering Construction	4,056	$6,569,839	$1,620	$3,024,764	0.05%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
2381	Foundation, Structure, and Building Exterior Contractors	91,279	$125,277,109	$1,372	$1,699,487	0.08%
2382	Building Equipment Contractors	177,612	$233,824,679	$1,316	$1,621,258	0.08%
2383	Building Finishing Contractors	114,496	$106,453,318	$930	$1,078,107	0.09%
2389	Other Specialty Trade Contractors	68,126	$72,672,079	$1,067	$1,929,027	0.06%
3111	Animal Food Manufacturing	636	$1,601,425	$2,520	$24,357,224	0.01%
3112	Grain and Oilseed Milling	250	$1,211,561	$4,854	$62,037,403	0.01%
3113	Sugar and Confectionery Product Manufacturing	868	$2,204,453	$2,539	$9,556,299	0.03%
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	743	$3,725,663	$5,016	$25,690,434	0.02%
3115	Dairy Product Manufacturing	588	$2,637,411	$4,484	$49,929,979	0.01%
3116	Animal Slaughtering and Processing	1,456	$12,280,924	$8,438	$38,292,294	0.02%
3117	Seafood Product Preparation and Packaging	221	$902,567	$4,087	$22,008,470	0.02%
3118	Bakeries and Tortilla Manufacturing	5,471	$11,517,147	$2,105	$3,818,211	0.06%
3119	Other Food Manufacturing	1,655	$5,268,917	$3,183	$16,374,321	0.02%
3121	Beverage Manufacturing	4,226	$6,542,557	$1,548	$8,758,819	0.02%
3122	Tobacco Manufacturing	58	$515,881	$8,848	$182,294,825	0.00%
3131	Fiber, Yarn, and Thread Mills	102	$1,037,014	$10,139	$19,374,286	0.05%
3132	Fabric Mills	345	$1,937,288	$5,609	$12,945,642	0.04%
3133	Textile and Fabric Finishing and Fabric Coating Mills	378	$1,346,267	$3,565	$7,871,921	0.05%
3141	Textile Furnishings Mills	769	$2,410,151	$3,134	$5,547,861	0.06%
3149	Other Textile Product Mills	1,981	$2,870,758	$1,449	$2,012,712	0.07%
3152	Cut and Sew Apparel Manufacturing	1,485	$1,708,817	$1,151	$907,132	0.13%
3159	Apparel Accessories and Other Apparel Manufacturing	279	$488,329	$1,750	$1,772,440	0.10%
3161	Leather and Hide Tanning and Finishing	75	$78,767	$1,048	$6,384,614	0.02%
3162	Footwear Manufacturing	102	$410,499	$4,029	$5,074,485	0.08%
3211	Sawmills and Wood Preservation	1,425	$5,001,937	$3,510	$7,582,835	0.05%
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	169	$1,273,144	$7,533	$21,682,868	0.03%
3219	Other Wood Product Manufacturing	4,412	$11,586,726	$2,626	$4,072,371	0.06%
3221	Pulp, Paper, and Paperboard Mills	35	$855,082	$24,193	$136,863,576	0.02%
3222	Converted Paper Product Manufacturing	1,264	$6,774,484	$5,360	$24,890,031	0.02%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3231	Printing and Related Support Activities	12,027	$11,573,349	$962	$2,522,782	0.04%
3241	Petroleum and Coal Products Manufacturing	464	$3,199,326	$6,895	$177,980,216	0.00%
3251	Basic Chemical Manufacturing	642	$4,655,288	$7,251	$78,530,261	0.01%
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	530	$4,077,855	$7,695	$52,682,176	0.01%
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	355	$1,140,904	$3,217	$18,940,264	0.02%
3254	Pharmaceutical and Medicine Manufacturing	925	$5,779,821	$6,251	$51,766,648	0.01%
3255	Paint, Coating, and Adhesive Manufacturing	705	$2,479,397	$3,516	$16,249,794	0.02%
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	1,002	$3,477,371	$3,470	$17,908,986	0.02%
3259	Other Chemical Product and Preparation Manufacturing	872	$2,542,871	$2,916	$12,165,378	0.02%
3261	Plastics Product Manufacturing	4,134	$19,980,060	$4,833	$13,921,131	0.03%
3262	Rubber Product Manufacturing	699	$3,192,709	$4,565	$12,772,546	0.04%
3271	Clay Product and Refractory Manufacturing	463	$1,199,726	$2,590	$5,587,274	0.05%
3272	Glass and Glass Product Manufacturing	706	$1,989,379	$2,819	$6,976,531	0.04%
3273	Cement and Concrete Product Manufacturing	2,173	$8,394,899	$3,863	$8,676,117	0.04%
3274	Lime and Gypsum Product Manufacturing	74	$303,318	$4,126	$15,209,592	0.03%
3279	Other Nonmetallic Mineral Product Manufacturing	1,369	$3,198,469	$2,336	$5,186,460	0.05%
3311	Iron and Steel Mills and Ferroalloy Manufacturing	191	$2,633,059	$13,753	$115,596,140	0.01%
3312	Steel Product Manufacturing from Purchased Steel	246	$1,720,852	$6,991	$28,374,263	0.02%
3313	Alumina and Aluminum Production and Processing	155	$1,282,335	$8,290	$35,439,130	0.02%
3314	Nonferrous Metal (except Aluminum) Production and Processing	309	$1,616,110	$5,227	$39,316,152	0.01%
3315	Foundries	691	$2,989,596	$4,329	$11,281,321	0.04%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3321	Forging and Stamping	991	$2,784,200	$2,810	$10,193,180	0.03%
3322	Cutlery and Handtool Manufacturing	529	$928,777	$1,755	$5,517,119	0.03%
3323	Architectural and Structural Metals Manufacturing	5,974	$16,517,707	$2,765	$5,735,883	0.05%
3324	Boiler, Tank, and Shipping Container Manufacturing	589	$2,689,023	$4,567	$12,577,513	0.04%
3325	Hardware Manufacturing	272	$770,518	$2,836	$8,866,155	0.03%
3326	Spring and Wire Product Manufacturing	492	$1,152,112	$2,340	$6,269,990	0.04%
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	11,032	$15,208,419	$1,379	$2,901,748	0.05%
3328	Coating, Engraving, Heat Treating, and Allied Activities	2,521	$5,835,961	$2,315	$4,178,955	0.06%
3329	Other Fabricated Metal Product Manufacturing	2,806	$7,766,243	$2,767	$7,493,462	0.04%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,247	$5,944,680	$4,766	$18,417,556	0.03%
3332	Industrial Machinery Manufacturing	425	$1,030,865	$2,425	$10,195,646	0.02%
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	699	$3,921,041	$5,609	$15,601,508	0.04%
3335	Metalworking Machinery Manufacturing	3,010	$4,202,594	$1,396	$4,357,322	0.03%
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	337	$1,582,741	$4,698	$25,365,617	0.02%
3339	Other General Purpose Machinery Manufacturing	1,762	$5,979,770	$3,394	$12,034,903	0.03%
3341	Computer and Peripheral Equipment Manufacturing	415	$490,089	$1,182	$8,911,705	0.01%
3342	Communications Equipment Manufacturing	547	$1,256,142	$2,294	$13,522,113	0.02%
3343	Audio and Video Equipment Manufacturing	219	$262,564	$1,198	$5,604,208	0.02%
3344	Semiconductor and Other Electronic Component Manufacturing	1,680	$4,552,187	$2,709	$13,079,398	0.02%
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	2,157	$4,626,878	$2,145	$12,820,769	0.02%
3352	Household Appliance Manufacturing	101	$332,021	$3,290	$14,304,913	0.02%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3353	Electrical Equipment Manufacturing	852	$2,906,501	$3,411	$10,715,020	0.03%
3359	Other Electrical Equipment and Component Manufacturing	752	$2,497,573	$3,319	$12,404,672	0.03%
3361	Motor Vehicle Manufacturing	23	$51,856	$2,260	$58,221,416	0.00%
3362	Motor Vehicle Body and Trailer Manufacturing	803	$4,874,596	$6,071	$15,741,094	0.04%
3363	Motor Vehicle Parts Manufacturing	1,978	$13,487,337	$6,817	$32,394,740	0.02%
3364	Aerospace Product and Parts Manufacturing	646	$3,977,519	$6,160	$29,941,829	0.02%
3365	Railroad Rolling Stock Manufacturing	74	$567,108	$7,707	$33,655,605	0.02%
3366	Ship and Boat Building	658	$7,118,392	$10,818	$14,164,896	0.08%
3369	Other Transportation Equipment Manufacturing	392	$641,075	$1,635	$6,718,062	0.02%
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	4,766	$9,401,064	$1,972	$2,859,010	0.07%
3372	Office Furniture (including Fixtures) Manufacturing	1,690	$3,989,090	$2,360	$5,125,287	0.05%
3379	Other Furniture Related Product Manufacturing	326	$1,166,170	$3,581	$8,591,445	0.04%
3391	Medical Equipment and Supplies Manufacturing	4,621	$7,495,312	$1,622	$4,733,183	0.03%
3399	Other Miscellaneous Manufacturing	8,582	$11,161,673	$1,301	$2,660,648	0.05%
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	1,544	$11,511,623	$7,456	$8,053,146	0.09%
4232	Furniture and Home Furnishing Merchant Wholesalers	1,077	$5,781,729	$5,367	$5,828,655	0.09%
4233	Lumber and Other Construction Materials Merchant Wholesalers	993	$5,631,821	$5,671	$6,885,143	0.08%
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	2,259	$10,168,859	$4,501	$5,929,082	0.08%
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	709	$4,763,004	$6,715	$13,288,617	0.05%
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	1,907	$11,364,290	$5,960	$8,540,329	0.07%
4237	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers	1,026	$5,820,745	$5,674	$6,361,789	0.09%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4238	Machinery, Equipment, and Supplies Merchant Wholesalers	4,033	$29,834,160	$7,398	$5,737,517	0.13%
4239	Miscellaneous Durable Goods Merchant Wholesalers	2,831	$10,561,663	$3,731	$5,222,434	0.07%
4241	Paper and Paper Product Merchant Wholesalers	717	$3,784,639	$5,277	$5,821,550	0.09%
4242	Drugs and Druggists' Sundries Merchant Wholesalers	662	$4,340,575	$6,561	$10,574,055	0.06%
4243	Apparel, Piece Goods, and Notions Merchant Wholesalers	386	$1,344,807	$3,483	$5,167,182	0.07%
4244	Grocery and Related Product Merchant Wholesalers	2,662	$15,934,090	$5,986	$10,630,078	0.06%
4245	Farm Product Raw Material Merchant Wholesalers	325	$2,641,457	$8,119	$23,756,996	0.03%
4246	Chemical and Allied Products Merchant Wholesalers	809	$4,315,458	$5,336	$8,980,738	0.06%
4247	Petroleum and Petroleum Products Merchant Wholesalers	376	$3,206,820	$8,522	$61,864,570	0.01%
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	326	$3,172,050	$9,724	$13,306,719	0.07%
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	2,124	$10,353,521	$4,876	$5,895,079	0.08%
4251	Wholesale Trade Agents and Brokers	3,749	$9,368,912	$2,499	$12,764,272	0.02%
4411	Automobile Dealers	6,500	$37,276,607	$5,735	$15,961,277	0.04%
4412	Other Motor Vehicle Dealers	955	$3,490,111	$3,656	$5,414,403	0.07%
4441	Building Material and Supplies Dealers	544	$1,021,683	$1,877	$2,831,193	0.07%
4451	Grocery and Convenience Retailers	6,886	$22,913,996	$3,328	$3,311,379	0.10%
4452	Specialty Food Retailers	1,180	$2,429,585	$2,059	$1,053,778	0.20%
4811	Scheduled Air Transportation	727	$10,339,037	$14,225	$97,899,634	0.01%
4812	Nonscheduled Air Transportation	1,637	$3,179,136	$1,942	$6,496,273	0.03%
4821	Rail Transportation	113	$78,448	$697	$1,132,927	0.06%
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	606	$2,154,113	$3,553	$16,994,169	0.02%
4832	Inland Water Transportation	410	$1,791,814	$4,371	$6,386,189	0.07%
4841	General Freight Trucking	55,843	$50,365,637	$902	$1,458,914	0.06%
4842	Specialized Freight Trucking	39,386	$41,886,506	$1,063	$1,812,364	0.06%
4851	Urban Transit Systems	513	$590,618	$1,151	$2,151,325	0.05%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4852	Interurban and Rural Bus Transportation	488	$896,937	$1,837	$2,488,321	0.07%
4853	Taxi and Limousine Service	6,453	$7,243,177	$1,122	$862,937	0.13%
4854	School and Employee Bus Transportation	2,232	$3,191,204	$1,430	$2,019,525	0.07%
4855	Charter Bus Industry	978	$1,507,466	$1,541	$2,813,587	0.05%
4859	Other Transit and Ground Passenger Transportation	3,856	$3,185,344	$826	$1,343,491	0.06%
4861	Pipeline Transportation of Crude Oil	70	$347,281	$4,984	$28,045,336	0.02%
4862	Pipeline Transportation of Natural Gas	59	$90,847	$1,528	$15,269,599	0.01%
4869	Other Pipeline Transportation	71	$269,120	$3,788	$22,870,110	0.02%
4871	Scenic and Sightseeing Transportation, Land	572	$1,034,717	$1,808	$1,542,634	0.12%
4872	Scenic and Sightseeing Transportation, Water	1,479	$2,781,692	$1,881	$961,471	0.20%
4879	Scenic and Sightseeing Transportation, Other	229	$354,470	$1,551	$1,442,518	0.11%
4881	Support Activities for Air Transportation	3,639	$7,427,615	$2,041	$2,726,627	0.07%
4882	Support Activities for Rail Transportation	494	$1,414,555	$2,861	$3,694,856	0.08%
4883	Support Activities for Water Transportation	1,852	$6,207,901	$3,353	$4,619,864	0.07%
4884	Support Activities for Road Transportation	9,012	$6,993,625	$776	$1,019,225	0.08%
4885	Freight Transportation Arrangement	12,925	$18,974,056	$1,468	$2,467,206	0.06%
4889	Other Support Activities for Transportation	1,387	$1,669,460	$1,203	$1,765,588	0.07%
4921	Couriers and Express Delivery Services	3,724	$12,926,412	$3,471	$9,170,589	0.04%
4922	Local Messengers and Local Delivery	3,431	$3,012,249	$878	$1,312,866	0.07%
4931	Warehousing and Storage	9,681	$56,004,514	$5,785	$3,692,460	0.16%
5121	Motion Picture and Video Industries	2,568	$7,638,794	$2,975	$1,544,741	0.19%
5122	Sound Recording Industries	466	$946,190	$2,032	$1,914,032	0.11%
5174	Satellite Telecommunications	46	$165,892	$3,602	$3,473,723	0.10%
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	1,352	$3,731,170	$2,759	$2,821,642	0.10%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5221	Depository Credit Intermediation	1,562	$21,857,409	$13,995	$15,334,364	0.09%
5222	Nondepository Credit Intermediation	1,085	$3,521,500	$3,245	$2,825,317	0.11%
5223	Activities Related to Credit Intermediation	1,822	$4,068,120	$2,232	$1,274,881	0.18%
5232	Securities and Commodity Exchanges	1	$26,178	$39,745	$753,808,884	0.01%
5239	Other Financial Investment Activities	1,542	$3,322,810	$2,154	$3,014,962	0.07%
5241	Insurance Carriers	724	$7,767,572	$10,729	$64,751,762	0.02%
5242	Agencies, Brokerages, and Other Insurance Related Activities	18,002	$37,871,610	$2,104	$884,543	0.24%
5251	Insurance and Employee Benefit Funds	161	$187,816	$1,164	$860,458	0.14%
5259	Other Investment Pools and Funds	122	$253,899	$2,075	$1,915,830	0.11%
5311	Lessors of Real Estate	13,445	$32,370,835	$2,408	$1,498,519	0.16%
5312	Offices of Real Estate Agents and Brokers	14,553	$27,775,521	$1,909	$848,299	0.22%
5313	Activities Related to Real Estate	10,787	$33,316,314	$3,088	$865,500	0.36%
5321	Automotive Equipment Rental and Leasing	567	$2,987,344	$5,267	$2,647,455	0.20%
5322	Consumer Goods Rental	1,185	$5,301,598	$4,475	$1,093,599	0.41%
5323	General Rental Centers	318	$1,344,257	$4,222	$1,436,198	0.29%
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	1,171	$5,466,318	$4,667	$3,114,198	0.15%
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	315	$671,532	$2,130	$3,900,891	0.05%
5411	Legal Services	23,897	$49,298,948	$2,063	$1,105,731	0.19%
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	15,652	$36,586,403	$2,338	$715,353	0.33%
5413	Architectural, Engineering, and Related Services	12,833	$75,874,312	$5,913	$1,482,804	0.40%
5414	Specialized Design Services	4,402	$11,949,232	$2,715	$783,080	0.35%
5415	Computer Systems Design and Related Services	16,220	$39,798,676	$2,454	$1,363,070	0.18%
5416	Management, Scientific, and Technical Consulting Services	22,491	$62,683,511	$2,787	$917,797	0.30%
5417	Scientific Research and Development Services	2,115	$15,224,604	$7,199	$5,734,418	0.13%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5418	Advertising, Public Relations, and Related Services	4,587	$16,632,694	$3,626	$1,610,062	0.23%
5419	Other Professional, Scientific, and Technical Services	8,774	$45,327,608	$5,166	$1,037,261	0.50%
5511	Management of Companies and Enterprises	932	$7,466,268	$8,009	$7,794,296	0.10%
5611	Office Administrative Services	4,204	$10,143,593	$2,413	$1,807,749	0.13%
5612	Facilities Support Services	296	$3,898,123	$13,148	$4,474,249	0.29%
5613	Employment Services	3,752	$42,559,048	$11,344	$2,963,924	0.38%
5614	Business Support Services	3,342	$5,943,802	$1,778	$1,306,752	0.14%
5615	Travel Arrangement and Reservation Services	1,972	$3,129,421	$1,587	$1,663,607	0.10%
5616	Investigation and Security Services	2,773	$25,002,454	$9,018	$1,245,244	0.72%
5617	Services to Buildings and Dwellings	26,019	$112,901,810	$4,339	$671,194	0.65%
5619	Other Support Services	2,399	$7,136,600	$2,975	$1,533,830	0.19%
5621	Waste Collection	1,078	$2,523,921	$2,342	$3,245,312	0.07%
5622	Waste Treatment and Disposal	181	$743,227	$4,112	$3,879,488	0.11%
5629	Remediation and Other Waste Management Services	1,259	$6,361,525	$5,055	$2,114,365	0.24%
6111	Elementary and Secondary Schools	2,856	$34,194,636	$11,975	$4,338,191	0.28%
6112	Junior Colleges	61	$567,155	$9,272	$7,096,235	0.13%
6113	Colleges, Universities, and Professional Schools	178	$641,408	$3,603	$3,148,365	0.11%
6114	Business Schools and Computer and Management Training	1,150	$2,051,773	$1,785	$1,184,543	0.15%
6115	Technical and Trade Schools	1,020	$3,125,752	$3,063	$1,475,233	0.21%
6116	Other Schools and Instruction	7,124	$15,777,099	$2,215	$471,098	0.47%
6117	Educational Support Services	1,184	$2,055,225	$1,736	$994,278	0.17%
6211	Offices of Physicians	7,538	$16,396,965	$2,175	$1,557,548	0.14%
6212	Offices of Dentists	5,517	$15,448,753	$2,800	$1,107,348	0.25%
6213	Offices of Other Health Practitioners	5,985	$13,236,859	$2,212	$610,067	0.36%
6214	Outpatient Care Centers	799	$6,631,683	$8,303	$3,531,393	0.24%
6215	Medical and Diagnostic Laboratories	326	$1,639,918	$5,023	$2,880,366	0.17%
6216	Home Health Care Services	1,021	$21,196,909	$20,756	$1,947,504	1.07%
6219	Other Ambulatory Health Care Services	290	$2,399,519	$8,280	$2,122,696	0.39%
6221	General Medical and Surgical Hospitals	58	$3,146,213	$54,588	$31,988,544	0.17%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
6222	Psychiatric and Substance Abuse Hospitals	10	$1,136,474	$118,967	$26,840,059	0.44%
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	6	$408,435	$64,547	$24,345,151	0.27%
6231	Nursing Care Facilities (Skilled Nursing Facilities)	377	$15,692,040	$41,623	$7,737,051	0.54%
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	454	$12,424,041	$27,345	$2,746,969	1.00%
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	779	$13,425,442	$17,232	$2,104,725	0.82%
6239	Other Residential Care Facilities	136	$3,155,732	$23,216	$2,165,006	1.07%
6241	Individual and Family Services	2,496	$39,826,256	$15,956	$1,571,030	1.02%
6242	Community Food and Housing, and Emergency and Other Relief Services	480	$5,254,947	$10,949	$2,633,784	0.42%
6243	Vocational Rehabilitation Services	172	$4,469,310	$25,964	$2,335,393	1.11%
6244	Child Care Services	2,687	$51,565,482	$19,189	$676,561	2.84%
7111	Performing Arts Companies	4,679	$5,483,031	$1,172	$1,560,279	0.08%
7112	Spectator Sports	2,011	$2,409,683	$1,198	$2,328,568	0.05%
7113	Promoters of Performing Arts, Sports, and Similar Events	4,046	$5,398,753	$1,334	$2,099,056	0.06%
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	2,119	$2,111,109	$996	$1,445,877	0.07%
7115	Independent Artists, Writers, and Performers	15,342	$14,460,165	$942	$835,413	0.11%
7121	Museums, Historical Sites, and Similar Institutions	3,845	$6,836,964	$1,778	$2,394,793	0.07%
7131	Amusement Parks and Arcades	1,742	$3,288,557	$1,888	$1,040,189	0.18%
7132	Gambling Industries	1,000	$2,273,300	$2,272	$5,012,918	0.05%
7139	Other Amusement and Recreation Industries	34,659	$51,264,046	$1,479	$1,051,729	0.14%
7211	Traveler Accommodation	17,375	$32,853,003	$1,891	$2,184,689	0.09%
7212	RV (Recreational Vehicle) Parks and Recreational Camps	2,543	$2,405,045	$946	$991,813	0.10%
7213	Rooming and Boarding Houses, Dormitories, and Workers' Camps	687	$741,076	$1,079	$930,215	0.12%
7223	Special Food Services	7,295	$8,312,585	$1,139	$857,031	0.13%

Table VIII.F.4. Economic Impacts on Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
7224	Drinking Places (Alcoholic Beverages)	14,383	$13,061,680	$908	$663,521	0.14%
7225	Restaurants and Other Eating Places	157,253	$276,972,590	$1,761	$1,144,923	0.15%
8111	Automotive Repair and Maintenance	62,789	$100,273,474	$1,597	$798,630	0.20%
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	8,982	$14,997,313	$1,670	$1,261,858	0.13%
8114	Personal and Household Goods Repair and Maintenance	9,417	$11,449,589	$1,216	$455,661	0.27%
8121	Personal Care Services	52,932	$64,529,881	$1,219	$346,123	0.35%
8122	Death Care Services	6,955	$13,214,986	$1,900	$1,130,650	0.17%
8123	Drycleaning and Laundry Services	13,051	$16,733,433	$1,282	$564,862	0.23%
8129	Other Personal Services	16,792	$22,209,398	$1,323	$509,230	0.26%
8131	Religious Organizations	83,837	$126,171,312	$1,505	$722,894	0.21%
8132	Grantmaking and Giving Services	7,839	$8,889,289	$1,134	$3,473,007	0.03%
8133	Social Advocacy Organizations	6,903	$8,993,435	$1,303	$1,442,084	0.09%
8134	Civic and Social Organizations	11,030	$15,706,906	$1,424	$697,379	0.20%
8139	Business, Professional, Labor, Political, and Similar Organizations	25,710	$33,664,444	$1,309	$1,384,987	0.09%
9993	Local Government	4,846	$132,114,558	$27,261	$17,292,921	0.16%
Total		**1,985,235**	**$3,863,384,856**	**$1,946**	**$2,403,819**	**0.08%**

Source: OSHA.

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
1111	Oilseed and Grain Farming	7,184	$6,027,437	$839	$609,184	0.14%
1112	Vegetable and Melon Farming	1,227	$3,233,900	$2,636	$705,291	0.37%
1113	Fruit and Tree Nut Farming	3,060	$4,119,361	$1,346	$384,931	0.35%
1114	Greenhouse, Nursery, and Floriculture Production	1,545	$4,149,308	$2,686	$513,448	0.52%
1119	Other Crop Farming	5,537	$6,434,964	$1,162	$198,860	0.58%
1121	Cattle Ranching and Farming	10,474	$11,742,592	$1,121	$523,461	0.21%
1122	Hog and Pig Farming	585	$921,175	$1,575	$2,022,974	0.08%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
1123	Poultry and Egg Production	1,356	$2,018,022	$1,488	$2,264,037	0.07%
1124	Sheep and Goat Farming	856	$968,612	$1,131	$59,994	1.89%
1125	Aquaculture	91	$239,911	$2,630	$875,290	0.30%
1129	Other Animal Production	2,806	$3,272,814	$1,166	$88,841	1.31%
1131	Timber Tract Operations	429	$403,940	$942	$1,293,445	0.07%
1132	Forest Nurseries and Gathering of Forest Products	144	$104,419	$725	$679,386	0.11%
1133	Logging	7,530	$6,292,246	$836	$1,170,494	0.07%
1141	Fishing	2,416	$1,100,212	$455	$667,346	0.07%
1142	Hunting and Trapping	331	$292,626	$885	$619,029	0.14%
1151	Support Activities for Crop Production	4,102	$3,213,003	$783	$1,530,220	0.05%
1152	Support Activities for Animal Production	4,531	$2,962,939	$654	$405,439	0.16%
1153	Support Activities for Forestry	1,534	$1,037,673	$676	$765,904	0.09%
2111	Oil and Gas Extraction	4,571	$6,341,178	$1,387	$2,574,156	0.05%
2131	Support Activities for Mining	8,845	$14,462,495	$1,635	$937,066	0.17%
2211	Electric Power Generation, Transmission and Distribution	832	$2,254,730	$2,709	$13,316,386	0.02%
2212	Natural Gas Distribution	267	$546,792	$2,049	$10,690,728	0.02%
2213	Water, Sewage and Other Systems	3,468	$5,937,995	$1,712	$850,747	0.20%
2361	Residential Building Construction	167,394	$90,561,837	$541	$1,043,976	0.05%
2362	Nonresidential Building Construction	34,810	$32,498,908	$934	$2,948,013	0.03%
2371	Utility System Construction	13,929	$14,564,718	$1,046	$1,657,874	0.06%
2372	Land Subdivision	4,615	$2,626,758	$569	$1,167,179	0.05%
2373	Highway, Street, and Bridge Construction	6,251	$5,486,633	$878	$2,619,746	0.03%
2379	Other Heavy and Civil Engineering Construction	3,581	$3,418,173	$954	$1,444,677	0.07%
2381	Foundation, Structure, and Building Exterior Contractors	83,470	$72,226,262	$865	$936,942	0.09%
2382	Building Equipment Contractors	161,684	$141,354,524	$874	$847,521	0.10%
2383	Building Finishing Contractors	108,028	$74,449,281	$689	$653,438	0.11%
2389	Other Specialty Trade Contractors	62,342	$43,480,559	$697	$1,039,609	0.07%
3111	Animal Food Manufacturing	377	$349,776	$928	$5,316,620	0.02%
3112	Grain and Oilseed Milling	130	$273,983	$2,115	$22,940,721	0.01%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3113	Sugar and Confectionery Product Manufacturing	652	$541,708	$831	$1,163,232	0.07%
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	441	$532,718	$1,207	$3,760,308	0.03%
3115	Dairy Product Manufacturing	337	$456,581	$1,353	$9,285,097	0.01%
3116	Animal Slaughtering and Processing	996	$872,620	$876	$2,401,951	0.04%
3117	Seafood Product Preparation and Packaging	129	$107,828	$838	$3,136,053	0.03%
3118	Bakeries and Tortilla Manufacturing	4,379	$4,017,779	$918	$635,675	0.14%
3119	Other Food Manufacturing	1,111	$1,075,034	$968	$2,724,529	0.04%
3121	Beverage Manufacturing	3,429	$2,263,370	$660	$1,398,536	0.05%
3122	Tobacco Manufacturing	32	$42,411	$1,311	$6,587,893	0.02%
3131	Fiber, Yarn, and Thread Mills	60	$75,096	$1,254	$2,191,371	0.06%
3132	Fabric Mills	192	$233,984	$1,217	$3,435,732	0.04%
3133	Textile and Fabric Finishing and Fabric Coating Mills	263	$271,517	$1,031	$1,915,018	0.05%
3141	Textile Furnishings Mills	630	$573,335	$910	$780,741	0.12%
3149	Other Textile Product Mills	1,705	$1,270,778	$745	$614,109	0.12%
3151	Apparel Knitting Mills	54	$66,320	$1,228	$1,443,320	0.09%
3152	Cut and Sew Apparel Manufacturing	2,095	$1,429,596	$682	$637,842	0.11%
3159	Apparel Accessories and Other Apparel Manufacturing	236	$188,102	$796	$619,537	0.13%
3161	Leather and Hide Tanning and Finishing	61	$42,671	$698	$2,839,687	0.02%
3162	Footwear Manufacturing	75	$123,351	$1,655	$2,193,374	0.08%
3169	Other Leather and Allied Product Manufacturing	302	$187,558	$621	$626,299	0.10%
3211	Sawmills and Wood Preservation	1,006	$1,185,132	$1,179	$1,727,380	0.07%
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	264	$633,617	$2,400	$4,044,768	0.06%
3219	Other Wood Product Manufacturing	3,327	$3,257,167	$979	$1,053,722	0.09%
3221	Pulp, Paper, and Paperboard Mills	27	$376,078	$13,794	$93,208,301	0.01%
3222	Converted Paper Product Manufacturing	559	$893,086	$1,597	$4,579,693	0.03%
3231	Printing and Related Support Activities	10,124	$5,790,603	$572	$693,094	0.08%
3241	Petroleum and Coal Products Manufacturing	244	$494,702	$2,027	$28,484,143	0.01%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3251	Basic Chemical Manufacturing	277	$556,651	$2,011	$21,892,698	0.01%
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	226	$335,765	$1,485	$6,835,167	0.02%
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	229	$350,781	$1,534	$7,269,726	0.02%
3254	Pharmaceutical and Medicine Manufacturing	546	$603,519	$1,106	$3,960,913	0.03%
3255	Paint, Coating, and Adhesive Manufacturing	448	$542,317	$1,211	$3,140,147	0.04%
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	704	$655,288	$931	$2,390,628	0.04%
3259	Other Chemical Product and Preparation Manufacturing	579	$723,101	$1,250	$3,072,599	0.04%
3261	Plastics Product Manufacturing	2,192	$2,911,100	$1,328	$2,782,966	0.05%
3262	Rubber Product Manufacturing	382	$557,177	$1,459	$2,487,702	0.06%
3271	Clay Product and Refractory Manufacturing	328	$323,850	$989	$1,473,179	0.07%
3272	Glass and Glass Product Manufacturing	539	$546,405	$1,014	$1,791,588	0.06%
3273	Cement and Concrete Product Manufacturing	1,336	$1,655,935	$1,240	$2,456,404	0.05%
3274	Lime and Gypsum Product Manufacturing	51	$122,726	$2,409	$7,351,270	0.03%
3279	Other Nonmetallic Mineral Product Manufacturing	1,006	$1,149,905	$1,143	$1,653,776	0.07%
3311	Iron and Steel Mills and Ferroalloy Manufacturing	103	$218,406	$2,121	$6,567,240	0.03%
3312	Steel Product Manufacturing from Purchased Steel	121	$265,350	$2,191	$7,339,261	0.03%
3313	Alumina and Aluminum Production and Processing	82	$262,328	$3,197	$12,497,676	0.03%
3314	Nonferrous Metal (except Aluminum) Production and Processing	178	$278,430	$1,566	$8,757,990	0.02%
3315	Foundries	391	$547,296	$1,398	$2,192,210	0.06%
3321	Forging and Stamping	556	$557,664	$1,003	$2,020,339	0.05%
3322	Cutlery and Handtool Manufacturing	373	$259,248	$695	$1,107,327	0.06%
3323	Architectural and Structural Metals Manufacturing	4,125	$4,085,887	$991	$1,456,833	0.07%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3324	Boiler, Tank, and Shipping Container Manufacturing	300	$423,339	$1,409	$3,917,337	0.04%
3325	Hardware Manufacturing	186	$153,954	$828	$1,511,537	0.05%
3326	Spring and Wire Product Manufacturing	298	$292,858	$983	$1,589,842	0.06%
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	8,812	$6,785,989	$770	$910,823	0.08%
3328	Coating, Engraving, Heat Treating, and Allied Activities	1,740	$1,753,611	$1,008	$985,271	0.10%
3329	Other Fabricated Metal Product Manufacturing	1,998	$2,026,136	$1,014	$1,910,855	0.05%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	776	$880,986	$1,135	$2,303,225	0.05%
3332	Industrial Machinery Manufacturing	951	$827,287	$870	$1,790,885	0.05%
3333	Commercial and Service Industry Machinery Manufacturing	602	$467,902	$777	$1,741,883	0.04%
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	409	$485,787	$1,186	$2,390,594	0.05%
3335	Metalworking Machinery Manufacturing	2,174	$1,503,816	$692	$1,172,111	0.06%
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	186	$279,911	$1,504	$4,514,698	0.03%
3339	Other General Purpose Machinery Manufacturing	1,576	$1,782,884	$1,131	$2,828,012	0.04%
3341	Computer and Peripheral Equipment Manufacturing	317	$181,009	$570	$2,040,422	0.03%
3342	Communications Equipment Manufacturing	374	$275,245	$735	$2,213,015	0.03%
3343	Audio and Video Equipment Manufacturing	180	$98,831	$548	$1,509,740	0.04%
3344	Semiconductor and Other Electronic Component Manufacturing	991	$740,401	$747	$1,810,399	0.04%
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1,411	$961,637	$682	$2,280,952	0.03%
3346	Manufacturing and Reproducing Magnetic and Optical Media	158	$80,247	$509	$869,333	0.06%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
3351	Electric Lighting Equipment Manufacturing	321	$290,904	$906	$2,228,223	0.04%
3352	Household Appliance Manufacturing	73	$67,216	$915	$1,907,392	0.05%
3353	Electrical Equipment Manufacturing	543	$585,477	$1,078	$2,265,967	0.05%
3359	Other Electrical Equipment and Component Manufacturing	530	$775,438	$1,462	$4,923,782	0.03%
3361	Motor Vehicle Manufacturing	72	$42,019	$586	$8,079,095	0.01%
3362	Motor Vehicle Body and Trailer Manufacturing	462	$571,401	$1,237	$2,128,388	0.06%
3363	Motor Vehicle Parts Manufacturing	1,140	$1,248,555	$1,096	$2,450,442	0.04%
3364	Aerospace Product and Parts Manufacturing	368	$569,759	$1,550	$4,750,992	0.03%
3365	Railroad Rolling Stock Manufacturing	32	$104,712	$3,303	$12,137,746	0.03%
3366	Ship and Boat Building	446	$605,519	$1,357	$1,347,324	0.10%
3369	Other Transportation Equipment Manufacturing	321	$258,348	$804	$1,487,253	0.05%
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	4,244	$3,437,887	$810	$718,130	0.11%
3372	Office Furniture (including Fixtures) Manufacturing	1,162	$1,046,524	$901	$1,149,394	0.08%
3379	Other Furniture Related Product Manufacturing	216	$288,388	$1,337	$2,340,433	0.06%
3391	Medical Equipment and Supplies Manufacturing	3,950	$2,735,349	$693	$758,887	0.09%
3399	Other Miscellaneous Manufacturing	7,399	$5,215,239	$705	$801,390	0.09%
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	1,257	$4,993,354	$3,973	$3,303,747	0.12%
4232	Furniture and Home Furnishing Merchant Wholesalers	910	$3,110,498	$3,417	$2,854,446	0.12%
4233	Lumber and Other Construction Materials Merchant Wholesalers	785	$2,505,110	$3,193	$3,557,039	0.09%
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	1,916	$5,577,568	$2,912	$2,405,983	0.12%
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	556	$2,106,984	$3,790	$6,228,340	0.06%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	1,576	$5,580,492	$3,542	$3,369,434	0.11%
4237	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers	816	$2,636,524	$3,230	$2,796,763	0.12%
4238	Machinery, Equipment, and Supplies Merchant Wholesalers	3,312	$15,267,247	$4,610	$2,896,468	0.16%
4239	Miscellaneous Durable Goods Merchant Wholesalers	2,551	$6,358,104	$2,492	$2,832,277	0.09%
4241	Paper and Paper Product Merchant Wholesalers	610	$2,004,758	$3,287	$2,995,604	0.11%
4242	Drugs and Druggists' Sundries Merchant Wholesalers	563	$1,888,913	$3,356	$4,020,123	0.08%
4243	Apparel, Piece Goods, and Notions Merchant Wholesalers	1,248	$3,098,845	$2,483	$2,808,295	0.09%
4244	Grocery and Related Product Merchant Wholesalers	2,242	$7,359,247	$3,283	$4,893,717	0.07%
4245	Farm Product Raw Material Merchant Wholesalers	266	$1,240,969	$4,671	$11,316,686	0.04%
4246	Chemical and Allied Products Merchant Wholesalers	676	$2,375,082	$3,516	$5,030,093	0.07%
4247	Petroleum and Petroleum Products Merchant Wholesalers	263	$1,242,062	$4,718	$20,772,751	0.02%
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	243	$763,626	$3,147	$3,176,806	0.10%
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	1,870	$6,010,140	$3,215	$2,900,974	0.11%
4251	Wholesale Trade Agents and Brokers	3,577	$7,395,194	$2,068	$8,758,811	0.02%
4411	Automobile Dealers	4,702	$9,420,631	$2,004	$3,255,236	0.06%
4412	Other Motor Vehicle Dealers	1,853	$4,518,777	$2,439	$2,697,277	0.09%
4413	Automotive Parts, Accessories, and Tire Retailers	4,859	$11,159,040	$2,297	$1,134,410	0.20%
4441	Building Material and Supplies Dealers	5,693	$7,059,545	$1,240	$1,614,974	0.08%
4442	Lawn and Garden Equipment and Supplies Retailers	2,502	$5,016,485	$2,005	$1,498,082	0.13%
4451	Grocery and Convenience Retailers	10,521	$16,794,972	$1,596	$1,054,320	0.15%
4452	Specialty Food Retailers	3,551	$5,729,397	$1,613	$900,891	0.18%
4453	Beer, Wine, and Liquor Retailers	5,163	$5,975,343	$1,157	$1,325,671	0.09%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4491	Furniture and Home Furnishings Retailers	6,010	$8,962,736	$1,491	$1,223,523	0.12%
4492	Electronics and Appliance Retailers	3,217	$4,908,069	$1,525	$1,030,417	0.15%
4551	Department Stores	148	$190,770	$1,287	$1,621,586	0.08%
4552	Warehouse Clubs, Supercenters, and Other General Merchandise Retailers	2,556	$3,419,681	$1,338	$842,471	0.16%
4561	Health and Personal Care Retailers	7,776	$9,533,570	$1,226	$1,791,759	0.07%
4571	Gasoline Stations	10,327	$15,498,593	$1,501	$2,804,858	0.05%
4572	Fuel Dealers	649	$1,060,755	$1,635	$2,693,189	0.06%
4581	Clothing and Clothing Accessories Retailers	5,967	$8,712,135	$1,460	$698,207	0.21%
4582	Shoe Retailers	1,010	$1,421,801	$1,408	$1,020,151	0.14%
4583	Jewelry, Luggage, and Leather Goods Retailers	2,976	$3,898,966	$1,310	$1,079,268	0.12%
4591	Sporting Goods, Hobby, and Musical Instrument Retailers	5,150	$7,074,290	$1,374	$864,136	0.16%
4592	Book Retailers and News Dealers	774	$988,633	$1,278	$744,295	0.17%
4593	Florists	2,213	$3,540,277	$1,600	$494,498	0.32%
4594	Office Supplies, Stationery, and Gift Retailers	3,317	$4,621,207	$1,393	$627,443	0.22%
4595	Used Merchandise Retailers	2,352	$3,240,613	$1,378	$608,402	0.23%
4599	Other Miscellaneous Retailers	5,911	$8,732,908	$1,477	$1,042,423	0.14%
4811	Scheduled Air Transportation	278	$293,355	$1,054	$3,080,504	0.03%
4812	Nonscheduled Air Transportation	1,285	$1,286,819	$1,001	$2,040,509	0.05%
4821	Rail Transportation	96	$51,361	$536	$399,619	0.13%
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	455	$544,184	$1,196	$2,200,414	0.05%
4832	Inland Water Transportation	323	$453,643	$1,403	$1,350,810	0.10%
4841	General Freight Trucking	51,643	$37,499,799	$726	$861,013	0.08%
4842	Specialized Freight Trucking	35,020	$26,650,522	$761	$892,912	0.09%
4851	Urban Transit Systems	373	$312,637	$839	$839,880	0.10%
4852	Interurban and Rural Bus Transportation	332	$422,567	$1,274	$833,268	0.15%
4853	Taxi and Limousine Service	5,931	$6,596,898	$1,112	$473,725	0.23%
4854	School and Employee Bus Transportation	1,444	$1,578,496	$1,093	$381,438	0.29%
4855	Charter Bus Industry	663	$764,143	$1,152	$976,121	0.12%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
4859	Other Transit and Ground Passenger Transportation	3,097	$2,381,262	$769	$514,988	0.15%
4861	Pipeline Transportation of Crude Oil	27	$34,499	$1,282	$5,687,521	0.02%
4862	Pipeline Transportation of Natural Gas	59	$90,847	$1,528	$15,269,599	0.01%
4869	Other Pipeline Transportation	29	$37,586	$1,288	$4,867,763	0.03%
4871	Scenic and Sightseeing Transportation, Land	474	$570,363	$1,203	$670,486	0.18%
4872	Scenic and Sightseeing Transportation, Water	1,385	$2,109,958	$1,524	$589,761	0.26%
4879	Scenic and Sightseeing Transportation, Other	208	$272,900	$1,311	$812,572	0.16%
4881	Support Activities for Air Transportation	2,961	$3,481,748	$1,176	$1,058,641	0.11%
4882	Support Activities for Rail Transportation	315	$430,553	$1,366	$1,603,240	0.09%
4883	Support Activities for Water Transportation	1,396	$1,914,888	$1,372	$1,256,551	0.11%
4884	Support Activities for Road Transportation	8,222	$6,121,945	$745	$687,092	0.11%
4885	Freight Transportation Arrangement	11,283	$15,674,157	$1,389	$1,583,872	0.09%
4889	Other Support Activities for Transportation	1,202	$1,095,829	$912	$799,155	0.11%
4921	Couriers and Express Delivery Services	3,125	$2,811,195	$900	$843,986	0.11%
4922	Local Messengers and Local Delivery	2,990	$2,455,403	$821	$741,162	0.11%
4931	Warehousing and Storage	3,555	$3,599,514	$1,012	$1,301,304	0.08%
5121	Motion Picture and Video Industries	2,383	$4,673,631	$1,962	$903,851	0.22%
5122	Sound Recording Industries	445	$780,716	$1,754	$660,025	0.27%
5131	Newspaper, Periodical, Book, and Directory Publishers	1,936	$4,503,697	$2,326	$816,692	0.28%
5132	Software Publishers	1,057	$2,023,518	$1,915	$1,268,517	0.15%
5161	Radio and Television Broadcasting Stations	370	$1,470,235	$3,969	$662,207	0.60%
5162	Media Streaming Distribution Services, Social Networks, and Other Media Networks and Content Providers	235	$560,991	$2,388	$1,346,479	0.18%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5171	Wired and Wireless Telecommunications (except Satellite)	942	$1,900,994	$2,018	$1,249,302	0.16%
5174	Satellite Telecommunications	40	$86,847	$2,157	$1,745,466	0.12%
5178	All Other Telecommunications	287	$502,736	$1,753	$1,126,736	0.16%
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	1,112	$2,196,650	$1,976	$1,171,961	0.17%
5192	Web Search Portals, Libraries, Archives, and Other Information Services	468	$867,704	$1,853	$507,510	0.37%
5221	Depository Credit Intermediation	637	$1,709,643	$2,682	$1,711,700	0.16%
5222	Nondepository Credit Intermediation	1,654	$3,919,691	$2,369	$1,191,143	0.20%
5223	Activities Related to Credit Intermediation	1,718	$3,212,716	$1,870	$758,941	0.25%
5231	Securities and Commodity Contracts Intermediation and Brokerage	1,349	$2,298,865	$1,704	$1,235,568	0.14%
5232	Securities and Commodity Exchanges	0	$19,633	$39,745	$753,808,884	0.01%
5239	Other Financial Investment Activities	6,852	$11,878,438	$1,734	$1,247,480	0.14%
5241	Insurance Carriers	499	$1,011,256	$2,025	$3,600,269	0.06%
5242	Agencies, Brokerages, and Other Insurance Related Activities	17,366	$34,184,872	$1,968	$575,155	0.34%
5251	Insurance and Employee Benefit Funds	197	$166,858	$849	$198,788	0.43%
5259	Other Investment Pools and Funds	112	$200,679	$1,786	$1,085,641	0.16%
5311	Lessors of Real Estate	12,961	$26,616,095	$2,054	$1,090,656	0.19%
5312	Offices of Real Estate Agents and Brokers	14,379	$25,261,103	$1,757	$700,221	0.25%
5313	Activities Related to Real Estate	10,077	$22,407,861	$2,224	$584,901	0.38%
5321	Automotive Equipment Rental and Leasing	482	$1,447,641	$3,004	$1,018,247	0.29%
5322	Consumer Goods Rental	1,039	$3,003,692	$2,891	$609,218	0.47%
5323	General Rental Centers	284	$865,973	$3,049	$969,539	0.31%
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	949	$2,282,588	$2,404	$1,447,107	0.17%
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	285	$476,238	$1,669	$3,054,162	0.05%
5411	Legal Services	22,852	$45,807,442	$2,005	$747,237	0.27%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	14,754	$29,735,652	$2,015	$425,212	0.47%
5413	Architectural, Engineering, and Related Services	11,568	$42,680,149	$3,690	$796,165	0.46%
5414	Specialized Design Services	4,322	$10,844,535	$2,509	$651,156	0.39%
5415	Computer Systems Design and Related Services	15,074	$30,869,789	$2,048	$699,158	0.29%
5416	Management, Scientific, and Technical Consulting Services	21,484	$48,439,074	$2,255	$605,529	0.37%
5417	Scientific Research and Development Services	1,662	$4,503,806	$2,709	$1,184,901	0.23%
5418	Advertising, Public Relations, and Related Services	4,240	$11,597,282	$2,735	$972,915	0.28%
5419	Other Professional, Scientific, and Technical Services	8,042	$31,055,715	$3,862	$718,191	0.54%
5511	Management of Companies and Enterprises	622	$1,694,619	$2,724	$2,000,475	0.14%
5611	Office Administrative Services	3,518	$5,423,804	$1,542	$785,494	0.20%
5612	Facilities Support Services	157	$441,128	$2,817	$1,344,810	0.21%
5613	Employment Services	2,522	$4,435,122	$1,758	$862,254	0.20%
5614	Business Support Services	2,939	$3,932,901	$1,338	$637,724	0.21%
5615	Travel Arrangement and Reservation Services	1,846	$2,452,247	$1,328	$1,145,290	0.12%
5616	Investigation and Security Services	2,305	$7,402,537	$3,212	$568,222	0.57%
5617	Services to Buildings and Dwellings	24,202	$62,022,534	$2,563	$441,221	0.58%
5619	Other Support Services	2,194	$4,403,819	$2,007	$960,942	0.21%
5621	Waste Collection	893	$1,162,660	$1,301	$1,262,504	0.10%
5622	Waste Treatment and Disposal	140	$316,092	$2,251	$1,725,940	0.13%
5629	Remediation and Other Waste Management Services	1,086	$3,133,580	$2,885	$1,098,195	0.26%
6111	Elementary and Secondary Schools	1,169	$3,475,761	$2,973	$637,302	0.47%
6112	Junior Colleges	29	$111,992	$3,817	$2,336,262	0.16%
6113	Colleges, Universities, and Professional Schools	119	$231,971	$1,952	$1,512,355	0.13%
6114	Business Schools and Computer and Management Training	1,062	$1,591,435	$1,498	$755,854	0.20%
6115	Technical and Trade Schools	841	$1,646,426	$1,959	$687,422	0.28%
6116	Other Schools and Instruction	6,476	$11,488,813	$1,774	$332,175	0.53%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
6117	Educational Support Services	1,096	$1,574,151	$1,437	$604,768	0.24%
6211	Offices of Physicians	6,908	$12,269,746	$1,776	$960,870	0.18%
6212	Offices of Dentists	5,290	$13,513,854	$2,555	$948,924	0.27%
6213	Offices of Other Health Practitioners	5,695	$10,110,019	$1,775	$447,256	0.40%
6214	Outpatient Care Centers	536	$1,544,461	$2,879	$989,325	0.29%
6215	Medical and Diagnostic Laboratories	265	$717,035	$2,703	$1,182,302	0.23%
6216	Home Health Care Services	653	$2,917,046	$4,468	$518,702	0.86%
6219	Other Ambulatory Health Care Services	209	$655,184	$3,137	$797,038	0.39%
6221	General Medical and Surgical Hospitals	4	$20,164	$5,297	$10,704,238	0.05%
6222	Psychiatric and Substance Abuse Hospitals	1	$60,072	$40,967	$15,140,669	0.27%
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	2	$89,129	$45,058	$23,112,360	0.19%
6231	Nursing Care Facilities (Skilled Nursing Facilities)	97	$299,181	$3,092	$1,138,055	0.27%
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	246	$1,184,615	$4,820	$495,389	0.97%
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	523	$2,224,552	$4,252	$439,078	0.97%
6239	Other Residential Care Facilities	83	$513,007	$6,216	$469,247	1.32%
6241	Individual and Family Services	1,805	$7,386,994	$4,092	$424,361	0.96%
6242	Community Food and Housing, and Emergency and Other Relief Services	334	$1,555,480	$4,659	$990,632	0.47%
6243	Vocational Rehabilitation Services	81	$345,131	$4,262	$566,673	0.75%
6244	Child Care Services	2,132	$20,144,880	$9,448	$290,434	3.25%
7111	Performing Arts Companies	4,171	$4,129,821	$990	$787,860	0.13%
7112	Spectator Sports	1,794	$1,430,879	$797	$1,258,295	0.06%
7113	Promoters of Performing Arts, Sports, and Similar Events	3,604	$3,665,186	$1,017	$1,122,492	0.09%
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	2,047	$2,033,576	$993	$1,093,566	0.09%

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue
7115	Independent Artists, Writers, and Performers	15,202	$14,251,524	$937	$787,943	0.12%
7121	Museums, Historical Sites, and Similar Institutions	3,149	$3,311,160	$1,051	$608,424	0.17%
7131	Amusement Parks and Arcades	1,354	$1,316,414	$972	$516,918	0.19%
7132	Gambling Industries	744	$922,020	$1,239	$1,354,532	0.09%
7139	Other Amusement and Recreation Industries	28,297	$22,821,999	$807	$483,584	0.17%
7211	Traveler Accommodation	12,993	$15,574,139	$1,199	$877,297	0.14%
7212	RV (Recreational Vehicle) Parks and Recreational Camps	2,293	$1,620,981	$707	$721,900	0.10%
7213	Rooming and Boarding Houses, Dormitories, and Workers' Camps	654	$651,616	$996	$650,782	0.15%
7223	Special Food Services	6,293	$4,826,527	$767	$453,753	0.17%
7224	Drinking Places (Alcoholic Beverages)	12,801	$9,231,321	$721	$450,393	0.16%
7225	Restaurants and Other Eating Places	117,267	$109,738,307	$936	$537,890	0.17%
8111	Automotive Repair and Maintenance	64,015	$85,582,777	$1,337	$646,006	0.21%
8112	Electronic and Precision Equipment Repair and Maintenance	4,843	$7,081,340	$1,462	$555,490	0.26%
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	8,375	$11,158,572	$1,332	$842,857	0.16%
8114	Personal and Household Goods Repair and Maintenance	9,205	$10,159,719	$1,104	$380,439	0.29%
8121	Personal Care Services	50,363	$59,103,771	$1,174	$267,441	0.44%
8122	Death Care Services	6,418	$9,445,610	$1,472	$854,725	0.17%
8123	Drycleaning and Laundry Services	12,190	$12,520,561	$1,027	$353,835	0.29%
8129	Other Personal Services	15,818	$15,920,372	$1,006	$339,338	0.30%
8131	Religious Organizations	76,718	$98,017,873	$1,278	$417,227	0.31%
8132	Grantmaking and Giving Services	7,573	$8,483,782	$1,120	$2,705,446	0.04%
8133	Social Advocacy Organizations	6,199	$6,958,994	$1,123	$816,788	0.14%
8134	Civic and Social Organizations	10,249	$12,512,391	$1,221	$479,271	0.25%
8139	Business, Professional, Labor, Political, and Similar Organizations	23,841	$28,061,383	$1,177	$819,457	0.14%
9993	Local Government	1,922	$4,052,837	$2,109	$1,111,959	0.19%
Total		**1,847,745**	**$2,177,399,776**	**$1,178**	**$987,455**	**0.12%**

Table VIII.F.5. Economic Impacts on Very Small Entities Affected by the Proposed Standard with Costs Calculated Using a 2% Discount Rate

NAICS	Industry	Entities	Total Annualized Costs	Average Annualized Cost per Entity	Average Revenue per Entity	Costs as % of Revenue

Source: OSHA.

F. Federal rules which may duplicate, overlap, or conflict with the proposed rule.

The Regulatory Flexibility Act (RFA) requires that the agency's initial regulatory flexibility Analysis identify, "to the extent practicable, ... all relevant Federal rules which may duplicate, overlap or conflict with the proposed rule" (5 U.S.C. 603(b)(5)). Below, OSHA discusses whether the rules it has identified would duplicate, overlap, or conflict with the options for a potential standard as outlined above. While some Federal rules may have overlapping requirements, OSHA did not identify any rules that would conflict with the proposed standard. The agency therefore believes that no Federal rules would prevent compliance with the proposed standard.

I. Other Federal Agency Rules.

The first Federal rules that OSHA identified are regulations promulgated by the Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. 136 et seq). The Worker Protection Standard (WPS) (40 CFR part 170) is designed to protect agricultural workers from "unreasonable adverse effects of pesticides" (80 FR 67496); however, there are some provisions of the WPS addressing heat hazards associated with PPE use required by that standard. The WPS requires that employers implement "appropriate" or "sufficient" measures to prevent heat-related illness when workers must wear PPE (40 CFR 170.507, 170.605). The WPS also requires employers to ensure pesticide handlers are trained on how to recognize, prevent, and provide first aid treatment for heat-related illnesses (40 CFR 170.501). Although there may be some overlap between these requirements and some elements of the proposed standard (e.g., training), OSHA is not aware of any conflicts. OSHA's proposed standard would be entirely consistent with EPA's requirements around PPE considerations and training for pesticide handlers. Additionally, the WPS, designed to protect workers from pesticide exposure, does not obviate the need for OSHA's proposed

standard, designed to protect workers from hazardous heat. A multitude of factors, including PPE, can contribute to heat injury and illness.

The second set of Federal rules that OSHA identified are Department of Transportation (DOT) regulations. The Federal Motor Carrier Safety Administration (FMCSA) requires drivers of vehicles with gross vehicle weight ratings of 26,001 pounds or more to be instructed about extreme driving conditions, including high heat, to obtain commercial driver's licenses (49 CFR part 380). FMCSA's regulations might overlap with OSHA's proposed rule to the extent they require some training for a limited group of individuals. However, these regulations would not conflict with OSHA's proposed rule, nor do they obviate the need for a comprehensive OSHA standard with provisions specifically designed to protect workers exposed to a broad range of hazardous heat conditions.

II. OSHA Standards.

OSHA does not have any standards that specifically address workplace exposure to hazardous heat. However, OSHA has identified some current standards applicable to some issues related to hazardous heat. These standards, described below, do not conflict with the proposed rule, nor do they obviate the need for an OSHA standard addressing occupational exposure to hazardous heat.

The first set of standards OSHA identified are the sanitation standards (29 CFR 1910.141, 1926.51, 1915.88, 1917.127, 1918.95, 1928.110). Among other things, these standards require employers to provide employees with readily accessible potable drinking water and access to toilet facilities. The field sanitation standard for agriculture also requires employers to notify employees of the location of water and the importance of drinking water frequently, especially on hot days (29 CFR 1928.110(c)(4)). These existing standards and the provisions of the proposed rule do not conflict, nor do these existing standards obviate the need for a heat-specific standard. While OSHA's sanitation

standards require employers to make drinking water available to employees, their primary purpose is to ensure sanitary conditions in the workplace and they do not include the same level of specificity for provision of water as the proposed standard (e.g., specific quantity of water to be provided).

The second set of standards OSHA has identified are specific to pulp and paper and textile mills. These standards require that exposed water pipes that carry either steam or hot water and are located close to working platforms be guarded to prevent contact (29 CFR 1910.261(k)(11), 1910.262). These standards are primarily concerned with burn and scalding-related hazards to employees. However, when employers guard these pipes by using insulating material, they may also help protect their workplace from increases in temperatures that may, in some cases, induce HRIs. Thus, the existing standards and the proposed standard would be complementary in nature.

The third set of standards that OSHA has identified are two broadly applicable standards that may apply to some heat-related hazards—the Recordkeeping standard (29 CFR 1904.7) and the Safety Training and Education standard for construction (29 CFR 1926.21). OSHA's Recordkeeping standard requires employers to record and report injuries and illnesses, including heat-related injuries and illnesses, that meet recording criteria. This proposed standard does not include additional requirements for recording and reporting injuries and illnesses and therefore does not duplicate or conflict with 29 CFR 1904.7. OSHA's Safety Training and Education standard requires employers in the construction industry to train employees in the recognition, avoidance, and prevention of unsafe conditions in their workplaces. However, the standard does not specifically identify hazardous heat as a hazard for which workers need training, nor does it establish heat-specific training requirements.

These standards might, in some cases, overlap with some of the provisions of the proposed standard. However, they do not duplicate or conflict with the proposed

standard. OSHA believes that a comprehensive standard addressing HRIs is necessary to ensure that all employers take all appropriate measures to protect workers from the hazards associated with exposure to hazardous heat. If specific requirements of any final heat standard were to directly overlap with more general requirements in other existing standards, the specific requirements would apply in lieu of the more general requirements, unless otherwise noted (see 29 CFR 1910.5(c)(1)); see also the discussion of the continued applicability of the sanitation standards in the *Explanation of Proposed Requirements* for paragraph (e)(2), Drinking Water).

G. Alternatives and Regulatory Options to the Proposed Rule.

This section presents regulatory alternatives and options to the proposed OSHA Heat Injury and Illness Prevention standard and OSHA's responses to the findings and recommendations of the SBAR panel.

Under the RFA, a regulatory alternative is one that would accomplish the stated objectives of the proposed standard and that would minimize or reduce economic impact of the proposed rule on small entities. A regulatory alternative can reduce the impact on businesses of all sizes, and it need not focus solely on small entities. OSHA also presents regulatory options. Regulatory options would increase the burden of compliance on affected entities and therefore do not meet the definition of a regulatory alternative set out in the RFA. Nevertheless, the agency presents them in this section to provide notice of potential alternate approaches and to solicit comment on these options. Table VIII.F.1. presents these options and alternatives. The assumptions and parameters for estimating the impact of these options and alternatives is discussed below the table.

OMB Circular A-4 (2023) directs agencies, for purposes of complying with E.O. 12866, to identify key attributes or provisions of a proposed standard and examine options for each "including: the proposed or finalized option; at least one option that achieves additional benefits (and presumably costs more due to, for example, greater

stringency); and at least one option that costs less (and presumably generates fewer benefits due to, for example, less stringency).” For this proposed standard, OSHA identified requirements for rest breaks and for written HIIPPs as the key provisions for purposes of its E.O. 12866 analysis. The requirements of the proposed standard work in concert to produce the benefit of avoided HRIs and fatalities. The agency is unable to directly attribute avoided HRIs and fatalities to any specific provision so is unable to discuss the differences in the benefits of alternatives other than based on the assumption that more stringent options might increase benefits while less stringent alternatives might decrease benefits.

As shown in table VIII.F.6. an option to require high heat triggered rest breaks every hour, is the costliest, incurring an additional $23.0 billion annually compared to the proposed requirement of rest breaks every two hours. The alternative that would reduce the compliance costs the most would be one that required 10-minute high heat triggered rest breaks (versus the 15-minute rest breaks required in the proposed standard), which results in approximately $3.2 billion less in compliance costs per year.

Table VIII.F.6. Costs for Regulatory Options and Alternatives (2023$)

Description	In-Scope Entities	In-Scope Establishments	In-Scope Employees	Annualized Costs (2%)	Difference
Proposed standard as written	2,230,750	2,535,774	35,954,325	$7,823,661,638	$0
Review HIIPP at least every other year instead of at least annually	2,230,750	2,535,774	35,954,325	$7,737,630,422	-$86,031,216
No written HIIPP required for < 20 employees instead of < 10 employees	2,230,750	2,535,774	35,954,325	$7,821,535,276	-$2,126,362
All establishments write HIIPP regardless of number of employees	2,230,750	2,535,774	35,954,325	$7,839,027,706	$15,366,068
At or above the high heat trigger, 15-minute rest break at least every hour instead of at least every two hours	2,230,750	2,535,774	35,954,325	$30,821,032,888	$22,997,371,249
At or above the high heat trigger, 10-minute rest break at least every two hours instead of 15-minute rest break at least every two hours	2,230,750	2,535,774	35,954,325	$4,601,335,411	-$3,222,326,227
Refresher trainings at least every other year instead of annually	2,230,750	2,535,774	35,954,325	$7,585,132,580	-$238,529,059
High heat trigger of 95° heat index instead of 90° heat index	2,230,750	2,535,774	35,954,325	$5,967,548,421	-$1,856,113,217
Acclimatization for employees returning after 30 days away from work, instead of after 14 days away from work	2,230,750	2,535,774	35,954,325	$7,822,809,795	-$851,843
Limit the sedentary work exemption to sedentary work activities at indoor work areas below [a heat index of 90°F]	2,230,750	2,535,774	35,954,325	$7,824,928,699	$1,267,060
Add a requirement for employers to provide medical surveillance	2,230,750	2,535,774	35,954,325	$10,301,080,493	$2,477,418,855

Source: OSHA.

I. Regulatory Options.

a. Regulatory Option 1 – All establishments write HIIPPs regardless of number of employees.

This alternative assumes that all establishments have their HIIPP in writing compared to the proposed standard where establishments with ten or fewer employees do not need to have their HIIPP in writing. All establishments with ten or fewer employees that do not have an existing HIIPP in place are modeled as either using OSHA's template (six hours of a designated person's labor time) or writing their HIIPP from scratch (30 hours) in the same proportions that were assumed for establishments of other sizes.

This regulatory option would add about $15.4 million in additional costs. OSHA believes that having a written plan is an important tool in protecting employees from heat and other workplace hazards. However, experience has shown that for the smallest employers, employees and supervisors or owners are working closely enough together that the details of safety plans can be readily communicated between individuals. The agency believes that written plans are not necessary for employers with 10 or fewer employees and that this is a useful way to reduce the burden on the smallest employers (although they would still need to have a HIIPP as required by this proposed standard).

b. Regulatory Option 2 – At or above the high heat trigger 15-minute rest break at least every hour.

The proposed standard would require employers to provide a 15-minute rest break at least every two hours when the high heat trigger is met. This option would require employers to instead provide a 15-minute rest break to their at-risk employees at least every hour where the high heat trigger is met. As such, the cost for rest breaks would be incurred six times during an 8-hour work shift where the high heat trigger is met (excluding rest breaks before lunch and at the end of the workday).

This option would add considerable costs to this proposed standard – nearly $23.0 billion. As discussed throughout this preamble, OSHA believes that rest breaks are a crucial tool to protect employees from heat injury and illness. As discussed in Section VII.F., Paragraph (f) Requirements at or above the High Heat Trigger, at the high heat trigger, evidence supports providing 15-minute rest breaks where employees are provided with shade, water, and a chance to shed PPE in order to reduce their body temperature every two hours.

c. Regulatory Option 3 – Upper bound heat index for sedentary work exemption.

When calculating the costs of requirements under the high heat trigger, this alternative leaves in-scope those employees who are considered sedentary but who work in non-climate-controlled indoor work conditions where temperatures are reasonably expected to meet or exceed the high heat trigger (i.e., a heat index of 90°F). This scope change results in more employees qualifying for high heat trigger rest breaks and requiring more observation time from designated persons. This option is estimated to increase the costs of the proposed standard by about $1.27 million.

d. Regulatory Option 4 – Medical surveillance.

Under the medical surveillance alternative, OSHA adds a requirement that all at-risk employees receive and complete a medical screening questionnaire to determine whether an employee may be predisposed to heat-related health risks. This questionnaire is assumed to take 15 minutes. All at-risk employees are assumed to take this questionnaire in the first year. Only new employees (as determined by using the annual hire rates for each sector) are modeled to take this questionnaire in subsequent years.

OSHA also assumes that employees screened as having a predisposition to heat-related health risks (assumed to be 23 percent of all at-risk employees) undergo a medical examination. This medical examination would take one hour of an at-risk worker's labor

time. The cost of the medical examination itself, which the employer would need to cover at no cost to the employee, is estimated to cost $501.28.

Based on these assumptions, this option would increase the costs of the proposed standard by about $2.5 billion. The proposed standard currently includes a suite of controls that OSHA has preliminarily determined would confer a high level of protection to all workers, irrespective of individual risk factors.

II. Alternatives.

a. Alternative 1 – Review HIIPP at least every other year.

Under this regulatory alternative, establishments would need to review their HIIPP at least every other year instead of at least annually. Therefore, OSHA assumes that costs would be incurred every other year including both a designated person's time and the time of employees involved in the plan review and update as estimated in Section VIII.C., Costs of Compliance.

As shown in table VIII.F.6., this alternative would reduce the cost of the proposed standard by about $86 million. OSHA believes it is important that the written program be reviewed and updated annually to ensure that any deficiencies are identified and remedied promptly. This also maintains consistency with other OSHA standards that require annual program review and update.

b. Alternative 2 – No written HIIPP required for establishments with < 20 employees.

This alternative adjusts the number of establishments that do not need to have their HIIPP in writing from establishments with ten or fewer employees to those with 20 or fewer employees and would reduce the cost of the proposed standard by about $2.1 million.

As discussed above, OSHA believes that the smallest employers can effectively administer a program that is not written. However, the agency believes that this is less effective for a slightly larger employer and, given the fact that employers with between

10 and 20 employees represents a proportionately large group of covered employers, OSHA believes there are benefits to requiring a written program for this group of employers.

c. Alternative 3 – 10-minute rest breaks at the high heat trigger.

This alternative revises the rest break requirements at the high heat trigger to require 10-minute rest breaks every two hours rather than 15-minute rest breaks. The time to walk to and from rest areas are maintained at two minutes for indoor employees and four minutes for outdoor employees.

This alternative reduces the cost of the proposed standard by about $3.2 billion. OSHA has proposed 15-minute rest breaks based on the available literature on rest break efficacy (see Section VII.F., Paragraph (f) Requirements at or above the High Heat Trigger).

d. Alternative 4 – Refresher trainings at least every other year.

Instead of annual refresher trainings, this alternative assumes refresher trainings take place every other year for both at-risk employees and designated persons. This alternative would reduce the cost of the proposed standard by about $238.5 million. Training is a highly effective method to protect workers from workplace hazards and regular refresher training is necessary to reinforce the topics of the training. Training must be frequent enough that employees maintain the knowledge necessary to recognize heat-related hazards and to understand and comply with the employer's HIIPP. OSHA has preliminarily determined that annual training is necessary for employees to maintain the requisite knowledge and that it is particularly important for outdoor workers to receive this training before the start of each heat season.

e. Alternative 5 – 95-degree high heat trigger.

The high heat trigger is increased from 90 degrees to 95 degrees under this alternative. Revising the high heat trigger upward results in fewer hours for which

establishments need to implement required procedures under these high heat conditions and, thus, results in lower costs.

As shown in table VIII.F.6., this alternative would reduce costs by about $1.9 billion (although this is a highly uncertain estimate). However, OSHA has preliminarily determined that a high heat trigger of a heat index of 90 °F would be highly protective and higher triggers may not be adequate for preventing HRIs (see Section V.B., Basis for Initial and High Heat Triggers).

f. Alternative 6 – Acclimatization for employees returning after 30 days away.

The amount of time away from work that qualifies an employee as a returning employee is adjusted from 14 days to 30 days under this alternative. While OSHA assumes that two percent of all employees would qualify as returning employees given the 14-day qualifying period, the agency assumes half a percent of employees would qualify with a 30-day period.

OSHA estimates that this alternative would reduce the cost of the proposed standard by about $850,000. Again, this is a highly uncertain estimate given the lack of data on the number of workers who are away from work for two weeks and those away for 30 days during heat season. This affects a small population, and OSHA has proposed the more protective approach of requiring acclimatization for workers who have been away for 14 consecutive days.

Are there additional burden reducing alternatives that the agency should include that would impact costs to entities? If so, what burden reducing alternatives would be most useful to assess these impacts on entities? The agency would welcome any suggestions in this area.

H. SBAR Panel Recommendations.

Table VIII.F.7. lists the SBAR Panel recommendations and OSHA's responses to these recommendations.

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
1	SERs expressed concern that the potential standard should not be a "one size fits all" approach and that it would be difficult for a standard to reasonably and effectively cover heat hazards in all settings and all regions of the U.S. SERs agreed that an OSHA standard should be flexible with a programmatic approach that allows employers to tailor their program to their particular workplace. SERs thought this flexibility was necessary for employers to prevent heat-related injuries and illnesses in their workplace most effectively. Some SERs thought the employer should determine what approaches should be implemented to address heat based on the conditions in their work settings as long as those approaches adhere to the regulatory framework. One SER asked whether the regulatory text, like the regulatory framework provided to SERs, could list multiple options employers can choose from.	The Panel recommends that OSHA's standard include performance-based provisions where practical to allow employers to tailor their heat injury and illness prevention program to their setting and situations, including the local climate and the type of work being performed, and also taking into consideration the size and complexity of the employer's operations. To the extent practicable, the Panel recommends that OSHA offer multiple methods of compliance with provisions of a heat standard.	The agency has drafted a proposed standard that ensures flexibility for workplaces. By incorporating elements that can be tailored to the workplace, OSHA is effectively addressing concerns of applicability to various workplace settings while establishing minimum requirements that are intended to ensure the heat injury and illness prevention program remains effective and accessible to employees. For example, the proposed standard does not apply to indoor workplaces where air conditioning consistently keeps the ambient temperature below 80°F, the proposed standard only requires employers with 10 or more employees to have a written plan, allows employers to choose the heat metric that works best for their workplace, and make other determinations based on their employee operations. OSHA requests further comment on the flexibility of the provisions included in the proposed heat standard.
2	SERs felt that the heat triggers that OSHA had suggested in the regulatory framework were too low and questioned whether the heat triggers were appropriate across different regions of the U.S. Some SERs reported finding OSHA's table of heat triggers presented in the regulatory framework and the use of an initial and a high heat trigger to be confusing and stressed that OSHA should keep the requirements simple. SERs also asked how the heat triggers had been determined and whether they were scientifically based. However, other SERs supported having two trigger levels and some reported that they had already implemented policies based on multiple trigger	In light of input received from SERs, the Panel recommends that OSHA consider whether the heat trigger levels presented in the regulatory framework—both the initial and high heat triggers—are too low, and also recommends that the agency present these heat triggers as simply as possible to avoid confusion. The Panel also	The agency has provided a discussion of the methodology for determining the initial and high heat triggers in Section V.B., Basis for Initial and High Heat Triggers, which cites both observational and experimental evidence. OSHA simplified the triggers that were initially presented in the regulatory framework; there are no longer ambient temperature triggers or separate, lower forecast triggers. OSHA has also provided evidence that higher triggers, including the NWS

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
	points already. Some SERs suggested using the National Weather Service heat advisory as a single measure for a heat trigger tailored to local conditions.	recommends that OSHA provide the methodology used to select the heat triggers, including any scientific evidence or other supporting data, along with consideration of potential alternatives.	heat advisories, would not be protective enough.
2	A few SERs voiced strong concerns about the underlying data on heat related injuries and illnesses. SERs felt that the numbers of illnesses, injuries, and fatalities reported in the BLS data are low relative to the total number of employees nationally, suggesting that any action or change is unnecessary. One SER thought that the number of heat illnesses and injuries is statistically insignificant, given the millions of workers in the labor force. SERs requested clarification on these data including requests that the data on heat-related injury and illness be published in the record by detailed industry.	The Panel recommends that OSHA clearly present the data being used to justify a potential standard. The Panel recommends that OSHA thoroughly explore whether and how the injury, illness, and fatality data support the promulgation of a heat standard.	The agency has provided a discussion of the data on occupational heat-related injuries, illnesses, and fatalities in Section V.A., Risk Assessment, and Section VIII.E., Benefits, including the significant likelihood of underreporting of such data. The agency relied on publicly available data from BLS, State health departments, and the peer-reviewed literature. OSHA discusses the need for the standard in Section III.B., Need for Proposal, and whether the threshold for agency action is met in Section VI., Significance of Risk.
3	Many SERs questioned whether the recordkeeping requirements that OSHA had suggested were necessary. Some SERs thought they would have to hire additional staff or take time away from other safety initiatives to complete the paperwork outlined in the regulatory framework. SERs thought that documenting rest breaks would be infeasible, and that recordkeeping of daily temperature monitoring was unnecessary and would be burdensome to comply with.	The Panel recommends that OSHA reconsider or simplify recordkeeping of temperature monitoring and not require documentation of rest breaks unless the agency can show that such a requirement is necessary or appropriate to protect workers. The Panel also recommends that OSHA reconsider other potential	OSHA is proposing requirements in this section, based in part on feedback, which will allow more flexibility for workplaces. Employers of only indoor workplaces will be required to create written or electronic records of on-site temperature measurements and retain these records for a minimum of six months. Employers have flexibility on how they can comply with the recordkeeping requirement by using monitoring devices with sufficient storage capability, or employers could comply by creating and maintaining written records

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
		recordkeeping to determine if those are necessary or appropriate and whether they positively impact worker safety and health.	based on monitoring devices that do not have digital recording capabilities. OSHA has determined that this provision would have a positive impact on worker safety and health by assisting OSHA in determining conditions at the worksite, and aiding employers to identify trends in indoor temperatures and their effect on employee health and safety. In part based on feedback, OSHA is not requiring documentation of rest breaks.
4	SERs raised concerns about recordkeeping of heat related injuries and illnesses requiring only first aid. Other SERs asked why OSHA is considering requiring records of first-aid-only injuries and illnesses that are heat-related while not requiring records of first-aid-only injuries and illnesses that are not heat-related. Some SERs stated it was unclear what first aid means regarding heat illness with one SER wondering whether asking workers to take a break and hydrate because they appear to be hot would need to be captured as a first-aid incident.	The Panel recommends that OSHA not include a requirement for recording first-aid-only heat-related illnesses or injuries unless the agency can demonstrate some particular circumstances where such a requirement is necessary or appropriate to protect workers when such records are not required under OSHA's general injury and illness recordkeeping regulation.	OSHA is not proposing to require additional injury and illness reporting beyond what is required by the existing Recordkeeping standard (29 CFR 1904.7). The only proposed recordkeeping requirement applies to monitoring data collected for indoor work areas.

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
5	Many SERs reported already monitoring the temperature at their facility or job sites. SERs relied on various heat assessment methods including the OSHA/NIOSH Heat Safety Tool App, local weather forecasts, the National Weather Service's online calculator or measuring temperature with standard thermometers, heat index monitors, or wet bulb globe thermometers. Some SERs thought terms like "wet/dry bulb temperature" and "heat index" would be confusing while other SERs thought that measurements with a WBGT was complicated and may be difficult for some employers to use. SERs told the Panel about some difficulties they have with measuring temperature at their locations. SERs with indoor worksites said that the temperature can vary across different parts of their facility. SERs with workers who are mobile and work at many different locations or elevations throughout the day said that temperature monitoring was a challenge for them because of various complicating factors.	The Panel recommends that OSHA allow flexibility in monitoring methods and not mandate a single method that employers must use to measure heat in their workplace or on their worksite. The Panel also recommends that OSHA clarify how and when temperature monitoring must occur for all employers but especially for those with indoor settings and those with mobile workforces.	The agency has drafted a proposed standard that would provide flexibility to employers in both what heat metric they can use and how they are required to monitor the worksite (including allowing outdoor employers to use the forecast instead of on-site monitoring). OSHA provides guidance on how and when monitoring must occur.
6	The majority of the SERs said that they allowed their employees to take rest breaks when they needed to, but many objected to OSHA including a specific frequency or duration of breaks in a rule. Some SERs said that shorter, more frequent breaks might be ideal sometimes, while others said that the intensity of the job or other personal, physiological characteristics may make more frequent breaks necessary. Some SERs thought that giving 15-minute breaks every two hours would be unworkable in their situation. SERs in construction and manufacturing reported that there were times that work could not simply stop while workers took breaks (e.g., while pouring concrete, during certain industrial processes). In these cases, SERs reported that they rotated	The Panel recommends that OSHA consider allowing employers some flexibility, to the extent feasible within the constraints of the OSH Act, in the frequency of any rest breaks required in a rule. The Panel also recommends that OSHA clarify where workers can take breaks and provide the maximum flexibility possible to employers to determine what works best for their employees and	The proposed standard only requires rest breaks at the initial heat trigger when they are needed to prevent overheating. Under the high heat trigger, a minimum of a 15-minute paid rest break would be required every two hours because of increased risk of HRI at and above the high heat trigger, but some flexibility is provided by allowing a meal break to count as a rest break. Proposed provisions under the initial heat trigger specify the requirements for indoor and outdoor break areas and provide flexibility by allowing employers to choose from different options of cooling methods in the break area (e.g., shade OR air

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
	workers between more and less strenuous tasks. SERs with workers who wear complex PPE (e.g., construction, tree care, electric power) reported that their employees sometimes prefer to finish their work rather than stop for a break which would require removing and redonning their PPE. SERs whose employees worked at heights (e.g., roofing, telecommunications towers) expressed concern that these employees could be put in more danger if they were required to climb down from their working position for a break and back up afterwards. These SERs wondered if breaks needed to occur in a certain location like a shaded area on the ground or in an air-conditioned vehicle. A number of other SERs similarly wondered whether they had to provide air-conditioned break areas and require their employees take rest breaks in those areas. Some SERs said that their workers preferred to take breaks in non-air-conditioned spaces like shaded outdoor areas. A few SERs wondered whether other activities including things like downtime while waiting for materials to be delivered, toolbox talks or job briefings, engaging in non-strenuous work tasks, or driving between jobs could be considered breaks.	situation. The Panel further recommends that OSHA clarify what, if any, activities employees can engage in during rest breaks.	conditioning for outdoor break areas; air conditioning OR increased air movement and, if appropriate, de-humidification for indoor break areas). The summary and explanation for rest breaks under the high heat triggers clarifies that no work activities would be allowed during rest breaks.
7	SERs universally reported supplying drinking water to their employees generally with reusable bottles and water coolers, single use water bottles, or plumbed fountains or faucets. While SERs acknowledged the necessity of supplying drinking water, some objected to some of the specified potential requirements in the regulatory framework. One SER felt that the amount of water specified as required was too much. Some SERs thought that the phrase "suitably cool" was vague and did not take into account employee	The Panel recommends that OSHA consider eliminating or better defining the term "suitably cool" to provide clarity and take employee needs and preferences into account. The Panel also recommends that OSHA provide clarity on methods for complying with any potential	OSHA is including the term "suitably cool" in the proposed standard to provide flexibility to employers and maintain consistency with the field sanitation standard (29 CFR 1928.110), which has incorporated a "suitably cool" requirement since it was promulgated in 1987. The phrase is also used in California's heat standard for outdoor workplaces (Cal. Code Regs. tit. 8, section 3395). As discussed in Risk Reduction, Section V.C., the

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
	preferences for their water temperature.	requirements related to the provision of water and allow for flexibility, when appropriate, in the amount of water required to be provided.	temperature of drinking water impacts hydration levels, as cool or cold water has been found to be more palatable than warm water, thus leading to higher consumption of cool water and decreased risk of dehydration. Additional evidence highlighted in Section V.C., Risk Reduction, shows that cool fluid ingestion has beneficial effects for reducing heat strain. OSHA provides additional guidance on what it considers "suitably cool" in the Explanation of Proposed Requirements section of the proposed provision. OSHA is specifying the amount of water that employers need to provide to employees, not an amount that employees need to drink. OSHA provides guidance for how employers can comply with the provision of 1 quart of cool water every hour.

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
8	Many SERs objected to OSHA's option in the regulatory framework for gradual acclimatization to heat, requiring employees to gradually ramp up their exposure to heat over the course of a few days. Several SERs said that if they force employees to work fewer hours due to acclimatization requirements, these workers might just quit and look elsewhere for work. Other SERs reported that they must pay their union laborers for a minimum of four hours regardless of whether they worked that full time meaning that the SERs would be paying for time not worked during the acclimatization period. Other SERs said it would not be possible to move workers to light duty jobs during the acclimatization period either because they did not have enough of that type of work or because light duty tasks were not available at their workplaces. Some SERs thought that strictly prescribed acclimatization requirements were unnecessary because new workers they hired were either from the area and used to the weather, were coming from jobs where they performed similar tasks in similar conditions, or only those who were fit and able to work in hot weather would "self-select" into the types of jobs they offered. Many SERs reported having some form of enhanced supervision or "buddy system" for workers who were acclimatizing to the hot working conditions. Some said that new workers worked alongside supervisors during their first weeks on the job which allowed for supervision of their heat tolerance. Others said that the training process where new employees are learning and working up to doing the jobs fully and on their own serves as an acclimatization process.	The Panel recommends that OSHA provide multiple options for acclimatization in the rule to allow employers flexibility in determining the best method for acclimatizing their workers.	OSHA preliminarily finds that acclimatization is an effective preventative measure for preventing HRI and fatalities in unacclimatized workers. The proposed standard provides options for how to protect unacclimatized workers. The proposed standard provides a gradual exposure option as well as an option for employers to implement the requirements at the high heat trigger during an employee's first week of work. OSHA requests further comment on the proposed acclimatization provision and on a number of topics relating to acclimatization, including acclimatization during heat waves, acclimatization following illness, requests for examples of existing acclimatization programs and the clarity of the explanation of "similar heat conditions."
9	SERs raised a number of concerns about applying a heat standard to workers who work alone and workers who move between job	The Panel recommends that OSHA address the unique situations of	OSHA is proposing to establish heat triggers using a measurement of the Heat Index which is more readily

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
	locations throughout the day. SERs mentioned that they were not sure how they would have to monitor the temperature when workers were working at multiple locations since employees could cover a large range with varying climate conditions throughout their workday. One SER said it was not clear what areas need to be routinely monitored if the work site is not fixed while others were concerned that tracking the temperature forecasts and relevant heat triggers for the worksite that each worker or crew is visiting that day would be difficult. SERs said that such tracking becomes a greater challenge if each worker or crew visits multiple worksites within a day. SERs were also concerned that it would be difficult to monitor workers who work alone. SERs mentioned that it would be difficult to ensure that employees are taking required breaks with one SER saying that they believed this would become more difficult if mandated rest break durations depend on whether the temperatures were at or above the initial heat trigger or high heat trigger. Other SERs mentioned the difficulty of monitoring employees for signs and symptoms of heat injury and illness when employees are working alone. While some had equipment that monitored an employee's movement and reported to the employer if that movement stopped or procedures for regular check-ins via phone or tablet applications, other SERs said that they would not be able to implement a buddy system or close supervision of employees given the work arrangements.	employers whose employees work alone and/or travel to many worksites each day and offer flexibility to these employers and clarify the employer's responsibilities for employees in these circumstances.	available through local forecast data or heat monitoring apps. As discussed in this preamble, employers do not need to monitor all work locations continuously and are only required to verify whether the temperature exceeds the triggers in order to implement the applicable protective measures. OSHA recognizes that employees working alone can be at a greater risk for HRI due to the lack of immediate assistance or interventions. Therefore, OSHA has proposed that the employer maintain a form of two-way communication and regularly communicate with employees. When the high heat trigger is met or exceeded, the proposed standard would further require employers to stay in contact at least every two hours with employees working alone. Requirements for safety and health procedures when employees are working alone are not unique to this rule. OSHA believes that the employer responsibilities outlined under the proposal are necessary to ensure the safety of workers.

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Number	Finding	Recommendation	OSHA's Response
10	Almost all SERs agreed that training is one of the most important steps an employer can take to prevent heat injury and illness in their workers. SERs mentioned that they already provide some form of training on heat injury and illness prevention including recognition of signs and symptoms and how to respond and other topics including the importance of staying hydrated (electrolytes or water); working at a comfortable pace; contacting a supervisor to get an extra break or water; accessing and locations of cool down areas; sleeping well and being well rested; acclimatizing; and medical treatment of heat-related illnesses and injury. Training was reported to be provided in both formal and informal settings including regular training classes and tailgate or toolbox talks. Several SERs felt that a heat standard be centered around training; one SER thought that a heat standard should mandate training while questioning the necessity and usefulness of other potential requirements.	The Panel recommends that OSHA include a robust training provision in a heat standard. The Panel also recommends that OSHA continue to provide support for employer training efforts by providing training materials, sample curriculum, videos, and/or other methods.	OSHA preliminarily finds that it is necessary to train employees so they can recognize heat-related hazards and understand the appropriate steps they can take to minimize potential health effects in themselves and coworkers. Training on the employer's policies and procedures to address heat hazards would be an essential part of this proposed standard because it would help to ensure that employees understand heat hazards, the workplace-specific control measures that would be implemented to address the hazard, and the requirements of the proposed standard. OSHA has provided guidance on how employers can comply with the training provision and expects to provide sample training materials and other compliance assistance products to assist employers in implementing the requirements of the proposed standard if promulgated.
11	SERs reported a mix of informal and formal heat injury and illness prevention programs. Some said that they do not have a program that is in written form; while others said they have a written program that is relatively short in length (i.e., in bullet points). SERs were largely supportive of the idea of a written program or plan. SERs said that they believe a written plan could be beneficial and one SER said that their heat plan reduced the number of first-aid and more serious safety incidents, reduced workers' compensation costs, and maybe improved absenteeism. SERs said that employers should have flexibility to develop and implement such plans. Some SERs supported the potential exemption in the regulatory framework for very small	The Panel recommends that OSHA include a requirement for a written heat injury and illness prevention program that allows employers the flexibility to tailor their plans to their specific industry, location, and activities. The Panel also recommends that OSHA consider an exemption for very small employers from the requirement for the plan to be in writing. The Panel	OSHA is proposing a requirement for a heat injury and illness prevention plan (HIIPP) as a provision of the standard. The proposed HIIPP requirement allows employers the flexibility to tailor their plans to their specific industry location and work activities. OSHA understands that a HIIPP must be adaptable to the physical characteristics of the work site and the job tasks performed by employees, as well as the hazards identified by the employer when designing their HIIPP. To increase flexibility, in cases where employers have multiple work sites that are substantially similar, the HIIPP may be developed by

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
	employers (e.g., those with 10 or fewer employees) from the requirement for the plan to be in writing; one SER stated that requiring a written plan would place significant burden on these employers. Most SERs agreed that, if the standard required updates of a written plan, that requirement should be for annual reviews and updates. One SER commented that they believed option to review and update "whenever necessary to ensure ongoing effectiveness" or "whenever a heat-related illness or injury occurs" were vague and/or unclear.	further recommends that, unless the agency determines that it is appropriate to do otherwise, review and update of the plan be required annually and if updates are required in additional situations that those situations be clearly delineated to reduce confusion and ambiguity.	work site type rather than by individual work sites so long as any site-specific information is included in the plan (e.g., phone numbers and addresses). The proposed HIIPP requirement is consistent with the SBAR Panel's recommendation and requires that only employers with more than 10 employees need to have a written plan. For employers with 10 or fewer employees, the agency does not believe that there is a high likelihood of misunderstanding when employers communicate their HIIPPs to employees verbally. Employers with existing plans would be required to modify and/or update their current HIIPP plans to incorporate any missing required elements and provide training on these new updates or modifications to all employees. Furthermore, to delineate requirements surrounding HIIPP reviews and updates more clearly, OSHA is proposing to require the employer to review and evaluate the effectiveness of the HIIPP whenever a heat-related injury or illness occurs that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness, but at least annually. Following each review, the employer would be required to update the HIIPP as necessary. OSHA preliminarily finds that a heat-related injury that results in death, days away from work, medical treatment beyond first aid or loss of consciousness warrants an evaluation of the HIIPP because it could potentially indicate a deficiency of the HIIPP. OSHA provides more

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
			information in Section VII.C., Explanation of Proposed Requirements, of the HIIPP requirement.
12	SERs disagreed with some specific time and cost estimates that were provided in the SER background document. SERs thought that OSHA's estimates for the amount of time it would take to develop the written plan and to conduct the hazard analysis were both too low as were the estimates related to monitoring of employees, measuring or calculating the heat index or temperature, and recording heat-related illnesses or injuries. One SER said that OSHA's estimate of breaks was too low because it only counted the break time but did not account for the time spent going to and from the break area.	The Panel recommends that OSHA review time and cost estimates in the economic analysis and revise where appropriate to take the experience and feedback of the SERs into account.	All time and cost estimates provided in the SER background document were reviewed and revised for the NPRM where appropriate with consideration for SERs feedback and experience. As a result, travel time (time spent going to and from the break area) is added to the rest break costs. OSHA is not proposing additional requirements for recordkeeping for heat-related illnesses or injuries in the proposed standard, so it no longer requires a cost estimate. For some estimates, OSHA's review determined that the estimates in the SER background document were appropriate (e.g., outdoor monitoring costs). In other cases, OSHA determined that the estimates in the SER background document overestimated costs or did not account for overlap between provisions and therefore reduces the estimates (e.g., indoor hazard assessment).

Table VIII.F.7. OSHA's Responses to the SBAR Panel Recommendations

Number	Finding	Recommendation	OSHA's Response
13	Most SERs with indoor settings reported using some form of ventilation and air movement to cool their facilities. However, many of these SERs said it would be infeasible to lower the temperature using air-conditioning because their buildings were too large to do this effectively. A few SERs said they are limited in where they can place fans due to work processes or risk of contamination of materials or the air. Some SERs also said that they could not use some of the engineering controls discussed in the background documents such as misting fans (which could introduce slipping hazards or damage materials) or portable shelters (which cannot be used on work surfaces such as roofs). Other SERs discussed the difficulties of implementing engineering controls in buildings they do not own or when working on in-progress construction projects. SERs also questioned whether some administrative controls suggested in the background materials would work for their setting. While some SERs said they adjusted work start and stop times to avoid working during the hottest part of the day, some SERs said they were unable to do so, for example, because they could not work too early in residential areas or because employees preferred a later start time. Some SERs said they used text messages or other electronic communications to remind employees of or alert them to heat hazards. Some SERs whose employees spend a significant part of their day driving worried that sending their employees electronic notifications would distract them and put them at risk of motor vehicle accidents. Many SERs were, however, supportive of the idea of monitoring employees for signs and symptoms of heat illness and injury. Some SERs reported that they utilized a "buddy system" where employees monitored each	The Panel recommends that OSHA offer as much flexibility as possible to allow employers to implement engineering and administrative controls that are feasible and appropriate for their workplace and activities.	OSHA has drafted the rule to allow maximum flexibility in implementing engineering controls while still protecting workers. The agency has attempted to minimize feasibility issues by providing employers with multiple engineering control options for compliance, allowing them to select the controls that can be most effectively implemented. OSHA believes that the proposed control options are important and needed to adequately protect workers from HRIs as discussed in the *Explanation of Proposed Requirements*.

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Number	Finding	Recommendation	OSHA's Response
	other, or supervisors monitored employees, for signs and symptoms of heat illness or injury. Some SERs said they have found this practice very useful in reducing illnesses and injuries related to heat. Some SERs reported that they use technology like electronic monitors or check-ins via cell phone or tablet although SERs whose employees are mobile reported that that can be difficult if the employee is in a location with limited cell service. SERs suggested that biometric monitors or self-monitoring of urine color to determine hydration levels could be useful as well.		

G. Distributional Analysis.

I. Impact of Heat on Underserved Populations.

Executive Order 13985, "Advancing Racial Equity and Support for Underserved Communities through the Federal Government," directs Federal agencies to conduct an equity assessment on a subset of the agencies' programs and policies. OSHA has chosen to include an equity assessment regarding the proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings and the potential impact on economically or historically underserved populations. The purpose of an equity assessment is to analyze the distribution of regulatory impacts across individuals, households, and businesses/industries, with particular attention to economically or historically underserved or vulnerable groups. This assessment, which is entirely separate from OSHA's legal findings and rationale supporting the proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings, concludes that the proposed standard would have a positive impact on underserved populations (e.g., low-income and Hispanic workers) by providing workplace protections from extreme

temperatures that have a disproportionate impact on occupations held by individuals from underserved communities.

A. Heat Exposure of Workers by Socioeconomic Status.

Extreme temperatures affect the entire economy and pose a significant risk to individuals employed in workplaces (see Section II.B., Need for Proposal and Section II.C., Events Leading to the Proposal). This threat is unevenly distributed across demographic and socioeconomic groups, exacerbating inequalities. Individuals from underserved populations are more likely to work in occupations with heat-related risks (Ndugga et al., 2023). Evidence from the American Community Survey covering 2018 – 2022 (Ruggles et al., 2024) suggests that workers from historically underserved groups in core industries (see Section VIII.B.II.A., Potentially Affected Industries) have greater exposure to occupational heat-related hazards, with more severe outcomes that impact their ability to work. That includes, for example, exposure to high outdoor temperatures, radiant heat sources, or insufficient temperature control or ventilation in indoor work settings. The methodology to estimate exposure by demographic group is outlined in detail in appendix C.

Figure VIII.G.1 shows that workers from low-income households are disproportionately exposed to heat-related hazards in (1) indoor work settings that emit heat during the production process, (2) indoor work settings that have inadequate climate control, or (3) outdoor work settings (see exposure definitions in Section VIII.B., Profile of Affected Industries). This is non-trivial as occupational injuries and illnesses cost the average worker $35,000 with wide-reaching health impacts including the threat of death (Leigh, 2011; Ndugga and Artiga, 2023; Park et al., 2021).[104] Thus, workers from low-

[104] Note that this estimated cost to workers is different from the Value of a Statistical Injury (VSI) used to estimate benefits in Section VIII.E., Benefits. The VSI is an estimate of individuals' desire to avoid an illness or injury and calculates the willingness to pay to avoid said illness or injury. The $35,000 quoted reflects the average social cost of a workplace injury reported to workers compensation in 2021$.

income households who are often challenged with affording in-home air conditioning (Mann and Schuetz, 2022) face a concurrent burden: threat of costly workplace heat hazards.

Workers from low-income households are most vulnerable to occupational heat exposure across all phases of their careers. For example, workers aged 16 to 64 from households in the lowest income deciles face elevated indoor and outdoor exposure to heat-hazards (see Figure VIII.G.2.). The highest levels of exposure occur among workers aged 35 – 54 earning less than $60,000 (approximately 15 percent in indoor and outdoor workplaces). This high level of exposure occurs during these workers' peak earning years, posing a threat to not only health but also lifetime earnings which can facilitate socioeconomic mobility (see Figure VIII.G.2., Panels B and C).

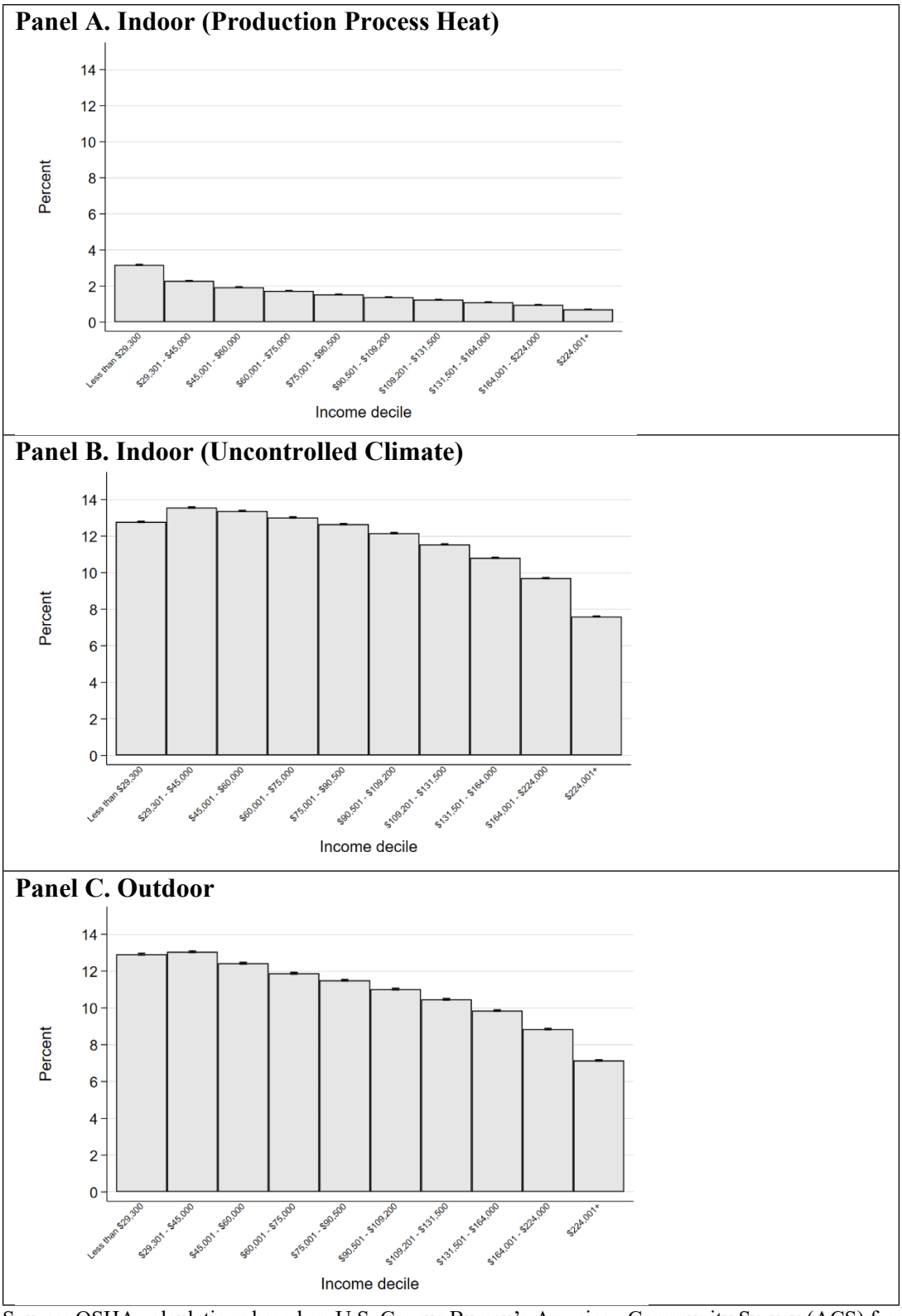
Figures VIII.G.3. and VIII.G.4. show that there is variation in exposure among low-income workers by sex, ethnicity, and race. While low-income individuals from some underserved backgrounds have heat hazard exposure levels exceeding 10 percent of the worker population (e.g. workers identifying as female, Black, multi-racial), male and Hispanic workers have the highest level of exposure to workplace heat hazards. Men earning less than $60,000 are nearly twice as likely to be exposed to workplace heat-related hazards than women, peaking at 17 percent for men working in non-climate controlled indoor settings and 19 percent for men working in outdoor settings.[105] Similarly, respective exposure to workplace heat hazards ranges from 16 percent to 19 percent in non-climate controlled indoor and outdoor settings among low-income Hispanic workers.

Despite evidence of elevated exposure along the socioeconomic gradient, research finds that many of the most vulnerable workers have minimal to no workplace

[105] For context, in 2022, the median annual earnings of men in the United States was $62,350 (Ruggles et al., 2024).

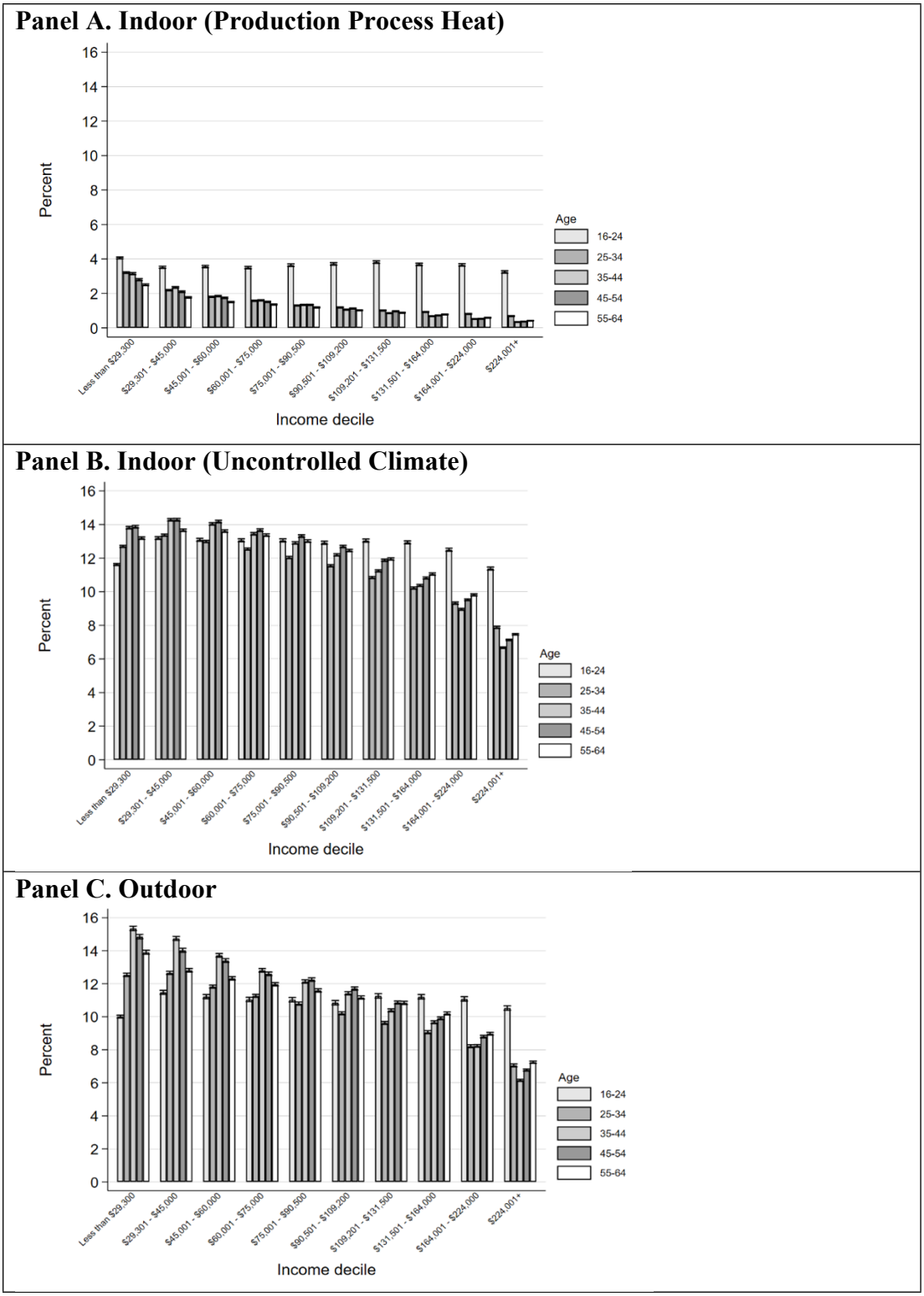
protections to manage occupational heat stress (Morrissey-Basler et al., 2024; Luque et al., 2019; Flocks et al., 2013). Although workers are aware of the health consequences of exposure to occupational heat stress, they report a feeling of lack of control over the condition of their work setting (Flocks et al., 2013). In the absence of formal workplace protections, some vulnerable workers assume responsibility for and implement heat stress management practices to preserve their well-being rather than view the employer as the arbitrator for protection against occupational heat hazards (Luque et al., 2019). Some of these worker-initiated heat stress prevention strategies may not be grounded in evidence-based science. Lack of employer safeguards against elevated temperature can, in turn, reinforce disparities in occupational heat exposure that leave the most vulnerable workers overexposed to preventable heat-induced injuries, illnesses, and fatalities.

Figure VIII.G.1. Workplace Heat Hazard Exposure by Income, 2018 - 2022



Source: OSHA calculations based on U.S. Census Bureau's American Community Survey (ACS) from 2018-2022 (Ruggles et al., 2024).

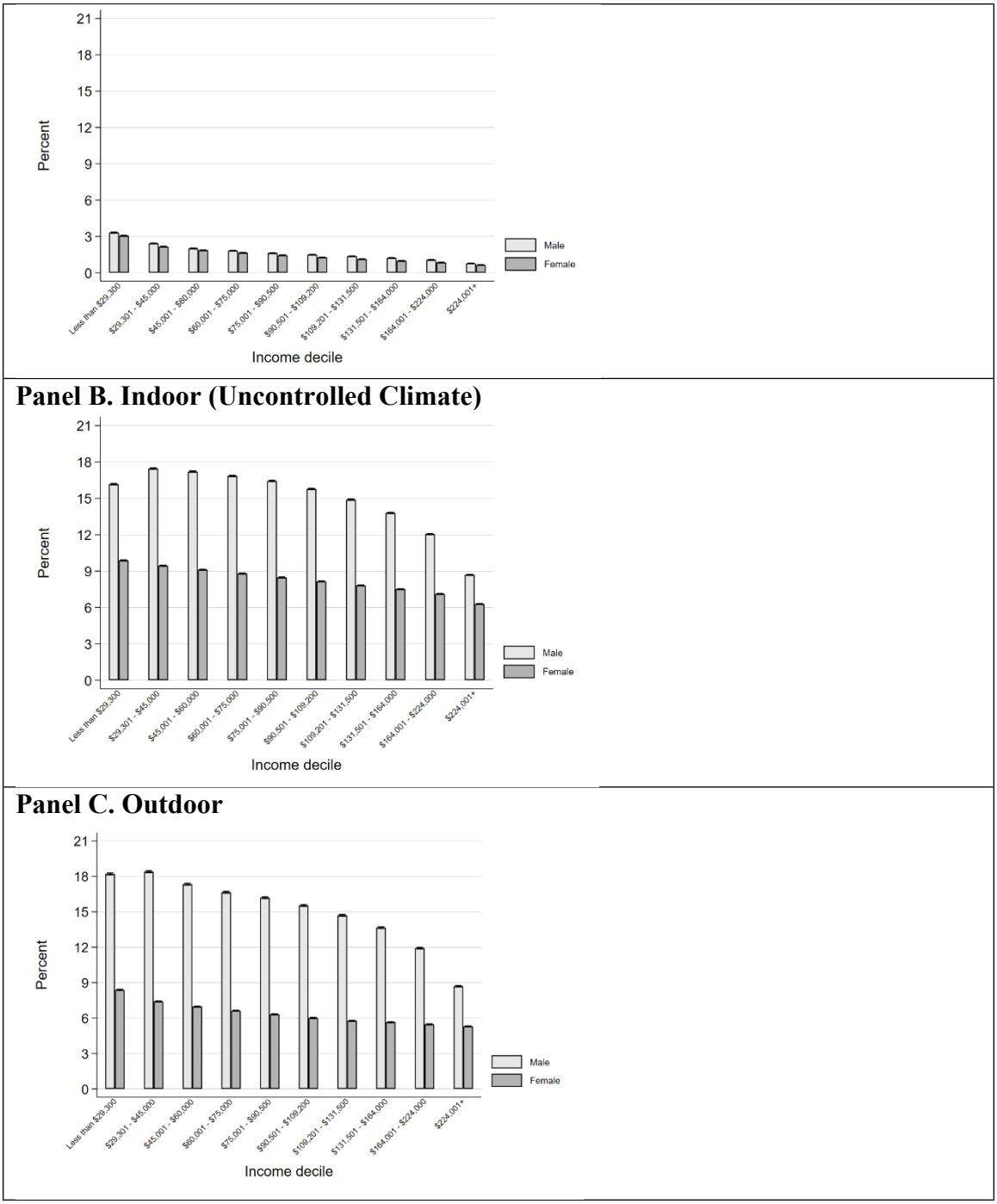
Figure VIII.G.2. Workplace Heat Hazard Exposure by Income and Age, 2018 – 2022



Source: OSHA calculations based on U.S. Census Bureau's American Community Survey (ACS) from 2018-2022 (Ruggles et al., 2024).

Figure VIII.G.3. Workplace Heat-Related Hazard Exposure by Income and Sex, 2018 – 2022

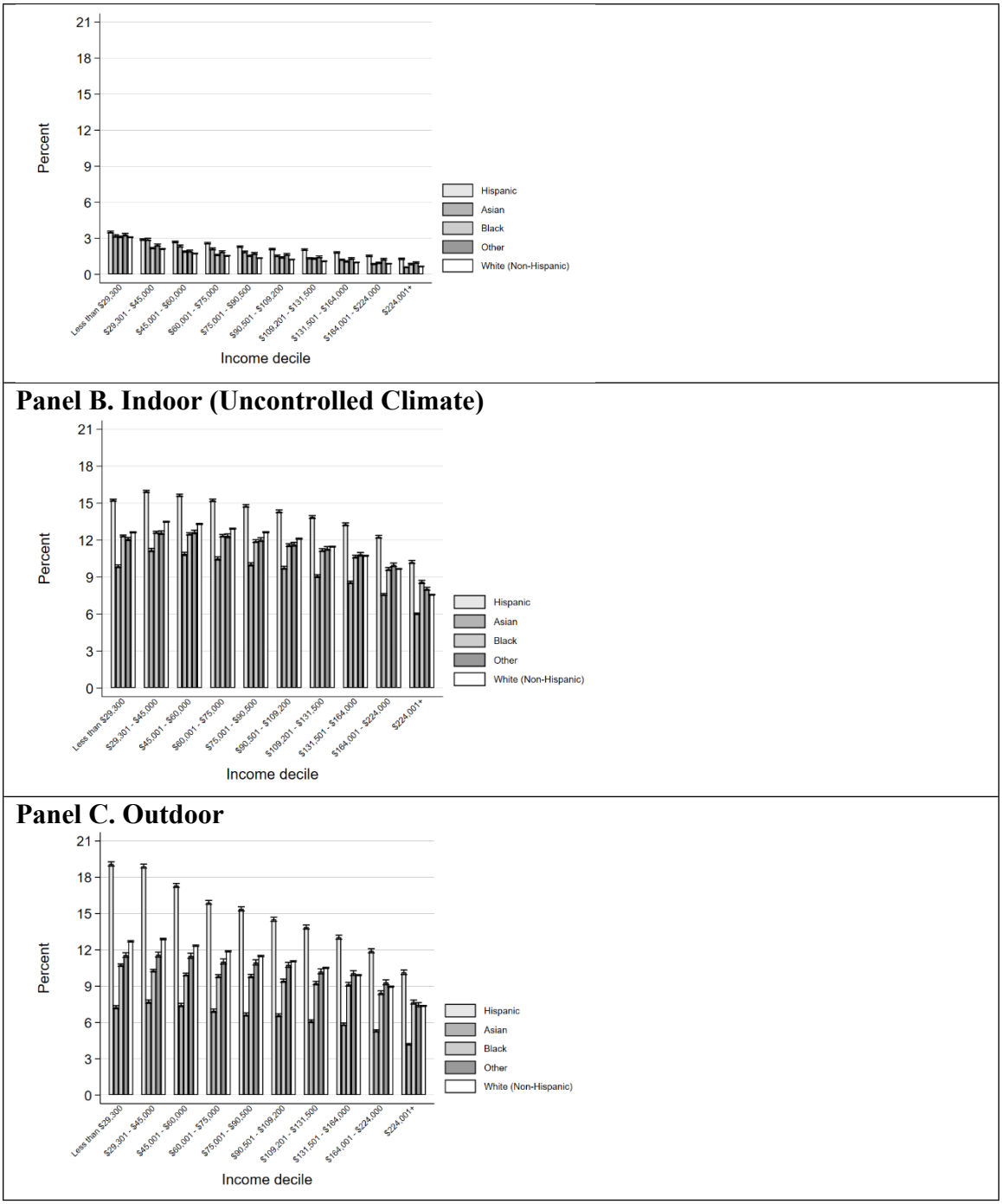
Panel A. Indoor (Production Process Heat)



Source: OSHA calculations based on U.S. Census Bureau's American Community Survey (ACS) from 2018-2022 (Ruggles et al., 2024).

Figure VIII.G.4. Workplace Heat Hazard Exposure by Income, Ethnicity, and Race [a] (2018 – 2022)

Panel A. Indoor (Production Process Heat)



Source: OSHA calculations based on U.S. Census Bureau's American Community Survey (ACS) from 2018-2022 (Ruggles et al., 2024).
[a] Other group is composed of individuals with multi-race ancestry or those reporting a race other than Hispanic, Black, Asian, or White (non-Hispanic).

B. Productivity and Health Effects.

The figures above show the fraction of workers who are exposed to workplace heat-related hazards and therefore likely to be covered by the proposed standard. Under an assumption that benefits of the standard correspond 1-for-1 to coverage, this fraction can be translated into the fraction of workers benefiting from the standard. In other

words, translating the results from the figures into benefits from the standard in terms of increased productivity, improved health, or other outcomes makes the assumption that all work-related exposure to heat is explained by industry and occupation. This assumption could over- or under-state the exposure to heat on the job that workers face. As a recent study of heat and occupational injuries discusses (Park et al., 2021), if there are compensating differentials for the risk associated with heat exposure, then workers exposed to the risk would be paid higher wages. This could be the case even within industry and occupation categories. Alternatively, if workers and employers negotiate over total compensation from income and amenities, then a worker could receive both lower wages and higher heat exposure (a workplace disamenity) due to imperfectly competitive labor markets[106] (Burdett and Mortensen, 1998; Sorkin, 2018).

Existing studies on workplace-related heat exposure do not currently say which of these two possibilities holds within industry and occupation groups. A recent review summarizes research on the effect of temperature on labor productivity (Lai et al., 2023). The focus of the literature has been on educational outcomes, cross-country comparisons, or cross-industry effects. Recent work on intensive-margin labor supply (i.e., hours worked) and heat exposure in the U.S. shows that whether or not the industry of workers is controlled for in the statistical model does not largely change the estimated effect of heat exposure on time spent working (Neidell et al., 2021). This result indicates that industry-level differences in exposure to heat do not fully capture the effect of heat on labor supply. The study does not control for occupation group, so exposure within versus across occupations cannot be parsed.

An analysis of workplace injuries and heat exposure in California examines the distribution of heat-related occupational injuries (Park et. al., 2021). The analysis is done

[106] The existence of jobs with different working conditions, in conjunction with variation in worker preferences, could in effect be the source of firms' power in the labor market that allows them to lower wages in the first place (Card et al., 2018).

using California Department of Workers' Compensation data, and the injuries are geocoded at the zip code of the worksite. In an analysis that controls for zip code-by-month and county-by-month-by-year fixed effects (as well as precipitation), the authors find that for the average worker, injuries go up on days with temperature above 90°F. The increase in injuries is 36 percent larger for workers in the lowest income quintile compared to workers in the highest income quintile.[107] The analysis also examines effects by worker age and sex. It finds that workers younger than 30 years of age are 3 times more likely to experience a workplace injury on a day about 90°F compared to a worker older than 60.[108] Male workers are 2.3 times more likely to experience injury compared to female workers.[109]

If the controls in the statistical model substantially account for differences in heat exposure due to industry and occupation (for instance, because industries and occupations are segmented across zip codes), then the effect would suggest that the distribution of exposure percentages could be a lower bound on the distribution of realized benefits from the proposed standard stemming from reduced workplace injuries. Further analysis that explicitly accounts for industry and occupation-based exposure to heat would be useful to determining the extent to which workers within industry and occupation groups are differentially affected by heat-related occupational injuries.

II. Averted Injuries, Illnesses, and Fatalities by Socioeconomic Status.

Table VIII.G.1. shows the estimated number of workplace heat-related injuries and illnesses (HRIs) as well as heat-related fatalities averted by the proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings.[110] Table VIII.G.1., columns 1 and 3, present the pre-standard estimate of HRIs and heat-related

[107] The point estimate for workers in the lowest quintile indicates a 0.0735 increase in injuries per day above 90°F for the lowest quintile and a 0.0541 increase for workers in the highest quintile.
[108] A point estimate of 0.0773 versus 0.0257.
[109] A point estimate of 0.0837 versus 0.0359.
[110] The methodology to derive exposure is detailed in appendix C.

fatalities. HRIs and heat-related fatalities are concentrated among workers who are low-income, in peak earning years (aged 35 – 54), male, or Hispanic. These vulnerable populations averaged 1,066 HRIs and 7 heat-related fatalities each year.

The Agency provides an example of the downstream impact of these consequential health events on firm costs in table VIII.G.2. The estimated cost to the employer of an HRI, such as heat prostration (or exhaustion), is $79,081 assuming a 3 percent profit margin.[111,112] Thus populations with more HRIs elevate firm cost (see table VIII.G.2., column 2). The extent to which the employer bears the full costs depends on the nature of their workers' compensation insurance policy. Nonetheless, the demographically disaggregated cost of projected HRIs suggests that concentrated efforts to reduce events among the most vulnerable populations can serve as a meaningful mechanism to reduce firm cost.

The Agency estimates that the proposed standard will reduce HRIs and heat-related fatalities among exposed workers by 65 and 95 percent, respectively (for more discussion, see Section VIII.E., Benefits). Table VIII.G.1., columns 2 and 4, present the projected average number of HRIs and heat-related fatalities averted by demographic group. The largest benefits are accrued to populations with heightened exposure: low-income, in peak earning years (aged 35 – 54), male, and Hispanic workers. This, in the case of heat prostration (or exhaustion), translates into an approximate 34 percent reduction in total firm costs among the respective demographic groups with heightened exposure (see table VIII.G.2., column 5).

Table VIII.G.1. Projected Annual Average Number of HRIs & Fatalities Averted by Demographic Group, 2011 - 2022

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[111] Total costs include a direct cost of $37,658 and indirect costs of $41,423.

[112] The estimate is derived using OSHA's Safety Pays Program's "Estimated Costs of Occupational Injuries and Illnesses and Estimated Impact on Company's Profitability Worksheet" *https://www.osha.gov/safetypays/estimator*. The tool projects and estimate of how injuries and illnesses may impact company's profitability. The above example assumes a 3 percent profit margin for heat prostration (or exhaustion) that cost $79,081 (i.e., includes a direct cost of $37,658 and indirect costs of $41,423).

	(1)	(2)	(3)	(4)
	HRIs	*Averted HRIs*	*Fatalities*	*Averted Fatalities*
Income decile				
Less than $29,300	1002.73	651.78	28.66	27.23
$29,301 - $45,000	1061.66	690.08	31.63	30.05
$45,001 - $60,000	1036.34	673.62	30.60	29.07
$60,001 - $75,000	1012.83	658.34	29.56	28.08
$75,001 - $90,500	988.55	642.55	28.70	27.26
$90,501 - $109,200	959.71	623.81	27.66	26.27
$109,201 - $131,500	921.58	599.03	26.16	24.86
$131,501 - $164,000	884.51	574.93	24.82	23.58
$164,001 - $224,000	830.46	539.80	22.68	21.54
Age				
16-24	882.46	573.60	23.88	22.69
25-34	931.32	605.36	26.52	25.19
35-44	974.79	633.61	28.89	27.45
45-54	980.33	637.21	28.52	27.09
55-64	971.74	631.63	27.52	26.14
Sex				
Male	1191.81	774.68	38.77	36.83
Female	679.87	441.91	14.30	13.59
Ethnicity & Race				
Hispanic	1214.52	789.44	39.98	37.98
Asian/Native American	753.23	489.60	16.49	15.67
Black/African American	879.14	571.44	21.89	20.79
Other	907.34	589.77	25.26	23.99
White (Non-Hispanic)	931.37	605.39	26.76	25.42

Table VIII.G.2. Projected Costs Savings of Annual HRI Cases by Demographic Group, 2011 – 2022

	(1)	(2)	(3)	(4)	(5)
	Pre-Standard		*# Cases Post-Standard*		*Savings*
	HRIs	*Total Costs*	*HRIs*	*Total Costs*	
Income decile					

Less than $29,300	1002.73	79,296,891.13	350.95	27,753,476.95	51,543,414.18
$29,301 - $45,000	1061.66	83,957,134.46	371.58	29,384,917.98	54,572,216.48
$45,001 - $60,000	1036.34	81,954,803.54	362.72	28,684,260.32	53,270,543.22
$60,001 - $75,000	1012.83	80,095,609.23	354.49	28,033,423.69	52,062,185.54
$75,001 - $90,500	988.55	78,175,522.55	346	27,362,026.00	50,813,496.55
$90,501 - $109,200	959.71	75,894,826.51	335.9	26,563,307.90	49,331,518.61
$109,201 - $131,500	921.58	72,879,467.98	322.55	25,507,576.55	47,371,891.43
$131,501 - $164,000	884.51	69,947,935.31	309.58	24,481,895.98	45,466,039.33
$164,001 - $224,000	830.46	65,673,607.26	290.66	22,985,683.46	42,687,923.80
Age					
16-24	882.46	69,785,819.26	308.86	24,424,957.66	45,360,861.60
25-34	931.32	73,649,716.92	325.96	25,777,242.76	47,872,474.16
35-44	974.79	77,087,367.99	341.18	26,980,855.58	50,106,512.41
45-54	980.33	77,525,476.73	343.12	27,134,272.72	50,391,204.01
55-64	971.74	76,846,170.94	340.11	26,896,238.91	49,949,932.03
Sex					
Male	1191.81	94,249,526.61	417.13	32,987,057.53	61,262,469.08
Female	679.87	53,764,799.47	237.96	18,818,114.76	34,946,684.71
Ethnicity & Race					
Hispanic	1214.52	96,045,456.12	425.08	33,615,751.48	62,429,704.64
Asian/Native American	753.23	59,566,181.63	263.63	20,848,124.03	38,718,057.60
Black/African American	879.14	69,523,270.34	307.7	24,333,223.70	45,190,046.64
Other	907.34	71,753,354.54	317.57	25,113,753.17	46,639,601.37
White (Non-Hispanic)	931.37	73,653,670.97	325.98	25,778,824.38	47,874,846.59

Source: OSHA calculations using OSHA's Safety Pays Program's "Estimated Costs of Occupational Injuries and Illnesses and Estimated Impact on Company's Profitability Worksheet" *https://www.osha.gov/safetypays/estimator*.

Note: OSHA's Safety Pays tool projects how injuries and illnesses may impact company's profitability. The above example assumes a 3 percent profit margin for heat prostration (or exhaustion)that cost $79,081 (i.e., includes a direct cost of $37,658 and indirect costs of $41,423). The extent to which the employer pays the direct costs depends on the nature of the employer's workers' compensation insurance policy. The employer always pays the indirect costs.

III. Which Business Owners Are Impacted by the Proposed Standard?

Figure VIII.G.5 shows, for owner-operated firms in industries affected by the proposed standard, ownership by demographic group in 2022. The analysis focuses on owner-operated firms because they are recorded in ACS data along with owner

characteristics. As such, analysis of owner-operated firms cannot be generalized to the entire set of affected industries, but sheds light on an important subset of these affected industries.

In general, the distribution of costs (see Section VIII.C., Costs of Compliance) are expected to have differential effects on firms in industries with different characteristics. In a highly competitive product market with many competitor suppliers of nearly identical goods or services, there will be limited pass-through of regulatory costs assessed on only a subset of firms to consumers in the form of higher prices, as individual firms lack the market power to shift prices. If firms raised prices, consumers would simply shift consumption to other firms not burdened by similar costs (e.g., because they operate in temperate climate) that do not raise prices. Were firms earning almost zero profits prior to the imposition of these regulatory costs, it would be possible that these firms would shut down (and other producers would likely expand operations, as demand shifted to them). However, evidence on firm revenues in these industries indicates that firms will largely be able to bear these costs without shutting down (see Section VIII.D., Economic Feasibility).

However, the assumption of perfectly competitive markets is not realized in the actual economy. To the extent that markets are less competitive, costs will be passed through in some combination to both consumers and firm owners, depending on the price elasticity of demand and the price elasticity of supply. In addition, frictions in the labor market will dictate how much of the costs are borne by workers, e.g., in the form of reduced pay or benefits. The difference in VSL for individuals who change and those that maintain the same job can inform estimates of the share of costs passed through to firm owners, workers, and consumers across industries in scope of this standard (see for example, Kniesner et al.'s 2012). Kniesner et al (2012) estimates a job switcher-derived VSL between $6.1 million and $10 million (in 2001 dollars) with a weighted average

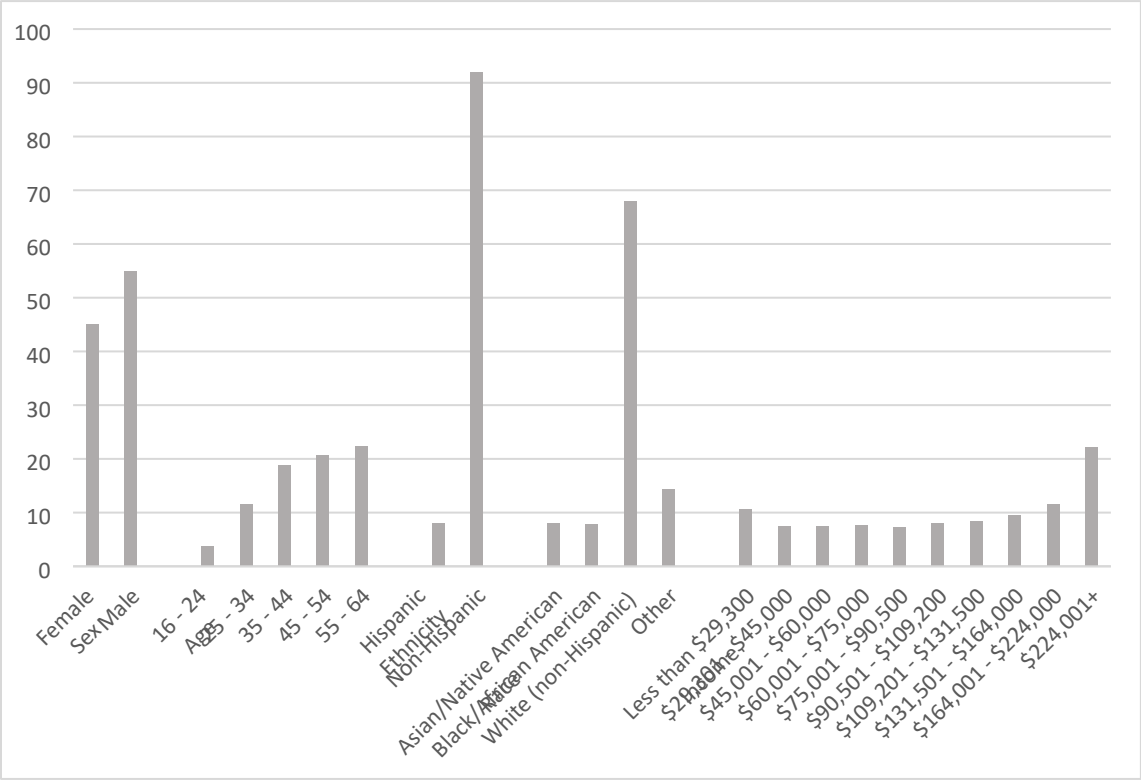
across job switchers and non-switchers is between $4.4 million and $5.5 million; the difference between these paired VSL estimates may approximate the average, over the first eight post-implementation years, of the portion of per-avoided-fatality benefits that accrues to workers without being offset by wage reductions. The benefits of the proposed standard could partially accrue in the form of increased productivity from workers less affected by heat. If firms are currently not offering the privately optimal level of workplace heat safety protection (e.g., due to principal-agent problems), these productivity gains could even theoretically exceed the increased costs borne by the firm. The magnitude of this effect determines whether firms are net better-off or worse-off, given both costs and increased productivity, as a result of the proposed standard (see sections VIII.G.I., and VIII.G.II.).

The Census Bureau's 2022 American Business Survey (Census Bureau and National Center for Science and Engineering Statistics, 2023) covers economic and demographic characteristics for businesses and business owners by sex, ethnicity, race, and veteran status. Tables VIII.G.3. and VIII.G.4., derived from the survey, show that owners from historically underrepresented populations (e.g., women and racial minorities) tend to be less profitable and have heightened concerns about the financial viability of their business (see tables VIII.G.3. and VIII.G.4.). These firms command 30 – 45 percent of the market.[113] Most owners were high-earning, non-Hispanic White males over the age of 34.

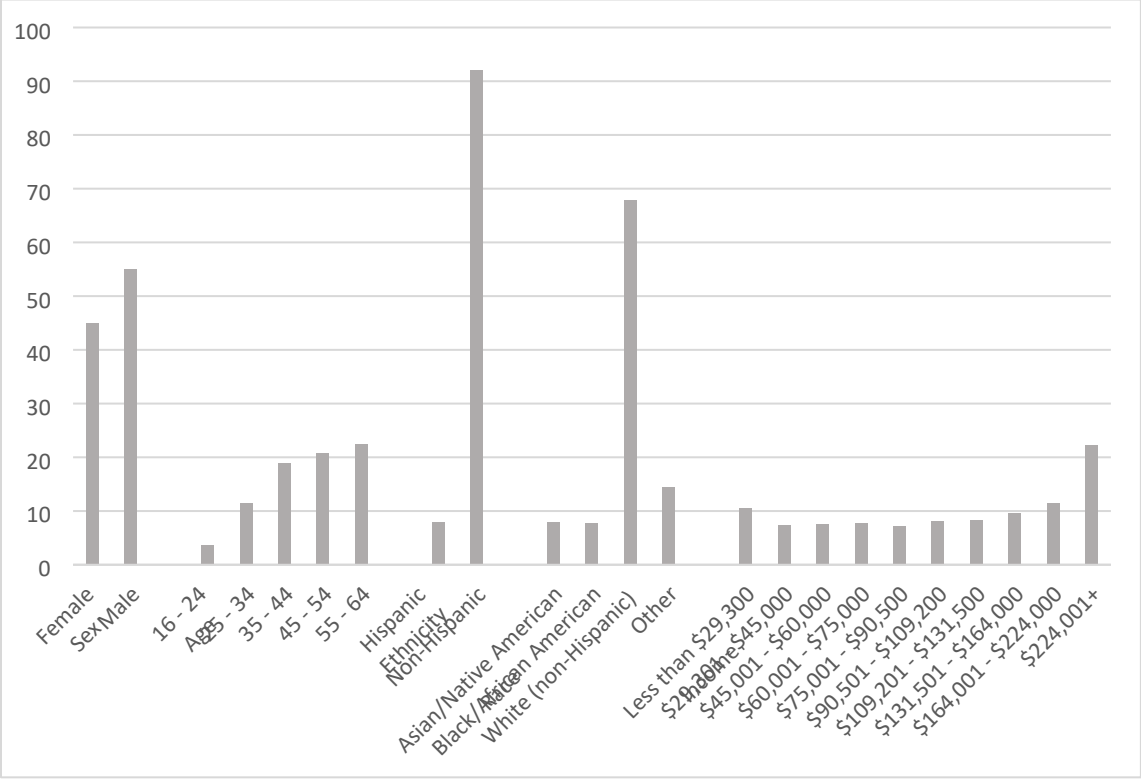
Taken together, this evidence suggests that the net benefits of the proposed standard for different groups (e.g., high-income and low-income populations) depend on how market competitiveness, elasticities of supply and demand, and the composition of groups affected by the standard's costs compare to the distribution of the standard's benefits for those groups (as discussed in sections VIII.G.I. and VIII.G.II.).

[113] Tables VIII.G.3. and VIII.G.4. reflect a representative sample of all U.S. industries.

Figure VIII.G.5. Market Share by Demographic Group, 2022



Source: OSHA calculations based on U.S. Census Bureau's 2022 Community Survey (ACS) (Ruggles et al., 2024).



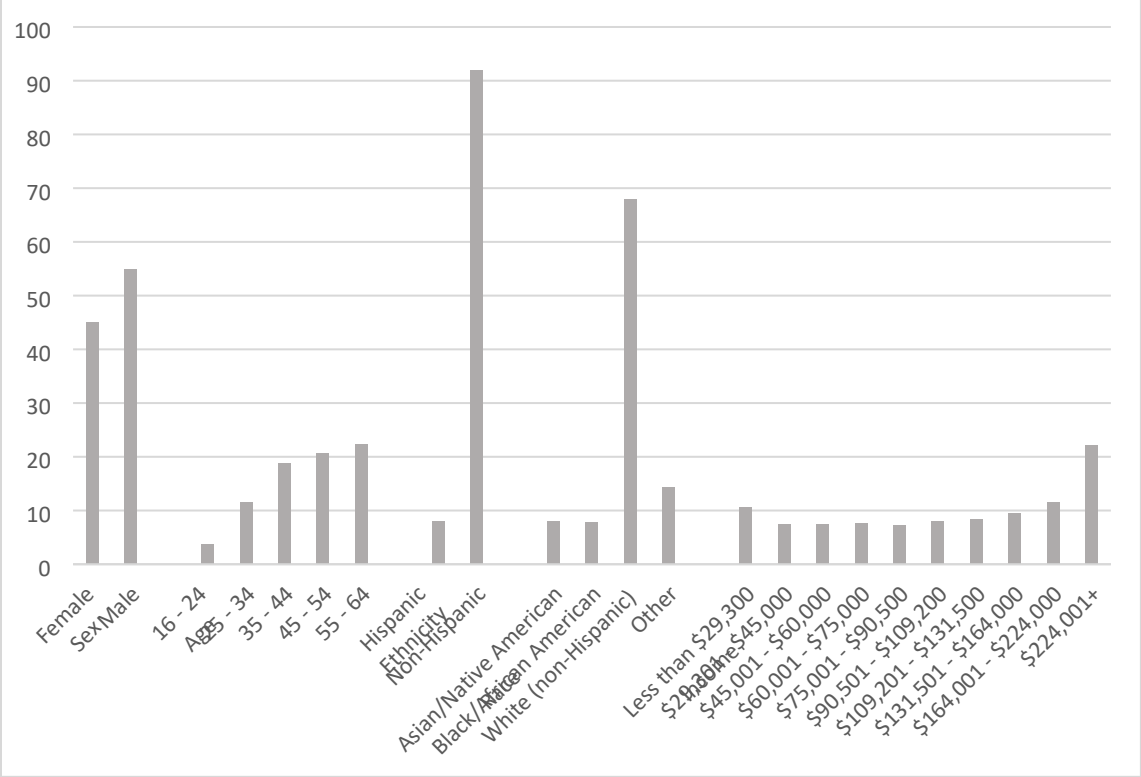


Table VIII.G.3. Financial Health of The Business In 2022 By Sex, Race, Ethnicity, Minority Status, and Veteran Status

	Level of concern about the financial health of the business in 2022			
	Percent of employer firms			
	Not that concerned	Somewhat concerned	Very concerned	Total
Total	41.9	39.4	18.7	100.0
Sex				
Female	38.7	39.9	21.4	100.0
Male	42.7	39.4	17.9	100.0
Equally male/female	41.7	39.6	18.7	100.0
Race				
White	44.0	38.5	17.4	100.0
Black or African American	26.9	41.5	31.6	100.0
American Indian and Alaska Native	30.1	42.1	27.8	100.0
Asian	27.0	47.2	25.8	100.0
Native Hawaiian and Other Pacific Islander	30.1	37.5	32.4	100.0
Ethnicity				

Hispanic	28.1	43.8	28.1	100.0
Equally Hispanic/non-Hispanic	34.1	40.5	25.5	100.0
Non-Hispanic	42.7	39.2	18.1	100.0
Minority Status				
Minority	27.6	45.2	27.2	100.0
Equally minority/nonminority	36.4	40.6	22.9	100.0
Nonminority	45.3	38.1	16.6	100.0
Veteran Status				
Veteran	44.5	37.1	18.4	100.0
Equally veteran/nonveteran	44.3	37.7	18.0	100.0
Nonveteran	41.4	39.7	18.8	100.0

Source: Census Bureau and National Center for Science and Engineering Statistics, 2023.
Note: Data are preliminary and will be revised when the final 2023 Annual Business Survey results are published. Firms were asked to report the percentage of ownership, sex, ethnicity, and race, for up to four persons owning the largest percentages in the business. A firm could be tabulated in more than one racial group for the following reasons: the sole owner was reported to be of more than one race; the majority owner was reported to be of more than one race; or a majority combination of owners was reported to be of more than one race. Firms classified as minority are those classified as any race and ethnicity combination other than non-Hispanic and White. For more information about the survey, visit *https://www.census.gov/programs-surveys/abs.html*. Unpublished estimates derived from this table by subtraction are subject to these same limitations and should not be attributed to the Census Bureau.

Table VIII.G.4. Business Profitability in 2022 By Sex, Race, Ethnicity, Minority Status and Veteran Status

	Business had profits, losses, or broke even			
	Percent of employer firms			
	Profits	Losses	Break even	Total
Total	65.6	19.6	14.8	100.0
Sex				
Female	63.2	21.3	15.5	100.0
Male	66.7	18.6	14.7	100.0
Equally male/female	65.1	20.1	14.8	100.0
Race				
White	66.9	18.9	14.2	100.0
Black or African American	49.5	30.2	20.3	100.0
American Indian and Alaska Native	59.1	22.1	18.9	100.0

Asian	60.7	21.3	18.0	100.0
Native Hawaiian and Other Pacific Islander	55.0	20.7	24.3	100.0
Ethnicity				
Hispanic	59.9	21.8	18.4	100.0
Equally Hispanic/non-Hispanic	60.9	23.5	15.6	100.0
Non-Hispanic	66.2	19.2	14.6	100.0
Minority Status				
Minority	59.1	22.6	18.3	100.0
Equally minority/nonminority	62.8	22.3	14.8	100.0
Nonminority	67.4	18.6	14.0	100.0
Veteran Status				
Veteran	62.3	21.9	15.9	100.0
Equally veteran/nonveteran	63.5	21.3	15.2	100.0
Nonveteran	65.9	19.3	14.8	100.0

Source: Census Bureau and National Center for Science and Engineering Statistics, 2023.
Note: Data are preliminary and will be revised when the final 2023 Annual Business Survey results are published. Firms were asked to report the percentage of ownership, sex, ethnicity, and race, for up to four persons owning the largest percentages in the business. A firm could be tabulated in more than one racial group for the following reasons: the sole owner was reported to be of more than one race; the majority owner was reported to be of more than one race; or a majority combination of owners was reported to be of more than one race. Firms classified as minority are those classified as any race and ethnicity combination other than non-Hispanic and White. For more information about the survey, visit *https://www.census.gov/programs-surveys/abs.html*. Unpublished estimates derived from this table by subtraction are subject to these same limitations and should not be attributed to the Census Bureau.

IV. Conclusion.

The proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings is well-positioned to protect the most at-risk workers, across the socioeconomic gradient. In response to the advance notice of proposed rulemaking (ANPRM) for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings, members of Congress emphasized that "jobs at the highest risk of heat stress illness and death are disproportionately held by workers of color" and occupational risk from heat is the "greatest for low-income workers" (OSHA-2021-0009-0266; 0270), a concern that was echoed by other commenters, including legal experts (see, e.g., OSHA-2021-0009-

0524), employee representatives (see, e.g., OSHA-2021-0009-0661), and advocacy groups (see, e.g., OSHA-2021-0009-0655; 0712). Commenters also called for a heat standard that minimizes risks of "…compounding language, social service access, and wealth-building barriers" (OSHA-2021-0009-0522). The proposed standard reinforces occupational heat hazard protections for all workers through the adoption of agile and culturally attunable provisions. For example, the provisions:

- Requiring training on occupational heat-related risks and protections covered by this standard (e.g., rest breaks, water) to employees upon hire and each year can enhance knowledge of heat safe work practices, reducing risk of HRIs among less experienced or vulnerable workers;
- Requiring the provision of training in a language and literacy level appropriate for staff along with the opportunities for questions and answers ensures heat protections (e.g., paid rest breaks, cool drinking water) are understood and accessible to all; and
- Requiring an acclimatization protocol along with paid rest breaks that include adequate drinking water, shade (or air conditioning), and medical attention (if necessary) at initial and high heat triggers foster non-exploitive treatment of non-salaried vulnerable workers (e.g., farmworkers).

The provisions have economic effects extending beyond the direct benefits to workers in affected industries. Heat is the leading cause of weather-related deaths, estimated to cost the U.S. $1 billion in excess health care costs each year with a projection to potentially reach $14.5 trillion in economic damages via factors impacting the economic production over the next fifty years (Woolf et al., 2023; Deloitte, 2022). The standard is projected to reduce occupational heat-induced deaths which can offset the estimated health costs due to weather. The proposed standard is primed for

responsiveness to workers of all levels of social vulnerability while counteracting the broader economic costs of extreme temperatures.

H. Appendix A. Description of the Cost Savings Approach.

I. Introduction.

This appendix details the underlying calculations of the potential cost savings from the proposed standard as a result of requiring employers to provide employees if-needed or scheduled rest breaks. The best available evidence indicates that when employees are exposed to heat and are not allowed to take rest breaks or adjust their work hours, they must pace themselves (i.e., work more slowly) to counteract the effects of heat exposure. OSHA has preliminarily determined that when employees are offered rest breaks, cost savings will accrue to employers currently noncompliant with the rest break requirement because employees will work more efficiently during the work time not spent on rest breaks (i.e., pace less), effectively replacing pacing with if-needed or scheduled rest breaks. First, for the three groups defined below, OSHA estimated the percentage of productivity loss at the initial heat trigger using the Heat Index (HI) option (i.e., (HI) at or above 80°F) and above the high heat trigger (i.e., HI at or above 90°F). These estimates were then translated to equivalent lost minutes of work time in an 8-hour work shift.

When working in hot conditions, OSHA assumes that employees can take three different measures to avoid overheating:

1) Measure #1: Employees *pace* themselves; for example, an employee shovels gravel at a slower pace in hot conditions than they would in cooler conditions.
2) Measure #2: Employees take *rest breaks if needed*; for example, an employee leans on their shovel for a few minutes at a time whenever they feel overwhelmed by the heat, which they otherwise would not do in cooler conditions.

3) Measure #3: Employees take *scheduled rest breaks*; for example, twice a day, for 15 minutes at a time, an employee sits in a cool or shaded area to drink water and recover from the heat.

Depending on what is allowed by their employers, employees can take multiple measures to avoid overheating (i.e., they are not mutually exclusive). Three groups of employees were defined based on possible combinations of measures:

1) Group #1: Employees who only use *pacing* (Measure #1). These employees do not take any rest breaks, possibly because their employer does not allow them to take breaks.
2) Group #2: Employees who take *rest breaks if needed* (Measure #2) and use *pacing* (Measure #1). These employees are allowed to take brief, unscheduled breaks by their employer. However, these rest breaks may not be long or frequent enough to allow for a full recovery from the heat exposure (return to normal body temperature of 98.6°F (37°C)). Therefore, these employees still display residual pacing while they work.
3) Group #3: Employees who take *scheduled rest breaks* (Measure #3), may take *rest breaks if needed* (Measure #2), and use *pacing* (Measure #1). These employees are allowed to take scheduled rest breaks, which may allow them to rehydrate and rest in a cool or shaded area, as well as rest breaks if needed. However, these rest breaks do not entirely eliminate productivity loss, as these employees also display residual pacing, though it is expected to be to a lesser extent than employees in Group #2.

II. Primary Approach.

This section describes the method that OSHA used to estimate labor productivity losses that result from pacing due to heat exposure. First, the general approach is

summarized, next the general assumptions of the analysis are outlined, and then the calculations are detailed for Groups 1, 2, and 3.

A. Summary of Approach.

For the primary approach, OSHA searched for studies that examined how working in hot vs. cool conditions affect employee productivity. Eastern Research Group (ERG) performed several literature searches (ERG, 2022a; ERG, 2022b; ERG, 2022c) and identified a total of 71 unique studies that could inform the relationship between heat and various outcomes (e.g., labor productivity, heat strain). OSHA also reviewed the reference lists of these studies and identified an additional 37 studies that were potentially relevant to this topic. This yielded a total of 108 studies considered for inclusion for the purposes of estimating the impact of rest breaks on labor productivity at the initial heat and high heat triggers. Generally, studies were excluded if they did not meet the inclusion criteria listed below (more detailed reasons for exclusion are listed in table VIII.H.A.3.).

- Measured labor productivity over a range of temperatures, so that a comparison could be made between a cool (REF) condition below the initial heat trigger (i.e., HI at or above 80°F), and a HOT condition(s) above the high heat trigger (i.e., HI at or above 90°F).
- Provided enough information on weather conditions so that HI could be estimated, even if based on historical weather data.
- Collected labor productivity data.
- Reported labor productivity as output per worker, per hour, or per day.
- Provided information as to whether breaks were offered, and if so, how long and frequent the breaks were.

Once studies were identified for inclusion, each included study was evaluated for four key pieces of information:

1) Which measure(s) employees took to avoid overheating (Measures #1, #2, and/or #3), allowing the assignment of employees to Groups #1, #2, or #3.
2) Weather data that describe the cool condition, or the referent (REF) condition. This could be when the HI was lowest, or when output was highest (i.e., 100% productivity). The HI was calculated based on the ambient or dry bulb temperature (T_a or T_d, respectively) and the relative humidity (RH).
3) Weather data that describe the HOT condition(s). This could be when the HI was highest, or at which output was lowest (i.e., 50% lower output means 50% productivity). Again, HI was calculated to ensure that the HOT condition(s) exceeded both the initial and high heat triggers.
4) Labor productivity at both the REF and HOT conditions, so that the loss in labor productivity (%) could be divided by the difference in HI (°F) and expressed as a rate of lost labor productivity per 1°F HI.

After calculating the rate of labor productivity loss per 1°F HI, OSHA calculated the (cumulative) labor productivity loss as a percentage relative to the REF condition at the initial heat trigger (HI of 80°F) and high heat trigger (HI of 90°F). This labor productivity loss was then translated into equivalent minutes of lost work time by multiplying by an 8-hour work shift (480 minutes).

Table VIII.H.A.1. Summary Table

Group	Study	HI at REF	HI at HOT	Productivity Loss per 1°F HI above REF	Productivity Loss at Initial Heat Trigger	Productivity Loss at High Heat Trigger
1	LoPalo, 2023	66.1°F	105.2°F	0.35%	23.4 min (4.9%)	40.2 min (8.4%)
	Foster et al., 2021	76.8°F	161.4°F	0.73%	11.3 min (2.4%)	46.4 min (9.7%)
	Hanna, 2004	79.2°F	122.3°F	0.86%	3.3 min (0.7%)	44.5 min (9.3%)
	Somanathan et al., 2021	63.4 - 82°F	90 - 105.8°F	0.29%	18.0 min (3.8%)	31.3 min (6.5%)
	Group Mean:			**0.56%**	**14.0 min**	**40.6 min**

Group	Study	HI at REF	HI at HOT	Productivity Loss per 1°F HI above REF	Productivity Loss at Initial Heat Trigger	Productivity Loss at High Heat Trigger
2	Ioannou et al., 2017	72.1 - 75.6°F	96.9 - 103.1°F	0.73%	22.3 min (4.6%)	57.4 min (12.0%)
	Sahu et al., 2013	85.5°F	116.6°F	1.00%	0 min (0%)	21.6 min (4.2%)
	Group Mean:			**0.865%**	**11.2 min**	**39.5 min**
3	Dally et al., 2018	88.3°F	102.6°F	1.03%	0 min (0%)	8.4 min (1.8%)
	Group Mean:			**1.03%**	**0 min**	**8.4 min**

B. General Assumptions.

When estimating labor productivity loss in each study, OSHA made the following assumptions:

a. Unless otherwise specified, productivity at or below the REF condition is 100%.

b. Above the REF condition, the relationship between HI and labor productivity loss is linear, i.e., the rate of loss (per 1°F HI) is a constant. Therefore, the productivity loss function for any firm can be fully characterized by two parameters: the REF condition and the rate of loss.

c. Employees in Group 2 are allowed to take up to 10 minutes of rest breaks if needed (with 2–4 minutes of travel time to/from break areas).

d. Employees in Group 3 are allowed to take 30 minutes of scheduled rest breaks, along with 5 minutes of rest breaks if needed (with 2–4 minutes of travel time to/from break areas for each break).

e. An employee's expected productivity loss from pacing, given a specific temperature and the employer's rest break policy, can be estimated by the average productivity loss measured in studies where that rest break policy is in effect. In other words, the set of studies with each group fully characterizes the productivity loss that would be

experienced by employees at a firm that offered the associated rest break policy, regardless of what rest break policy it currently offers.

f. An employee's expected productivity gains from taking new or newly scheduled rest breaks (versus not taking breaks or taking only if-needed breaks) can be estimated by differences in productivity losses due to pacing, as measured at the initial temperature (i.e., trigger) at which the rest break policy goes into effect.[114].

C. Productivity Loss Estimates by Group.

I. Group 1 Studies.

LoPalo (2023) assessed the effects of temperature on the productivity of 9,000 Demographic and Health Surveys interviewers in 46 countries. Interviewers were paid an hourly wage and were assumed to be acclimatized because they were "recruited within a region of a country as much as possible so that the interviewer [did] not seem foreign to the respondent" (p. 197). The author concluded that "high temperatures are detrimental to productivity, with interviewers experiencing a 13.6 percent loss in interviews per hour on days over 85°F wet bulb" (pp. 208-209).

The author clarifies, "more specifically, I estimate the effect of daily average wet bulb temperature falling into a certain bin on my outcome variable of interest, relative to an excluded bin of 50–60°F (50–60°F wet bulb corresponds with a median dry bulb temperature of 66°F in my sample)" (p. 205). Thus, a dry bulb temperature (T_d) of 66°F was selected for the calculation of the heat index (HI) for the REF condition. Per Figure 1 (p. 203), in this sample, a T_d of 66°F yields a wet bulb temperature of 55°F when RH is 80%. Therefore, OSHA used 80% RH for the calculation of HI. A T_d of 66°F and 80% RH yielded an HI of 66.1°F for the REF condition.

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[114] All else equal, using the initial temperature (i.e., trigger) rather than the temperature inputs used elsewhere in this PEA will yield underestimates of the effects reported in table VIII.H.A.1. When subsequently performing subtraction (for expressing productivity differences across Groups), there is ambiguity about the direction of misestimation—because the difference between two underestimated amounts may be over- or underestimated.

The author created bins of both T_d and wet bulb temperature; the highest bin for T_d was ">95°F". Therefore, a T_d of 95°F was used to calculate the HI for the HOT condition. The author states, "the highest daily average wet bulb temperature in my sample is 87.7°F, while the highest daily average dry bulb temperature is 102.6°F" (p. 206). Per Figure 1 (p. 203), in this sample, a T_d of 102.6°F yields a wet bulb temperature of 87.7°F when RH is 50%. Therefore, OSHA used 50% RH for the calculation of HI. A T_d of 95°F and 50% RH yielded an HI of 105.2°F for the HOT condition.

Finally, the productivity loss from the REF condition to the HOT condition was estimated. In table 2. (p. 209), the author provides a regression estimate for each bin of dry bulb temperature to indicate its effect on the number of interviews completed per hour. The estimate in Column 2 (-0.135, or 13.5% loss) accounted for both T_d and high humidity and most closely matched the estimate in Column 4 for wet bulb temperature (-0.136, or 13.6% loss). Therefore, OSHA selected the estimate for T_d and high humidity, which yielded a rate of productivity loss of 0.35% per 1°F HI.

$$\frac{13.5\%}{|66.1 - 105.2|°\text{F}} = 0.35\% \text{ per } 1°\text{F HI}$$

Relative to the REF condition (66.1°F HI), the productivity loss at the initial heat trigger (80°F HI) is 4.87%. For an 8-hour work shift (480 minutes), this translates to a loss of 23.4 minutes.

$$\frac{0.35\%}{1°\text{F HI}} * (80 - 66.1)°\text{F HI} = 4.87\% \qquad 4.87\% * 480 \text{ minutes} = 23.4 \text{ minutes}$$

Relative to the REF condition (66.1°F HI), the productivity loss at the high heat trigger (90°F HI) is 8.37%. For an 8-hour work shift (480 minutes), this translates to a loss of 40.2 minutes.

$$\frac{0.35\%}{1°\text{F HI}} * (90 - 66.1)°\text{F HI} = 8.37\% \qquad 8.37\% * 480 \text{ minutes} = 40.2 \text{ minutes}$$

Foster et al. (2021) assessed the effects of temperature on physical work capacity (PWC) of 40 unacclimatized young adult males at 22 different combinations of air

temperature (T_a) and relative humidity (RH). First, the authors measured maximal PWC (i.e., 100% productivity) at a T_a of 59°F and RH of 50%. Then, the authors assessed PWC under various conditions, with T_a ranging from 77°F to 122°F and RH ranging from 20% to 80%.

To determine an appropriate REF condition, OSHA plotted the low-clothing coverage estimates from table 2. (p. 1222) and found a sigmoidal curve. That is, as T_a increased from 59°F to 77°F, the curve was nearly flat, indicating minimal productivity decline. Then, at a T_a of 77°F (and 50% RH), productivity began to decline in a nearly perfect linear fashion ($R^2 = 0.99$). Therefore, the REF condition was selected as a T_a of 77°F and RH of 50%. This combination yielded an HI of 76.8°F for the REF condition.

The combination of temperature and humidity that corresponded the greatest productivity loss (66%) along the linear portion of the curve was a T_a of 104°F and RH of 70%. This combination yielded an HI of 161.4°F for the HOT condition.

The productivity loss from the REF condition to the HOT condition was estimated. In table 2. (p. 1222), the authors reported that at the REF condition (T_a 77°F, RH 50%), PWC was 96%, and at the HOT condition (T_a 104°F, RH 70%), PWC was 34%. This yielded a rate of productivity loss of 0.73% per 1°F HI.

$$\frac{(96-34)\%}{|76.8-161.4|°\text{F}} = 0.73\% \text{ per } 1°\text{F HI}$$

Relative to the REF condition (76.8°F HI), the productivity loss at the initial heat trigger (80°F HI) is 2.35%. For an 8-hour work shift (480 minutes), this translates to a loss of 11.3 minutes.

$$\frac{0.73\%}{1°\text{F HI}} * (80-76.8)°\text{F HI} = 2.35\% \quad 2.35\% * 480 \text{ minutes} = 11.3 \text{ minutes}$$

Relative to the REF condition (76.8°F HI), the productivity loss at the high heat trigger (90°F HI) is 9.67%. For an 8-hour work shift (480 minutes), this translates to a loss of 46.4 minutes.

$\frac{0.73\%}{1°\text{F HI}} * (90 - 76.8)°\text{F HI} = 9.67\%$ $9.67\% * 480 \text{ minutes} = 46.4 \text{ minutes}$

Hanna (2004) assessed the effects of temperature on the productivity of two electrical journeymen in a climatic chamber at various combinations of T_a (ranging from -10°F to 110°F, in increments of 10°F) and RH (ranging from 40% to 80%, in increments of 10%). The journeymen were assessed for their performance of a routine work task (installing duplex receptacles) over a total of 6 days of testing. The author stated that "for the purpose of this study, the average number of receptacles installed in one hour during the first day of work measurement at 70°F and 60% RH is expressed as 100% productivity."

However, per Chart 2-1 (p. 15), productivity clearly only began to decline at a T_a of 80°F and RH of 30%. Therefore, the REF condition was selected as a T_a of 80°F and RH of 30%. This combination yielded an HI of 79.2°F for the REF condition.

According to table 2.3. (p. 11), the combination of temperature and humidity that corresponded the greatest productivity loss (38%) was a T_a of 110°F and RH of 30%. This combination yielded an HI of 122.3°F for the HOT condition.

The productivity loss from the REF condition to the HOT condition was estimated. In table 2.3. (p. 11), the authors reported that at the REF condition (T_a 80°F, RH 30%), productivity was 99%, and at the HOT condition (T_a 110°F, RH 30%), productivity was 62%. This yielded a rate of productivity loss of 0.86% per 1°F HI.

$$\frac{(99 - 62)\%}{|79.2 - 122.3|°\text{F}} = 0.86\% \text{ per } 1°\text{F HI}$$

Relative to the REF condition (79.2°F HI), the productivity loss at the initial heat trigger (80°F HI) is 0.69%. For an 8-hour work shift (480 minutes), this translates to a loss of 3.3 minutes.

$\frac{0.86\%}{1°\text{F HI}} * (80 - 79.2)°\text{F HI} = 0.69\%$ $0.69\% * 480 \text{ minutes} = 3.3 \text{ minutes}$

Relative to the REF condition (79.2°F HI), the productivity loss at the high heat trigger (90°F HI) is 9.27%. For an 8-hour work shift (480 minutes), this translates to a loss of 44.5 minutes.

$$\frac{0.86\%}{1°\text{F HI}} * (90 - 79.2)°\text{F HI} = 9.27\% \qquad 9.27\% * 480 \text{ minutes} = 44.5 \text{ minutes}$$

Somanathan et al. (2021) assessed the productivity of indoor workers in cloth-weaving, garment-sewing, and steel mill industries in India. OSHA only analyzed garment-sewing workers, who were "paid monthly wages" (p. 1803), and their productivity was assessed as "actual hourly output, when controlled for the target [output]" from "103 sewing lines over a period of 730 days during the calendar years of 2012 and 2013" (p. 1804). OSHA excluded workers from the cloth weaving industry because productivity was not reported for the full range of temperatures (Figure 1C, p. 1808). OSHA also excluded certain garment plants and the steel mill, as these facilities were climate-controlled (p. 1806), and workers experienced limited variations in temperature.

The authors reported productivity as a function of daily maximum temperature (T_a) in Figure 1 (p. 1808). Temperature data came from "recordings from public weather stations within the cities where… garment-sewing factories are located" (p. 1806), i.e., the National Capital Region (NCR), Hyderabad, and Chhindwara. The authors created temperature bins for each industry, as well as the equivalent bins based on wet-bulb temperature (WBT), which accounts for both T_a and RH (appendix, p. 3).

	Garment-Sewing (inside NCR)		Garment-Sewing (outside NCR)	
	Temperature Bin	Equivalent WBT Bin	Temperature Bin	Equivalent WBT Bin
REF	< 19°C	< 15°C	< 27°C	< 23°C
HOT	> 33°C	> 25.5°C	> 33°C	> 29°C
Max	> 35°C	> 27°C	> 35°C	> 31°C

To calculate the HI for the REF condition in the garment-sewing industry, the T_a for the lowest bin was used and RH was calculated using the equation below (provided by the authors). Inside the NCR, the T_a was 66.2°F (19°C) and RH was calculated at 18%, yielding an HI of 63.4°F for the REF condition. Outside the NCR, the T_a was 80.6°F (27°C) and RH was calculated as 56%, yielding an HI of 82°F for the REF condition.

$$WBT = 0.567T_a + 0.216\left(\frac{RH}{100} * 6.105 * \exp\left(\frac{17.27T_a}{237.7 + T_a}\right)\right) + 3.38$$

To calculate the HI for the HOT condition in the garment-sewing industry, the T_a for the second highest bin was used because this is where productivity losses reached a maximum and plateaued (Figure 1A-B, p. 1808). RH was again calculated using the equation above. Inside the NCR, the T_a was 91.4°F (33°C) and RH was calculated at 31%, yielding an HI of 90°F for the HOT condition. Outside the NCR, the T_a was also 91.4°F (33°C) and RH was calculated as 64%, yielding an HI of 105.8°F for the HOT condition.

The productivity losses from the REF conditions to the HOT conditions were estimated using data from Figure A.3 (appendix, p. 6). For garment workers inside the NCR, the authors reported that at the HOT condition, there was a 12% loss in productivity, which yields a rate of 0.45% per 1°F HI. Outside the NCR, the authors reported that at the HOT condition, there was a 3% loss in productivity, which yields a rate of 0.13% per 1°F HI.

Inside NCR: $\frac{(100-88)\%}{|63.4-90|°F} = 0.45\%$ per 1°F HI Outside NCR: $\frac{(100-97)\%}{|82-105.8|°F} = 0.13\%$ per 1°F HI

Mean: $\frac{(0.45+0.13)\%\text{ per 1°F HI}}{2} = 0.29\%$ per 1°F HI

Relative to the REF condition, inside the NCR, productivity loss at the initial heat trigger (80°F HI) was 7.49%. For an 8-hour work shift (480 minutes), this translates to a

loss of 35.9 minutes. Outside the NCR, productivity loss is assumed to be 0% because the REF (82°F HI) was above the initial heat trigger. The mean loss is 18.0 minutes.

$$\text{Inside NCR:} \quad \frac{0.45\%}{1°\text{F HI}} * (80 - 63.4)°\text{F HI} = 7.49\% \quad 7.49\% * 480 \text{ minutes} = 35.9 \text{ minutes}$$

$$\text{Outside NCR:} \quad 0 \text{ minutes}$$

$$\text{Mean:} \quad \frac{(35.9+0) \text{ minutes}}{2} = 18.0 \text{ minutes}$$

Relative to the REF condition, inside the NCR, productivity loss at the high heat trigger (90°F HI) was 12.0%. For an 8-hour work shift (480 minutes), this translates to a loss of 57.6 minutes. Outside the NCR, productivity loss at the high heat trigger was 1.0%, or a loss of 4.8 minutes. The mean loss is 31.3 minutes.

$$\text{Inside NCR:} \quad \frac{0.45\%}{1°\text{F HI}} * (90 - 63.4)°\text{F HI} = 12.0\% \quad 12.0\% * 480 \text{ minutes} = 57.6 \text{ minutes}$$

$$\text{Outside NCR:} \quad \frac{0.13\%}{1°\text{F HI}} * (90 - 82)°\text{F HI} = 1.04\% \quad 1.04\% * 480 \text{ minutes} = 5.0 \text{ minutes}$$

$$\text{Mean:} \quad \frac{(57.6+5.0) \text{ minutes}}{2} = 31.3 \text{ minutes}$$

II. Group 2 Studies.

Ioannou et al. (2017) assessed the effects of temperature on the productivity of 7 grape-picking workers in Cyprus over 4 study days: two in the summer (August 17–18, 2016) and two in the autumn (October 11–12, 2016). The workers were “healthy and heat-acclimatized” (p. 332), and their pay system was not specified. They were “officially not provided with any breaks other than the lunch break” (p. 338) but did take “irregular work breaks... defined as any unprescribed work cessation determined by workers’ own judgment, and not based on specific time intervals or instructions” (p. 333). Productivity was assessed as “the number of boxes full of grapes picked by the entire group in each hour divided by the number of workers” (p. 333).

The authors reported hourly productivity as a function of wet bulb globe temperature (WBGT). The calculation of WBGT was based on weather data (including T_a and RH) from the Paphos International Airport in Cyprus. OSHA accessed the same historical weather data (wunderground.com) for the 4 study days and calculated the hourly HI (based on T_a and RH) for each study day. On October 11 and 12, the highest HI was still below the high heat trigger (83.8°F and 85.6°F, respectively) and would have required extrapolation to estimate the rate of productivity loss. Therefore, only weather and productivity data from August 17 and 18 was considered. The lowest HI for each day served as the REF condition for that day; the REF HI for August 17 was 75.6°F (based on a T_a of 75°F and 73% RH), and the REF HI for August 18 was 72.1°F (based on a T_a of 72°F and 69% RH).

The highest HI for each day served as the HOT condition. The HOT HI for August 17 was 96.9°F (based on a T_a of 86°F and 74% RH), and the HOT HI for August 18 was 103.1°F (based on a T_a of 88°F and 75% RH).

The productivity loss from the REF condition to the HOT condition for the 2 study days (August 17-18) was estimated by plotting the hourly HI against the productivity data (boxes per hour) in Figure 6 (p. 337). The rate of productivity loss was 0.65% per 1°F HI for August 17, and 0.81% per 1°F HI on August 18, which yielded a mean rate of 0.73% per 1°F HI.

August 17: $\frac{(100-86.1)\%}{|75.6-96.9|°F} = 0.65\%$ per 1°F HI August 18: $\frac{(100-74.9)\%}{|72.1-103.1|°F}$

$= 0.81\%$ per 1°F HI

Mean: $\frac{(0.65+0.81)\%\text{ per 1°F HI}}{2} = 0.73\%$ per 1°F HI

Relative to the REF conditions, the productivity loss at the initial heat trigger (80°F HI) was 2.87% for August 17 and 6.40% for August 18. For an 8-hour work shift (480 minutes), this translates to a loss of 13.8 and 30.7 minutes, respectively, and a mean loss of 22.3 minutes.

August 17: $\frac{0.65\%}{1°\text{F HI}} * (80 - 75.6)°\text{F HI} = 2.87\% \quad 2.87\% * 480$

$$\text{minutes} = 13.8 \text{ minutes}$$

August 18: $\frac{0.81\%}{1°\text{F HI}} * (80 - 72.1)°\text{F HI} = 6.40\% \quad 6.40\% * 480$

$$\text{minutes} = 30.7 \text{ minutes}$$

Mean: $\frac{(13.7+30.7) \text{ minutes}}{2} = 22.3 \text{ minutes}$

Relative to the REF conditions, the productivity loss at the high heat trigger (90°F HI) was 9.40% for August 17 and 14.5% for August 18. For an 8-hour work shift (480 minutes), this translates to a loss of 45.1 and 69.6 minutes, respectively, and a mean loss of 57.4 minutes.

August 17: $\frac{0.65\%}{1°\text{F HI}} * (90 - 75.6)°\text{F HI} = 9.40\% \quad 9.40\% * 480$

$$\text{minutes} = 45.1 \text{ minutes}$$

August 18: $\frac{0.81\%}{1°\text{F HI}} * (90 - 72.1)°\text{F HI} = 14.5\% \quad 14.5\% * 480$

$$\text{minutes} = 69.6 \text{ minutes}$$

Mean: $\frac{(45.1+69.6) \text{ minutes}}{2} = 57.4 \text{ minutes}$

Sahu et al. (2013) assessed the effects of temperature on the productivity of 48 male rice harvesters in Bengal, India from April to June in 2011. Workers were paid on a piece-rate system, and their acclimatization status was not specified. They were allowed to take "small breaks (3-6 min) between work tasks [that] were included as part of the normal work time management" (p. 426). Productivity was assessed as the "hourly number of bundles divided by the number of workers to calculate the average hourly productivity per worker" (p. 426). The authors measured both T_a and WBGT in the farm fields and estimated the relationship between them (Figure 1, p. 427).

The authors only reported productivity as a function of WBGT (Figure 4, p. 428). First, the WBGT when productivity was highest (25.7°C) and lowest (30.9°C) was identified. Then the regression equation from Figure 1 was used to estimate T_a based on

WBGT. Finally, to estimate RH, historical weather data "from the nearby weather station at Kolkata Dum-Dum airport" (p. 426) was used, upon which the authors had also relied. OSHA identified the days from April through June 2011 that matched the T_a for highest productivity (80.6°F) and lowest productivity (97.4°F) at 6 a.m. (when T_a was measured for the first hour of work), and then used the corresponding level of RH. This yielded an HI of 85.5°F for the REF condition (based on a T_a of 80.6°F and 80% RH), and an HI of 116.6°F for the HOT condition (based on a T_a of 97.4°F and 56% RH).

OSHA estimated productivity loss from the REF condition to the HOT condition based on the productivity data (rice bundles per hour) for the first hour of work in Figure 4 (p. 428). Workers harvested 92 rice bundles per hour at the REF condition (i.e., 100% productivity), and 63.8 bundles per hour at the HOT condition (i.e., 69% productivity). This yielded a rate of productivity loss of 1.00% per 1°F HI.

$$\frac{(100-69)\%}{|85.5-116.6|°\text{F}} = 1.00\% \text{ per } 1°\text{F HI}$$

The productivity loss at the initial heat trigger (80°F HI) is assumed to be 0% because the REF condition, at which productivity was assumed to be 100%, is higher than the initial heat trigger.

Relative to the REF condition (85.5°F HI), the productivity loss at the high heat trigger (90°F HI) is 4.50%. For an 8-hour work shift (480 minutes), this translates to a loss of 21.6 minutes.

$$\frac{1.00\%}{1°\text{F HI}} * (90-85.5)°\text{F HI} = 4.50\% \quad 4.50\% * 480 \text{ minutes} = 21.6 \text{ minutes}$$

III. Group 3 Studies.

Dally et al. (2018) assessed the effects of temperature on the productivity of 4,095 sugarcane cutters in Guatemala from November 2015 to May 2016. Workers received "a base wage regardless of the amount of sugarcane harvested" (p. 3) and were acclimatized (i.e., they completed a "one week acclimatization period in November" (p.

3). They worked a "ten-hour shift (p. 3) and were allowed to "take three 20-minute breaks and one 60-minute lunch break in the provided shade during the work shift" (p. 4). The authors reported daily productivity as the "average daily tons cut per workday" (p. 4). The authors collected data on T_a, RH, and WBGT using the Cengicaña weather station located close to the sugarcane fields.

Using historical weather data (collected at 15-minute intervals) from the Cengicaña weather station, T_a and RH were used to calculate HI for each day of the harvest season. OSHA identified the days with the highest and lowest HI based on the 75th percentile of each day, which provided the range of temperatures that most closely corresponded to the extreme values of daily productivity (as compared with mean HI or max HI). This yielded an HI of 88.3°F for the REF condition and an HI of 102.6°F for the HOT condition.

The productivity loss from the REF condition to the HOT condition was estimated based on the productivity data (tons of sugarcane per day) in Figure 2 (p. 7). Workers harvested 6.0 tons per day at the REF condition (i.e., 100% productivity), and 5.42 tons per day at the HOT condition (i.e., 90.3% productivity). This yielded a rate of productivity loss of 0.68% per 1°F HI.

$$\frac{(100 - 90.3)\%}{|88.3 - 102.6|°\text{F}} = 0.68\% \text{ per } 1°\text{F HI}$$

However, the sugarcane cutters were given a total of 60 minutes of rest breaks (3x20 minutes) over the course of a 9-hour work shift, while the proposed rule would require a total of 35 minutes of rest breaks (2x15-minute scheduled rest breaks and 5 minutes of rest breaks if needed) over the course of an 8-hour work shift at the high heat trigger. Therefore, OSHA assumed that the rate of productivity loss should be multiplied by 1.52, or the ratio of the percentages of the work shift spent in breaks for these two scenarios. This yielded an adjusted rate of productivity loss of 1.03% per 1°F HI.

Dally et al. (2018): $\frac{60 \text{ min}}{540 \text{ min}} = 11.1\%$ Proposed Rule: $\frac{35 \text{ min}}{480 \text{ min}} = 7.3\%$

$$\frac{11.1\%}{7.3\%} = 1.52$$

$$0.68\% * 1.52 = 1.03\% \text{ per } 1°\text{F HI}$$

Relative to the REF condition (88.3°F HI), the productivity loss at the high heat trigger (90°F HI) is 1.75%. For an 8-hour work shift (480 minutes), this translates to a loss of 8.4 minutes.

$\frac{1.03\%}{1°\text{F HI}} * (90 - 88.3)°\text{F HI} = 1.75\%$ $1.75\% * 480 \text{ minutes} = 8.4 \text{ minutes}$

III. Findings of Primary Approach.

This appendix presents OSHA's estimates of the labor productivity loss resulting from pacing (i.e., working slowly during the work time not spent on breaks) when the heat index is equal to the initial and high heat triggers. This appendix also presents OSHA's estimates of the decrease in pacing with the introduction of if-needed and scheduled breaks—the findings of the primary approach suggest that employees pace less (i.e., work more efficiently) with if-needed rest breaks, and that scheduled rest breaks further reduce pacing (i.e., employees become even more efficient). These estimated labor productivity losses from pacing were translated to and presented as equivalent lost minutes of work time in an 8-hour work shift.

At the initial heat trigger, employees given if-needed rest breaks are estimated to pace less (i.e., work more efficiently) by an average of 2.8 minutes (per 8-hour shift) compared to those not given if-needed rest breaks. At the high heat trigger, employees given both scheduled and if-needed rest breaks are estimated to pace less (i.e., work more efficiently) by an average of 32.2 minutes (per 8-hour shift) compared to those not given neither if-needed nor scheduled rest breaks and by an average of 31.1 minutes (per 8-hour shift) compared to those given only if-needed rest breaks.

IV. Alternate Approaches Under Consideration.

OSHA has preliminarily determined that the assumptions made in the primary approach are plausible and appropriate. However, OSHA recognizes that the limited scope of available evidence affects the extent to which these key assumptions can be tested. For example, none of the available studies directly compared rest break policies in the same setting, so the estimates of cost savings are based on differences in productivity losses across settings. OSHA is considering alternate approaches with varying assumptions, such as the extent to which productivity losses in one setting, given a certain rest break policy, may be representative of such losses in other settings.

One alternate approach modifies some of the key assumptions made in the primary approach, while still relying on the same set of studies. Specifically, this approach retains Assumptions a) through d) and Assumption f), but it replaces Assumption e) with the following:

e.1. An employee's expected productivity loss from pacing, given a specific temperature and the employer's break policy, is estimated by taking the average REF condition observed in studies where that break policy is in effect, along with the average productivity loss per degree observed across all studies.

e.2. An employee's expected productivity gains from taking rest breaks do not exceed the productivity losses that are observed when they work at a slower pace and do not take rest breaks. In other words, if a rest break policy yielded an overall net increase in productivity, employers would already offer these rest breaks. Gains can be estimated by differences in productivity losses due to pacing, as measured at the initial temperature (i.e., trigger) at which the rest break policy goes into effect.

Compared with those of the primary approach, the above alternate assumptions are more relaxed in some ways and stronger in others. In particular, the assumption that productivity losses per degree are estimated in a pooled fashion, but REF conditions are not, implies that all productivity gains associated from reduced pacing come in the form

of a shift in the productivity loss function. This assumption addresses the potential concern that differences in work conditions other than temperature (such as sun exposure or work demands) limit the applicability of any findings on productivity loss to other work settings.

Under this alternate approach, OSHA expects that productivity losses at the initial and high heat triggers will be larger for employees in Group 1, and they will be smaller for employees in Groups 2 and 3 (see table VIII.H.A.2).[115] This means that under these assumptions, even greater cost savings could accrue to employers if they offered rest breaks if needed at the initial heat trigger, and scheduled rest breaks as well as if-needed rest breaks at the high heat trigger. OSHA welcomes feedback on this alternate approach and has not yet calculated how it would impact the total cost of the proposed standard.

Table VIII.H.A.2. Summary Table of Alternate Approach

Group	HI at REF (average within group)	Productivity Loss per 1°F HI above REF (pooled average for all groups)	Productivity Loss at Initial Heat Trigger	Productivity Loss at High Heat Trigger
1	73.7°F	0.71%	21.5 min	55.6 min
2	79.7°F	0.71%	1.0 min	35.1 min
3	88.3°F	0.71%	0 min	5.8 min

The average HI at REF uses the midpoint for each study in cases where a range was specified. The average productivity loss is the pooled average from table VIII.H.A.1.

In both the primary approach and the secondary approach (immediately above), the REF condition—which is, loosely, the minimum temperature at which heat begins to cause productivity loss—is assumed to differ across Groups. The two estimation approaches diverge in that the per-degree rate of loss in conditions above REF is always

[115] Not reflected in table VIII.H.A.2 is the possibility that the exclusion criteria listed in table VIII.H.A.3 may need to be reconsidered if the cost savings estimation approach is revised.

0.71% in the secondary approach but is allowed to differ by Group in the primary.[116] A tertiary approach would reverse which parameter is estimated in a pooled manner; the REF condition would be the same across Groups, while the per-degree rate of loss would differ. As shown in table VIII.H.A.1., however, the per-degree rate of loss is estimated to increase with amounts of rest, so this approach would yield an estimate of productivity-related costs, rather than cost savings. Although this result is not plausible, it illustrates some of the uncertainties about data and quantitative methods used in this appendix.

A pooled regression could address some of these challenges by producing a single estimate representing the relationship between temperature and productivity loss that does not differ by break policy, then separately producing estimates as to how each rest break policy might improve productivity. OSHA is considering an additional alternate approach that would incorporate regression analysis and might, as part of such analysis, relax the assumption regarding the linearity of the relationship between temperature and productivity loss. That is, a nonlinear specification could address the potential concern that productivity losses may become increasingly severe as the temperature exceeds the initial heat and high heat triggers.

In sum, OSHA welcomes feedback on the primary cost savings approach and the alternate approaches. OSHA also welcomes suggestions for other approaches to estimate cost savings related to the provision of rest breaks.

[116] However, allowing heterogeneity in the reference temperature has support in the literature; see Heutel et al. (2021).

Table VIII.H.A.3. Studies Excluded from Pacing Estimates, Grouped by Reason for Exclusion

Study, Listed as Author(s) and Year	Study Identified By
Did not measure temperature conditions (n=2)	
Hostler et al., 2016	ERG 2022b
O'Neill et al., 2013	ERG 2022a
Assumed outdoor (forecasted) conditions applied to indoor workers (n=2)	
Cai et al., 2018	OSHA
Adhvaryu et al., 2020	ERG 2022c
Temperature conditions did not vary (n=5)	
Schlader et al., 2011	OSHA
Uchiyama et al., 2022	OSHA
Schranner et al., 2017	ERG 2022a
Constable et al., 1994	ERG 2022a
Morrissey-Bassler et al., 2024	OSHA
Temperature range was entirely below the initial heat trigger (n=3)	
Van Cutsem et al., 2015 (HI of 77°F for HOT condition)	OSHA
Federspiel et al., 2004 (HI of 78.8°F for HOT condition)	ERG 2022c
Niemelä et al., 2002 (HI of 77.2°F for HOT condition)	ERG 2022a
Temperature range was entirely above the high heat trigger (n=3)	
Meegahapola and Prabodanie, 2018 (HI of 90.1°F for REF condition)	ERG 2022c
Wyndham, 1969 (HI of 97.5°F for REF condition)	OSHA
Ismail, 2009 (HI of 92°F for REF condition)	ERG 2022c
Unable to reproduce temperature data (n=2)	
Masuda et al., 2021	ERG 2022c
Sett and Sahu, 2014	ERG 2022c
Review studies, no empirical productivity data (n=15)	
Ioannou et al., 2022	ERG 2022a
Borg et al., 2021	ERG 2022a
Dasgupta et al., 2021	ERG 2022a
Morrissey et al., 2021a	ERG 2022a
Morrissey et al., 2021b	ERG 2022a
Foster et al., 2020	OSHA
Morris et al., 2020a	ERG 2022a
Morris et al., 2020b	ERG 2022b
Day et al., 2019	ERG 2022a
Flouris et al., 2018	ERG 2022a
Lundgren et al., 2013	ERG 2022c
Seppänen et al., 2006	ERG 2022c
Pilcher et al., 2002	ERG 2022c
Hancock et al., 2007	OSHA
Lai et al., 2023	OSHA
Modelling studies, no empirical productivity data (n=19)	
Casey et al., 2021	OSHA
Szewczyk et al., 2021	ERG 2022a

Atlantic Council/Vivid Economics 2021a	OSHA
Atlantic Council/Vivid Economics 2021b	OSHA
Atlantic Council/Vivid Economics 2017	OSHA
Bröde et al., 2018	ERG 2022c
Takakura et al., 2017	ERG 2022a
Carleton and Hsiang, 2016	ERG 2022a
Costa et al., 2016	OSHA
Yi and Chan, 2015	ERG 2022b
House et al., 2003	ERG 2022b
Kjellstrom et al., 2009a	ERG 2022a
Koehn and Brown, 1985	ERG 2022c
Srinavin and Mohamed, 2003	ERG 2022c
International Labour Organization, 2019	OSHA
Kjellstrom et al., 2016a	OSHA
Kjellstrom et al., 2009b	OSHA
Kjellstrom et al., 2017	OSHA
Kjellstrom et al., 2016b	OSHA
Outcome was heat strain (n=5)	
Wyndham, 1965	OSHA
Kalkowsky and Kampmann, 2006	OSHA
Miller et al., 2011	OSHA
Ioannou et al., 2021a	ERG 2022a
Kaltsatou et al., 2020	ERG 2022b
Outcome was physical activity or maximum work capacity (n=2)	
Mix et al., 2019	OSHA
Maresh et al., 2014	OSHA
Outcome was cognitive performance (n=3)	
Fine and Kobrick, 1987	ERG 2022c
Mazlomi et al., 2017	ERG 2022c
Spector et al., 2018	ERG 2022c
Outcome was heat-related injuries (n=1)	
Park et al., 2021	ERG 2022a
Outcome was loss of labor supply (including missed work hours) (n=2)	
Neidell et al., 2021 (ATUS)	ERG 2022a
Graff-Zivin and Neidell, 2014 (ATUS)	ERG 2022a
Outcome was non-working time (n=5)	
Flouris et al., 2020 (unplanned break time)	ERG 2022a
Ioannou et al., 2021b (unplanned break time)	ERG 2022c
Yi and Chan, 2017 (non-productive time)	ERG 2022c
Li et al., 2016 (idle time)	ERG 2022c
Zhao et al., 2009 (heat tolerance time)	OSHA
Outcome was payroll or income data (n=3)	
Deryugina and Hsiang, 2014	ERG 2022c
Park, 2016	ERG 2022c
Heal and Park, 2013	OSHA
Outcome was crop yields (n=1)	

Houser et al., 2014	OSHA
Outcome was firm-level output (no worker-level data available) (n=1)	
Cachon et al., 2012	ERG 2022c
Productivity losses were self-reported (e.g., surveys, focus groups) (n=9)	
Krishnamurthy et al., 2017	ERG 2022c
Zander et al., 2015	ERG 2022c
Langkulsen et al., 2010	ERG 2022c
Fahed et al., 2018	ERG 2022c
Budhathoki and Zander, 2019	ERG 2022c
Singh et al., 2015	ERG 2022c
Pogačar et al., 2019	ERG 2022c
Morera et al., 2020	ERG 2022a
Wadsworth et al., 2019	ERG 2022a
Provided single productivity estimate for a range of temperatures (n=6)	
Sadiq et al., 2019	ERG 2022c
Hansson et al., 2024	OSHA
Glaser et al., 2022	ERG 2022b
Prince et al., 2020	ERG 2022b
Wegman et al., 2018	ERG 2022b
Bodin et al., 2016	ERG 2022b
Provided single productivity estimate for multiple worksites with different conditions (n=2)	
Stevens, 2017	OSHA
Gun and Budd, 1995	ERG 2022c
Productivity data not comparable; workers observed or total work time varied (n=3)	
Sawka et al., 2015	OSHA
Nag et al., 2006	OSHA
Morrison, 1969	OSHA
Productivity data for firefighting tasks only (n=2)	
Larsen et al., 2015	ERG 2022c
Sol et al., 2021	ERG 2022c
Provided breaks but did not specify type (scheduled vs. if-needed) or duration/frequency (n=4)	
Mitchell et al., 2018	ERG 2022c
Quiller et al., 2017	ERG 2022c
Ciuha et al., 2019	ERG 2022c
Pan et al., 2021	ERG 2022a
Used work-time shifting instead of breaks (n=1)	
Morabito et al., 2020	OSHA

I. Appendix B. Review of Literature on Effects of Heat Exposure on Non-Health Outcomes.

I. Introduction.

A large literature from multiple disciplines (economics, occupational health, physiology) documents the negative effects of heat exposure on human health, such as mortality, injuries, and illnesses (for detailed discussion, see Section IV., Health Effects and Section V.A., Risk Assessment).

There is also a large literature that documents the negative effects of heat exposure on a broad range of non-health outcomes with potential economic implications (Heal and Park, 2016; Lai et al., 2023).

This document serves several purposes. First, this document synthesizes and summarizes the findings from multiple disciplines regarding the effects of heat exposure on non-health outcomes with potential economic implications. In particular, this document aims to examine a broad set of non-health outcomes that are potentially relevant to OSHA's economic analysis for the proposed standard for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings. Although the discussion centers around labor productivity, other outcomes are also discussed, including but not limited to labor supply, mental performance, economic output, and worker utility. This document also aims to clarify terminology, given that different terms have been used interchangeably in the existing literature (Dasgupta et al., 2021, p. e457).[117]

Studies summarized in this document were identified as follows. Eastern Research Group (ERG) performed several literature searches (ERG, 2022a; ERG, 2022b; ERG, 2022c) that could inform the relationship between heat and various outcomes (e.g., labor productivity, heat strain). Among these studies, studies reporting non-health

[117] For example, Burke et al. (2023) conducted a meta-analysis of 22 studies as part of their literature review of existing evidence of "labor productivity response to temperature." Some of these studies reported effects on mental performance or effects on economic output without clearly delineating the contribution of labor productivity. Changes in mental performance (e.g., error rates) may not directly reflect the magnitude of changes in labor productivity; for example, a 50% decrease in the error rate does not necessarily mean a 50% increase in labor productivity (Fisk, 2000, pp. 555–556). Flouris et al. (2018) conducted a meta-analysis of 111 studies on the effects of heat exposure on workers' outcomes, 11 of which were related to "productivity loss." Some of these studies reported effects on self-perceived labor productivity or labor supply.

outcomes were considered relevant. Studies reporting health outcomes like heat strain and work-related HRIs were not considered relevant, and readers are referred to relevant sections of the preamble for more detail. OSHA also independently identified additional studies pertaining to non-health outcomes. During this process, studies about general population-related outcomes (e.g., heat-related mortality for general population beyond workers) were considered irrelevant.

This document is organized as follows. Section VIII.I.II. summarizes the literature's findings on the negative effects of heat exposure on non-health outcomes with potential economic implications, especially labor productivity. Section VIII.I.III. summarizes the literature's findings on the role of workplace characteristics in the labor productivity effects of heat exposure. Section VIII.I.IV. concludes.

II. Effect of Heat Exposure on Non-Health Outcomes.

This section summarizes the literature's findings on the negative effects of heat exposure on non-health outcomes that could translate into economic costs: labor supply, labor productivity, mental performance, economic output, and worker utility.[118]

A. Labor Supply.

Literature has documented the negative effects of heat exposure on labor supply (hours worked), by increasing absenteeism due to illness or injury (Ioannou et al., 2022, p. 80) or increasing disutility of labor (working in the heat causes discomfort so workers increasingly avoid spending time at work at higher temperatures) (Lai et al., 2023, p. 222).

Many studies found that heat exposure increased absenteeism due to illness or injury in their evaluation of multiple types of health information datasets, such as workers' compensations claims data, emergency department visits and hospital discharge

[118] In general, the findings in this appendix (and other PEA sections that discuss benefits that are excluded from the primary benefits quantification) may be interrelated, such that simply summing the effects identified could lead to some amount of double-counting or other mis-counting.

datasets (for more detail, see Section IV., Health Effects and Section V.A., Risk Assessment).

Many studies in the economics literature found evidence that heat exposure led workers to allocate less hours to work (potentially due to absenteeism from illness or injury, increased disutility of work, or both). Graff Zivin and Neidell (2014) used data from the American Time Use Survey (ATUS) to find that workers in "high-risk industries" (agriculture, forestry, fishing, hunting, mining, construction, manufacturing, transportation, utilities) reduced their time allocated to labor by one hour when daily maximum ambient temperatures exceeded 85°F (29.4°C) compared to the 76°F–80°F (24.4°C–26.7°C) range. Almost all the decrease in the time allocated to labor happened at the end of the day when fatigue from prolonged exposure to heat has likely set in. They also found that that most of the decreased time allocated to labor was diverted to indoor leisure. They did not find evidence that workers worked longer during cooler days to make up for reduced work hours during hot days. Rode et al. (2022) compiled time use and labor force survey data from seven countries (Brazil, France, India, Mexico, Spain, UK, USA) and found that a day at daily maximum ambient temperature 104°F (40°C) lead to 28.65 fewer minutes worked per worker compared to a day at 80.6°F (27°C) for "high-risk industries" (agriculture, mining, construction, manufacturing); the corresponding decline was insignificant for workers in "low-risk industries" (p. 21). Garg et al. (2020a) found in Chinese time use survey data that an additional day with an average ambient temperature above 80°F (26.7°C) reduced weekly work time by 1.2 hours. They also found limited evidence for this reduced work time being substituted by increased non-work time such as time spent on childcare and household chores.[119]

[119] The authors found that higher temperatures reduce time spent on childcare by households without cooling technology (insignificant effect on households with cooling technology). They also found that higher temperatures reduce time spent on childcare by women (insignificant effect for men).

The effect of heat exposure on labor supply likely depends on the incentive structures[120] for these workers and their economic dependence on the income arising from their work (Lai et. al., 2023). Using daily attendance records from selected manufacturing firms in India, Somanathan et al. (2021) found that elevated temperatures in the current or preceding week reduced labor supply[121] (which the authors interpreted as possibly both increased absenteeism from illness or injury and increased disutility of labor), and the effect was stronger for workers with paid leave. Such dependence on specific incentive structures might explain the differences in results across studies. For example, Cai et al. (2018) examined worker attendance data from administrative records and found that neither the attendance decision nor the working hours of workers in a manufacturing facility in China were affected by temperature, likely because the workers were paid by piece-rate. Neidell et al. (2021) found in ATUS data that the relationship between hours worked and temperature depended on overall economic conditions. They found that during economic expansions, each additional degree above daily maximum ambient temperature 90°F (32.2°C) reduced the average workday by 2.6 minutes. On the other hand, no significant relationship was found between temperature and hours worked during economic recessions. Such lack of evidence of reduction in work hours on hotter days during weak labor market conditions suggests that the negative relationship between temperature and work hours is likely driven by changes in labor supply (from worker) rather than labor demand (from employer).

There are several reasons for the need for caution in interpreting the studies reporting effects of heat exposure on labor supply (or employment in general).

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[120] The role of workplace incentives in the labor productivity effects of heat exposure is discussed later in section VIII.I.III.B.

[121] This study's worker attendance data technically measures only whether the worker is present or absent that day (Somanathan et al., 2021, p. 1811). It is unclear if and how their attendance data captures cases where the worker is only partially present, and leaves work early that day.

First, the results presented in most of these studies could be driven by changes in labor demand as well as labor supply (Graff Zivin and Neidell, 2014, p. 4). Some studies did try to differentiate labor supply and demand, such as estimating the effect across business cycles (Neidell et al., 2021) or estimating wage effects as well as employment effects (e.g., Colmer, 2021; Jessoe et al., 2018).

Second, most economics studies reporting the negative effect of heat exposure on labor supply using data on hours worked did not disentangle the contribution of absenteeism due to illness or injury from the contribution of disutility from working in the heat. The distinction is important because improving workplace conditions may increase labor supply beyond reducing time lost to illness or injury.

Third, it is not very clear if reduced work time always has negative implications for worker welfare. Reduced work time on hot days such as cessation of work might be beneficial for workers if fewer workers are exposed to high temperatures that put their health at risk (Ireland et al., 2024, p. 18). However, if the lost work time is not compensated, workers face a tradeoff between health risk and earnings risk, both of which negatively affects the workers' welfare (EPA, 2021, p. F-3). Rode et al. (2022)'s theoretical framework also presented a similar tradeoff facing workers between decreased earnings and increased disutility of labor in face of higher temperatures. Their theoretical framework is based on their interpretation of their empirically-estimated decline in labor supply due to higher temperatures (discussed above) as uncompensated lost work time—workers choose to work less due to increased disutility of labor but at the cost of foregoing earnings. Based on this theoretical framework, they derived the willingness-to-pay to avoid the increased disutility of labor from higher temperatures (defined as the increase in the wage rate that is needed to offset the increased disutility of labor).

Fourth, the definition of work hours varies by dataset. Some datasets include, for example, paid or unpaid leave (Somanathan et al., 2021) or while other datasets include

time spent on job search[122] (studies that use the ATUS such as Graff Zivin and Neidell, 2014; Neidell et al., 2021; Rode et al., 2022). How work hours are defined has implications for the worker welfare effects of heat exposure. For example, as discussed above, worker welfare could depend on whether the reduced work hours from heat exposure are compensated (e.g., worker leaves work early forgoing pay versus using paid leave). See Eldridge et al. (2022) for more examples of various definitions of work hours across datasets.

B. Labor Productivity.

Numerous studies have documented the negative effects of heat exposure on labor productivity. Using direct measures of labor productivity (units of output produced per hour) and proxies of labor productivity (physical work capacity, physical activity, and self-perceived labor productivity), studies across various disciplines (e.g., physiology, occupational health, and economics) have found that heat exposure reduces labor productivity (Ioannou et al., 2022; Morrissey et al., 2021a; Mattke et al., 2007).

This section focuses on micro-level evidence across various disciplines based on laboratory or occupational settings. Studies reporting potential macro-level evidence on labor productivity based on macroeconomic proxies of labor productivity (e.g., per capita value added, revenue, payroll) are discussed in section VIII.I.II.D.

Overall, studies reported varying estimates of effects of heat exposure on labor productivity depending on the specific sectors and heat conditions (e.g., presence of indoor radiant heat, differences in regional climate between the U.S. and non-U.S. countries). Section VIII.I.III. discuses in more detail workplace factors that affect the

[122] Using the ATUS and following the "same methodology employed by" Graff Zivin and Neidell (2014). Neidell et al. (2021) defined "work" as "all activities under the 'work and work-related activities' major category," which "in addition to time spent at the workplace, […] also includes time devoted to other income-generating activities as well as job searching" (p. 2). Rode et al. (2022) also uses the same category to calculate time spent on work: "Total work is calculated as the sum of all time spent engaged in sub-activities listed under Category 5, Work and Work-Related Activities. Relevant sub-categories include time spent in work itself, income-generating activities, socializing as a part of work, job searching, and other miscellaneous work-related activities" (p. 52).

literature's estimates of the effect of heat exposure on labor productivity, such as contractual structures and adaptation measures that affect workers' incentives and ability to be productive in the heat.

I. Direct Measures of Labor Productivity.

Labor productivity is a "measure of economic performance that compares the amount of goods and services produced (output) with the amount of labor hours worked to produce that output" and is a "ratio of output to hours worked" (BLS, 2020a). Changes in labor productivity "reflect the changes in output that is not explained by the change in hours worked" (BLS, 2020a). Studies have documented the effects of heat exposure on labor productivity in different work settings in both U.S. and non-U.S. countries. Most of these studies are occupational studies with the exception of one laboratory-based study involving simulated work.

Some studies discussed in this section technically reported changes in an average worker's output per day or week, not output per hour. These studies are discussed in this section in the context of labor productivity based on their evidence that changes in their reported outcomes are likely being driven by changes in worker output per hour, not by changes in daily or weekly hours worked.

a. Agriculture.

Many studies analyzing the labor productivity effects of heat exposure are based on agricultural work settings, given the agricultural sector's high level of heat exposure and the feasibility of tracking individual production levels.

Using daily production data of Indian rice harvesters, Sahu et al. (2013) reported a 5% decline in labor productivity (rice bundles per worker per hour) for each additional degree above 26°C WBGT. Using daily production data of sugarcane cutters in Nicaragua, Hansson et al. (2024) reported that relative to below 82.4°F (28°C) WBGT, labor productivity (bundles per worker per day) decreased by 2.5% at 82.4°F–84.2°F

(28°C–29°C) WBGT, by 5% at 86°F–87.8°F (30°C–31°C) WBGT, and by 8.3% at above 87.8°F (31°C) WBGT. Using daily production data of maize farmers in Nigeria, Sadiq et al. (2019) reported that for every 1.8°F (1°C) increase in WBGT, labor productivity (ridges tilled or hoed per worker per hectare) decreased by 23% although their reported labor productivity effects of higher temperature could be confounded by the effects of fatigue over the workday. Using daily production data of sheep shearers and retrospective temperature records of a "Bureau of Meteorology recording station" in Australia, Gun and Budd (1995) reported that the labor productivity (number of sheep shorn per worker per hour) declined by approximately 7% per 1.8°F (1°C) increase in ambient temperature[123] although the estimated effect was not statistically significant. Using daily production data of Guatemalan sugarcane workers, Dally et al. (2018) reported that a day with 95th percentile WBGT of 34°C was associated with an estimated cumulative loss in labor productivity of 0.59 tons of cut sugarcane per worker per day over the following five days compared to a day with 95th percentile WBGT of 29°C (approximately 0.59/5.7=10.35% of the average production per worker per day).

Based on data from tree fruit harvesters in Washington State, Quiller et al. (2017) found that increasing daily maximum WBGT was associated with decreasing labor productivity (weight of fruit bins collected per worker per hour). However, this association became statistically insignificant after controlling for potential confounders such as price paid per bin and shift duration. The lack of evidence could also be due to relatively cool climate of Washington State—the time-weighted average WBGT was 72.1°F (22.3°C) and 60.6°F (15.9°C) in each of the months studied.

b. Manufacturing.

Several studies that directly measure labor productivity are based on manufacturing settings, likely due to feasibility of tracking individual production levels.

[123] This corresponds to a linear approximation of the results presented in Figure 5 of the study.

Using daily production data from a non-climate-controlled paper cup manufacturing setting in China, Cai et al. (2018) reported that daily maximum ambient temperatures above 95°F (35°C) resulted in an approximately 8.5% decrease in labor productivity (output per worker per day) relative to the baseline range of 75°F–79°F (23.9°C–26.1°C). Using daily production data from a rubber compound manufacturing plant in Sri Lanka, Meegahapola and Prabodanie (2018) reported that high temperature ranges, 105.8°F–113°F(41°C–45°C) and 96.8°F–104°F (36°C–40°C), reduced labor productivity (kilogram per worker per hour), by 22% and 18% respectively, relative to the baseline temperature range of 89.6°F–95°F (32°C–35°C). Using weekly production data of brick molders and carriers in India, Sett and Sahu (2014) found that for each 1.8°F (1°C) increase in ambient temperature, labor productivity (number of bricks molded or carried per worker per week) declined by 0.8%. Using daily worker-level production data from selected manufacturing firms in India, Somanathan et al. (2021) found that labor productivity (output per worker per day) declines in higher outdoor temperatures, falling 2.7% per 1.8°F (1°C) increase in daily maximum ambient temperature above 77°F (25°C).

c. Other Sectors.

Direct units of output are harder to measure in most other sectors, so comparatively fewer studies have been produced in other industries.

Observing call center workers in California, Federspiel et al. (2004) found that time to finish tasks (post-talk wrap-up to process information) increased by 16% when the ambient temperature increased from 73.4°F to 77.7°F (23°C to 25.4°C). Niemelä et al. (2002) also analyzed workers at two call centers. In one call center, they compared labor productivity (number of calls per hour) between two different temperature zones in the building. In another cell center, they introduced an intervention (installation of air-conditioning) and compared labor productivity before and after the intervention. They

reported that labor productivity in both call centers decreased by 5% to 7% at ambient temperatures over 77°F (25°C), although other seasonal changes likely confounded their results. From data on Demographic and Health Surveys (DHS) interviewers from 46 developing countries, LoPalo (2023) estimated the effects of heat exposure on DHS interviewers' labor productivity (number of surveys completed per hour). Exploiting variation in weather within a region of a country, survey waves, and interviewers, they found interviews per hour were fewer by 13.6 % on days over 85°F (29.4°C) wet bulb relative to days between 50°F (10°C) and 60°F (15.6°C) wet bulb. Hanna (2004) conducted an experiment in an environmental test chamber with journeymen electricians installing duplex receptacles on work panels. While their laboratory setting did not allow effects of real-world workplace factors that affect labor productivity, the controlled environment tracked heat exposure in detail by ambient temperature and humidity level. The study found that maximum labor productivity (number of receptables installed per hour) was achieved at ambient temperature between 40°F (4.4°C) and 70°F (21.1°C) with relative humidity below 80%. At 70% relative humidity, labor productivity decreased by 10% when ambient temperature increased from 70°F (21.1°C) to 90°F (32.2°C) (and by 23% when ambient temperature increased to 100°F (37.8°C)). They also found that higher relative humidity reduced labor productivity further at elevated ambient temperatures.

II. Proxies for Labor Productivity.

This section summarizes findings of studies that report "alternative" measures of labor productivity, such as physical work capacity, physical activity, and self-perceived labor productivity.

a. Physical Work Capacity, Exposure-Response Functions.

Work capacity or physical work capacity is the potential to perform work under specified set of environmental conditions (e.g., WBGT) and physical condition of the

worker (e.g., core body temperature, heart rate) (Ioannou et al., 2022, p. 75; Bröde et al., 2018, p. 332). Loss of work capacity occurs as a physiological response to heat exposure where the worker reduces physical activity to avoid negative health effects (e.g., increases in core body temperature or heart rate beyond the safe limit) (Kjellstrom et al., 2014).

Several studies have derived exposure-response functions that represent the relationship between heat exposure and work capacity. Exposure-response functions in the occupational health literature fall into two groups (Borg et al., 2021). The first group of exposure-response functions are based on empirical data (e.g., Kjellstrom et al., 2014; Foster et al., 2021). The second group are based on recommended work-rest ratios in existing work-rest guidelines by NIOSH, ACGIH, and ISO (e.g., Kjellstrom et al., 2009b; Dunne et al., 2013).

b. Empirically-Derived Exposure-Response Functions.

As part of the High Occupational Temperature Health and Productivity Suppression (Hothaps) Programme, Kjellstrom et al. (2014) derived an exposure-response function (henceforth "Hothaps function") linking WBGT to work capacity for three levels of work intensity (200 W, 300 W, 400 W) based on the empirical data involving acclimatized male workers in Wyndham (1969) (miners in South Africa) and Sahu et al. (2013) (rice harvesters in India).

Foster et al. (2021) derived an exposure-response function (henceforth "PWC function") linking varying environmental conditions to work capacity based on empirical data collected from one-hour trials involving young, unacclimatized males performing physical work in climatic chambers. In this study, work capacity is defined as the "maximum physical work output that can be reasonably expected from an individual performing moderate to heavy work over an entire shift." More specifically, Foster et al. (2021) aimed to measure the amount of work that can be performed across varying

environmental conditions (e.g., combinations of air temperature and relative humidity) while maintaining a fixed heart rate at a maximally acceptable level (e.g., 130 beats per minute) as a "surrogate for self-paced physical workloads." Smallcombe et al. (2022) replicated the environmental conditions of Foster et al. (2021) and computed work capacity during 6 work-rest cycles of 50-minute work/10-minute rest, with a 1-hour break after the first 3 cycles.

There are some benefits of evaluating the work capacity effects of heat exposure. Heat exposure-work capacity response functions (exposure-response) could be applied to macroeconomic data and models to estimate the economic impact of heat exposure (more examples of studies that borrow these exposure-response functions are discussed more detail below in section VIII.I.II.D.II.). Like Foster et al. (2021) and Smallcombe et al. (2022), work capacity could also be measured through laboratory experiments in controlled environments, reducing the influence of confounders and making their results generalizable across various environmental conditions.

However, there are caveats with interpreting the effects of heat exposure on work capacity reported in the studies above.

First, they may underestimate the labor productivity effects observed in actual work settings for several reasons (Ioannou et al., 2022). Heat exposure could reduce labor productivity not only through reduced work capacity but also other factors such as increased central fatigue and reduced cognitive performance. Also, as discussed more below in section VIII.I.III.B., workplace factors such as wage structure may not always incentivize workers to sustain high levels of effort at the maximum capacity every day throughout the entire shift.

Second, these studies may also overestimate the labor productivity effects observed in actual work settings where self-pacing is more limited. Although self-pacing is observed in most workplaces, there are some workplaces where ability to self-pace is

limited, such as emergency response activities or work performed on commission (Ioannou et al., 2022).

Third, some studies assume what is the physically maximally acceptable level (e.g., 130 beats per minute) which may not be appropriate for every worker. From the perspective of applying their findings to actual work settings, "it is not clear how various physiological (dehydration, cardiac fatigue, poor sleep quantity/quality) and psychological (motivation, anxiety) states impact upon what a worker deems as an acceptable working heart rate" (Ioannou et al., 2022).

c. Guideline-Based Exposure-Response Functions.

The second group of exposure-response functions are based on recommended work-rest ratios in existing work-rest guidelines set by NIOSH, ACGIH, and ISO (e.g., Kjellstrom et al., 2009b; Dunne et al., 2013).

There are several reasons for the need for caution when interpreting the guideline-based exposure-response functions.

First, work-rest guidelines represent the "the proportions of work hours during which workers need to take rest periods, depending on work intensity and WBGT, in order to avoid the core body temperature exceeding 38°C for an average worker" (Kjellstrom et al., 2009a). Exposure-response functions based on work-rest guidelines are "highly conservative because their objective is to minimize the risk of core body temperature of the average worker exceeding 38°C" (Foster et al., 2021). Guideline-based exposure-response functions therefore show greater declines in work capacity in higher temperatures than the empirically-derived functions (Kjellstrom et al., 2014, p. 17; Morrissey et al., 2021a, Figure 3).

Second, work-rest guidelines prescribe how much a worker should reduce their work capacity at different levels of heat exposure. They do not represent the causal effect of heat exposure on work capacity (Foster et al., 2021, p. 1216).

d. Physical Activity.

Some studies tracked the participants' level of physical activity, based on methods such as direct observation of work activities (that are then categorized into direct work, indirect work, and idle time), time-motion analysis (video recording movements that are then paired with metabolic equivalents) and accelerometers tracking data (step counts per minute which are also paired with metabolic equivalents). Although these methods do not directly track any effects on output, they measure changes in levels of labor input. A major advantage of these methods is that study participants are monitored in their actual working conditions, reflecting behavioral thermo-regulation (e.g., self-pacing and varying clothing insulation) and endogenous changes in effort in response to workplace incentives like piece-rate pay (Ioannou et al., 2022).

Li et al. (2016) and Yi and Chan (2017) directly observed rebar construction workers whose activities are categorized into direct work (activities that directly and productively contribute to task completion, i.e., steel bar reinforcement), indirect work (support activities that do not directly or productively contribute to task completion, such as walking with tools/materials or empty-handed, waiting for materials to be lifted, discussing tasks with foreman/coworkers), or idle time (personal time and non-utilization time due to work stoppage from any cause). Observing the activities of rebar construction workers in Hong Kong, Yi and Chan (2017) found that a 1.8°F (1°C) increase in hourly average WBGT was associated with an approximately 2.8 percentage-point (%p) decrease in the share of direct work time (corresponding to 2.8/64 = 4.38% of the average share of direct work time[124]; effects on the rest of the categories were not reported). Observing the activities of rebar construction workers in China, Li et al. (2016) reported

[124] The study's abstract reported the share of direct work time "decreasing by 0.33%" per 1.8°F (1°C) WBGT increase—OSHA conjectures that this statement meant that the estimated 2.8%p decrease is 3.3% of the predicted average share of direct work time at 22.28°C WBGT (lowest observed WBGT in their data) according to their regression model where the covariates are held at their sample average values (some of which are not reported in the study).

that a 1.8°F (1°C) increase in hourly average WBGT was associated with a 0.57%p decrease in the share of direct work time (corresponding to 0.57/74 = 0.77% of the average share of direct work time) and a 0.74%p increase in the share of idle time (corresponding to 0.74/11 = 6.72% of the average share of idle time) (0.18%p decrease was also observed in the share of indirect work time, but the effects were not significant). Unlike Yi and Chan (2017) that controlled for when the temperature was measured during the workday, a caveat with Li et al. (2016) is that their reported effects of higher temperatures could be confounded by effects of fatigue over the workday.

Using time-motion analysis on a sample of construction workers in Spain over two days, Flouris et al. (2020) found that the workers take longer irregular breaks during the hotter day, Day 1 with a WBGT range 71.2°F–99.1°F (21.8°C–37.3°C). They found a 4.7-fold difference between the time lost due to irregular work breaks on a hot day (Day 1) compared to a cool day (Day 2), with a WBGT range 71.4°F–88.9°F (21.9°C–31.6°C). Moreover, they also found that a planned break intervention providing hydration to workers could partially offset these irregular breaks.

Mitchell et al. (2018) used accelerometer data to track the physical activity of Californian farmworkers for one work shift each in the summers of 2014 and 2015. They found that an 18°F (10°C) increase in median WBGT reduced physical activity by 135 counts per minute compared to an average of 347 counts per minute across all participants (equivalent to a 3.9% decrease per 1.8°F (1°C) WBGT).

There are some caveats with using physical activity as a measure of labor productivity.

First, physical activity measures the amount of labor inputs instead of actual output. Some studies such as Ioannou et al. (2022) considered the focus on labor inputs rather than production output as an advantage; for instance, expressing labor productivity as the amount of crop produced implies constant availability and equal distribution of

crops across the tested piece of land. However, changes such as unequal crop availability are not problematic unless they are systematically correlated with changes in heat exposure.

Second, for studies based on accelerometer data, without information if other production inputs exist and how they affect output (e.g., capital), the relationship between physical activity (counts per minute) and labor productivity is uncertain. For example, suppose there are two workplaces exposed to the same temperature and workers display the same level of physical activity but one workplace has machines that assist the workers. Given the same level of temperature and physical activity, the workplace that has machines available could achieve higher labor productivity.

e. Self-Perceived Labor Productivity.

Based on worker surveys, some studies document effects of heat on self-perceived labor productivity, partly due to the comparative ease of obtaining such measurements. Compared to actual production data, the self-perceived measures are a less accurate measure of output and can be affected by other factors that impact an individual's self-perceived labor productivity, such as individual's level of awareness of heat stress.

Krishnamurthy et al. (2017) administered a standardized high occupational temperature health and productivity suppression questionnaire to 84 steel factory workers in India. Overall, 1% reported taking sick leave due to heat, 10.6% reported being less productive due to heat, and 27% reported that it took longer to complete the same tasks during summer compared to cooler seasons. Of the 27% who reported labor productivity losses, 91% were exposed to direct radiational heat during steel melting. This reduction in labor productivity occurred due to high heat and heavy workload despite taking rest breaks allowed by the management after the hot job was performed (work-rest regimen: 75% work, 25% rest, each hour). Workers reported drinking high quantities of water and rested in shade, but these actions did not abate the effects of heat due to the high ambient

humidity which limits sweat evaporation and evaporative cooling. This study did not have a direct control group to compare the actual efficacy of these cooling mechanisms.

Zander et al. (2015) conducted an online survey of 1,726 Australian workers and found that 70% of all surveyed workers reported productivity losses due to heat, corresponding to the majority (93%) of those that reported being stressed by heat at work. In comparison, 7% of respondents reported being absent from work at least one day in the previous 12 months due to heat, being absent for 4.4 days on average. Also focusing on understanding the impact of heat on Australian workers, Singh et al. (2015) interviewed key stakeholders (representatives for occupational safety and health, unions, industry, and government organizations) that reported labor productivity loss due to heat exposure, but the results were mostly qualitative and based on a small sample of 20 stakeholders.

Pogačar et al. (2019) surveyed 70 workers in Greece and 216 workers in Slovenia and found that most workers in both Greece (69%) and Slovenia (71%) reported that they felt heat stress during heat waves had a "significant impact" on their productivity. Additionally, 60% of workers in Greece and 74% in Slovenia reported that heat stress significantly impacts their “well-being.”[125] These two studies did not directly track the actual temperature exposure of these workers and instead relied on the workers’ own recollection of the workplace temperatures (e.g., “warm,” “hot,” “very hot”).

Langkulsen et al. (2010) analyzed a total of 21 Thai workers from four industrial sites and one agricultural site. Onsite measurements found that the workers were exposed to WBGT ranging from 78.8°F to 94.3°F (25.6°C to 34.6°C). For 4 of the 5 sites, the study assessed the workers' self-perceived labor productivity, which revealed large differences between sectors. While workers in 2 of the 4 sites that assessed self-perceived labor productivity reported losses of self-perceived labor productivity ranging from 10% to 60%, workers in the other two sites reported no losses when exposed to

[125] Authors are not specific what “well-being” means.

similar heat (e.g., agriculture). In general, the largest losses in self-perceived labor productivity were from sites that had access to shade and indoors, even sites with air-conditioning in some cases. The small sample size across diverse sites may limit the ability to generalize these results.

Surveying farmers in Nepal, Budhathoki and Zander (2019) reported that perceived labor productivity loss was strongly associated with the perceived levels of heat stress. Moreover, respondents with "access to actual weather information"[126] were more likely to perceive labor productivity losses from heat than those without this information, indicating that level of individuals' awareness potentially affects their self-reported assessments of labor productivity.

III. Occupational versus Laboratory Settings.

Studies discussed above in sections VIII.I.II.B.I. and VIII.I.II.B.II. were conducted either in occupational settings or laboratory settings. Both settings have advantages and disadvantages.

Laboratory settings grant a high degree of internal validity because the experiments are more easily reproducible and represent a direct causal effect of heat that removes the influence of confounders (Ioannou et al., 2022). While laboratory-based studies provide a relevant benchmark for the effects of heat on productivity observed in actual work settings, they are limited in the generalizability of their findings to different settings (Somanathan et al., 2021). In occupational settings, labor productivity effects of heat would depend on the physical and behavioral aspects of employment, such as the wage contract, particularities of production processes, management techniques, and mechanization, which are not accounted for by laboratory studies (Somanathan et al., 2021).

C. Mental Performance (Cognitive Function, Decision-Making).

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[126] Authors are not specific what "access to actual weather information" means.

The literature has documented the effect of heat exposure on mental performance in academic, athletic, and work settings.[127] These studies often use the term "performance" with the intent to "include a broader range of effects [such as test scores] than would be indicated by [labor] productivity" (Heal and Park, 2013, p. 10).

In a meta-analysis of 22 studies categorized into reaction time, attention/perceptual tasks, mathematical processing, or "reasoning, learning, memory," Pilcher et al. (2002) reported that a WBGT of 90°F (32.2°C) or greater was associated with a 14.9% decrease in performance compared to "neutral temperature conditions" defined as WBGT from 60°F to 69°F (15.6°C to 20.6°C). Moreover, they also report that these estimates are also affected by the duration of exposure to the heat conditions, the duration of exposure prior to the task onset, the type of task, and the task duration, which can explain the variability of results in the literature discussed below (test scores, athletic performance, workplace performance).

I. Test Scores.

Several studies found negative effects of heat exposure on cognitive test performance.[128] Using student-exam level panel data of high school exit exam scores from New York City high schools (Regents Exams) from 1998 to 2011, Park (2022) found that a 1°F (0.56°C) higher average exam-time ambient temperature reduces performance by 0.9% of a standard deviation. Using panel data of individual-level cognitive test scores administered at respondents' homes for children as part of the

[127] Reduced mental performance due to heat exposure (e.g., mistakes, inattention, long reaction time) is also linked to increased heat-related injuries—for a detailed discussion, see Section IV.P., Heat-Related Injuries.

[128] Literature has also found evidence of heat exposure on longer-term outcomes such as student learning and adult earnings. Cho (2017) reported effects of summertime heat exposure on national college entrance exam scores in South Korea (administered nationwide in November). Park et al. (2020) reported effects of cumulative heat exposure from hotter days during the prior school year on PSAT exam scores of U.S. high school students. Garg et al. (2020b) reported effects of hotter days during the prior school year on academic achievement for Indian children in primary and secondary school. Isen et al. (2017) reported effects of heat exposure in utero on adult earnings in U.S. employer-employee matched longitudinal data from the Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) program.

National Longitudinal Survey of Youth (NLSY79), Graff Zivin et al. (2018) found that an additional 1.8°F (1°C) of average daily ambient temperature above 69.8°F (21°C) reduced math performance by 0.219 percentile point (no significant effects found for reading). Using student-exam level panel data of national college entrance exam scores in China, Graff Zivin et al. (2020) found that a 1.8°F (1°C) higher average exam-period (2 days) ambient temperature reduced performance by 0.34%. Using panel data of individual-level cognitive test scores administered at respondents' homes for adults as well as children as part of a nationally representative biennial longitudinal survey in China, Zhang et al. (2024) found that a test day with an average ambient temperature above 89.6°F (32°C), relative to a day in the 71.6°F–75.2°F (22°C–24°C) range, leads to a reduction in math performance by 6.6% of a standard deviation (no significant effects found for reading).

II. Athletic Performance.

Several studies found negative effects of heat exposure on athletic performance, despite this discussion being grouped with studies on mental performance, athletic performance is likely related to both mental and physical performance (Burke et al., 2023, p. 11).

Using athlete-contest level panel data of 3,196 professional archers in China from 2010 to 2016, Qiu and Zhao (2022) found a negative effect of higher daily heat index on performance. Relative to the baseline heat index range of 64.4°F–71.6°F (18°C–22°C)[129], the study found that at sample average wind speed of 2.35 meters per second, average score decreased by approximately 3% when the heat index was 78.8°F–93.2°F (26°C–34°C) and by 10.4% when the heat index exceeded 93.2°F (34°C). They also found that the effect of higher heat index on performance was less negative for top performers

[129] To compute heat indices below 80°F (26.7°C), Qiu and Zhao (2022) used the following formula: HI = 0.5*(T+61.0+[(T-68.0)*1.2]+RH*0.094), where HI is heat index in Fahrenheit, T is ambient temperature in Fahrenheit, and RH is relative humidity in percentage (p. 1159, footnote 18).

(defined as athletes whose performance index, defined as their average scores in all contests in previous competitions, exceeds the 90th percentile).

Using athlete-competition level panel data on 3.5 million collegiate track and field performances from 2005 to 2019, Sexton et al. (2022) found a nonlinear relationship between daily average ambient temperature and performance. Performance of sprint and strength events improved with increasing temperatures up to 75°F (23.9°C), after which decline in performance was insignificant; on the other hand, performances in endurance events declined significantly when temperatures were above 60°F (15.6°C), by 5 percentage points for each 5°F (2.78°C) increase in daily average ambient temperature relative to the baseline temperature range of 55°F–60°F (12.8°C–15.6°C).

Using player-match level panel data on 177,000 tennis matches from 2002 to 2017, Burke et al. (2023) found negative effects of heat exposure on the performance of professional tennis players (e.g., more double faults, more match retirement, shorter rallies, less total distance run). They reported a "roughly 0.5% decline" in player performance per 1.8°F (1°C) increase in average ambient temperature of the day of the match. They also found that the effects of heat exposure on performance were less negative for players ranked in the top 10. They also noted that their estimated effect of heat exposure on professional tennis players, which the authors considered as "high-wage settings," is about "half of the roughly 1.0%" decline in labor productivity per 1.8°F (1°C) increase in ambient temperature that they estimated from their meta-analysis of 22 studies. The authors conducted the meta-analysis as part of their literature review of existing evidence of labor productivity effects of heat exposure, which focused on "lower-wage settings."

III. Workplace Performance.

Focusing on studies based on actual office work or laboratory experiments that resemble office work, Seppänen et al. (2006) conducted a meta-analysis of 24 published

studies, concluding that performance decreased with a temperature above 73.4°F to 75.2°F (23°C to 24°C). The tasks analyzed include text processing, simple calculations (addition, multiplication), length of telephone customer service time, and total handling time per customer for call center workers, making them comparable to cognitive tasks conducted in other studies. They estimated a non-linear relationship between performance and heat: performance decreased by 9% at 86°F (30°C) compared to an optimal level of 69.8°F to 71.6°F (21°C to 22°C).

Some studies found evidence that heat exposure affects the mental performance of outdoor workers. Bendak et al. (2022) conducted a longitudinal empirical study to assess how high ambient temperatures affect construction workers' performance on a variety of tasks measuring reaction time, finding that task performance was lower in high ambient temperatures.

However, their analysis compared summer and winter months; therefore, the results are possibly confounded by seasonality effects. Similarly, Mazlomi et al. (2017) reported that workplace heat conditions measured by WBGT were negatively correlated with foundry plant workers' performance in cognitive tests. In contrast, Spector et al. (2018) found no association between maximum work-shift WBGT and post-shift reaction time or postural sway for 46 tree fruit harvesters in Washington State.

D. Economic Output.

Studies that documented the economic output effects of heat exposure fall into two groups. The first group of studies directly estimated the effect on heat exposure using plant/firm-level and region-level output data. The second group of studies borrowed heat exposure-work capacity response functions from the occupational health literature (which are derived from empirical data or existing ACGIH/NIOSH/ISO work-rest guidelines) and assumed workers are behaving according to these exposure-response functions.

I. Studies Directly Estimating the Effect on Heat Exposure Using Economic Output Data.

Numerous studies in the economics literature found evidence of negative output effects of heat exposure at the plant/firm-level and region-level.

This section does not focus on studies about the effects of higher temperatures on economic output through other channels such as agricultural yield, productivity of capital (e.g., faster depreciation of infrastructure), labor reallocation, energy demand, and international trade.

This section focuses on studies that used panel data to analyze changes (e.g., daily, weekly, quarterly, yearly) in temperature and outcomes of interest across space (e.g., plant/firm, region) and time. By controlling for time-invariant differences across space that may be confounded with temperature, the panel data approach helps to address some concerns over omitted variable bias associated with cross-sectional studies (Auffhammer, 2018, p. 43; Massetti and Mendelsohn, 2018, p. 327).

a. Plant/Firm-Level Output Effects.

Several studies found economic output effects of heat exposure using plant/firm-level panel data. Cachon et al. (2012) followed 64 automobile manufacturing plants in the U.S. from 1994 to 2005 and found that a week with six or more days with a daily maximum ambient temperature exceeding 90°F (32.2°C) reduced weekly production by 8%. The findings control for potential confounders such as changes in national demand and seasonality in demand for specific types of automobiles. However, the data did not allow the study to distinguish the contribution of labor productivity and labor supply. Information on the extent of indoor climate controls in these manufacturing plants was also not available.

Somanathan et al. (2021) estimated the output effects of heat exposure at different levels of aggregation (worker, plant, district) and found that their estimated effects are all of similar magnitude. Using daily worker-level production data from selected manufacturing firms in India, they found that daily output per worker declined in higher

outdoor temperatures, falling 2.7% per 1.8°F (1°C) increase in daily maximum ambient temperature above 77°F (25°C) (this study was also mentioned above in section VIII.I.II.B.I.). Using annual plant-level output data from a nationally representative panel of manufacturing plants in India, they found that annual plant-level output (measured by value added, defined as the difference between total output and the value of intermediate inputs) decreased by 2.1% per 1.8°F (1°C) increase in the annual average of the daily maximum ambient temperature. Under the specification of the Cobb-Douglas function, they reported that changes in labor input as opposed to capital input explains these declines in plant-level output.[130] Using annual district-level manufacturing sector GDP data from a sample of 438 districts in India, they found that annual district-level manufacturing output decreased by 3.5% per 1.8°F (1°C) increase in the annual average of the daily maximum ambient temperature. The authors further noted that the magnitude of their estimated effects mirrored the country-level estimates of output effects in the literature (country-level studies are described in more detail in section VIII.I.II.D.I.b., below), which they interpreted as evidence heat exposure affects output through labor productivity.

Using daily production line-level data from garment factories around Bangalore, India, Adhvaryu et al. (2020) found that production line efficiency (measured as ratio of realized output to target output) decreased in higher outdoor temperatures, by 2.1% for per 1.8°F (1°C) increase in daily average WBGT above 66.2°F (19°C). They did not find significant effects of higher temperatures on worker attendance, providing further support that labor productivity effects were likely the reason behind the observed relationship.

[130] Assuming the specification of the Cobb-Douglas production function, Somanathan et al. (2021) also found that changes in labor input (measured by number of full-time workers) as opposed to capital input (measured by net value of equipment of machinery at the start of each year) explained the negative effect of higher temperature on plant-level output.

Using annual firm-level data from the annual survey of industrial firms that are "above-scale" (with sales over a certain threshold) in China from 1998 to 2007 and assuming the specification of the Cobb-Douglas function, Zhang et al. (2018) found an inverted U-shaped relationship between temperature and total factor productivity (TFP) and output in the Chinese manufacturing sector. They found that, relative to a year with an extra day of average ambient temperature of 50°F–60°F (10°C–15.6°C), a year with an extra day over 90°F (32.2°C) had lower annual firm-level TFP by 0.56% and lower firm-level output (measured by value added, defined as the difference between total output and the value of intermediate inputs) by 0.45%. They also found that the TFP effects and output effects of temperature are of similar magnitude for both labor-intensive and capital-intensive firms, suggesting that both labor productivity and capital productivity were affected by heat exposure.

Using the same dataset as Zhang et al. (2018), Chen and Yang (2019) found that a 1.8°F (1°C) increase in the average summer temperature (3-month average of daily average ambient temperatures for months June through August) decreased value added per worker by 3.4% to 4.5%. They also found two potential channels through which higher temperatures reduce output: decrease in firm investment and increase in inventory levels.

Using annual firm-level data on revenue per worker in the manufacturing and services sectors from 15 developed and developing countries, Nath (2020) found a stronger negative effect of an extra hot day (a day with maximum ambient temperature of 104°F (40°C) relative to a day of 86°F (30°C)) on annual revenue per worker for poorer countries (i.e., lower purchasing power parity (PPP)-adjusted GDP per capita). They also found that the decline in revenue per worker was driven by changes in both the numerator (annual revenue) and denominator (annual employment), where the change in the numerator was greater than that of the denominator.

There are several caveats with studies reporting plant/firm-level output effects of heat exposure. First, although some studies identified labor productivity as the main mechanism for their findings (Somanathan et al., 2021; Adhvaryu et al., 2020; Nath, 2020), the literature overall is inconclusive regarding the extent to which the effects are driven by labor productivity (versus other channels such as labor supply and capital).

Second, some studies used outdoor heat conditions as a proxy for indoor heat conditions to estimate the labor productivity effects of heat exposure in indoor work settings. However, indoor heat conditions may not be perfectly correlated with outdoor heat conditions, especially with the presence of heat-generating lighting and machines and the unknown extent of indoor climate controls (Cachon et al., 2012; Adhvaryu et al.,2020[131]).

b. Region-Level Output Effects.

Several studies found economic output effects of heat exposure using region-level panel data. Some studies used county-level or State-level panel data to estimate the effects of heat on economic output. Deryugina and Hsiang (2014) used U.S. county-level panel data of annual total personal income per capita and daily weather from 1969 to 2011 to find that average per-day personal income per capita declines 1.68% per 1.8°F (1°C) increase in daily average ambient temperature above 59°F (15°C). Behrer and Park (2017) used U.S. county-level panel data of annual non-agricultural payroll per capita and daily weather from 1986 to 2011 to find that an additional hot day (a day of daily maximum ambient temperature above 95°F (35°C) relative to a day of 70°F–79°F (21.1°C–26.1°C)) reduced annual payroll per capita by 0.04%. Colacito et al. (2019) used U.S. State-level panel data of State GDP (i.e., gross State product) and daily weather to find that annual growth rate of a State's output declined by 0.15–0.25 percentage point

[131] Using indoor temperature data that was not available during the period when labor productivity effects were analyzed and was available only afterwards, Adhvaryu et al. (2020) reported a high but imperfect pass-through of 79% of outdoor ambient temperature to indoor ambient temperature.

per 1°F (0.56°C) increase in the average summer ambient temperature (three-month average of daily average ambient temperatures for months July through September).

Some studies used country-level panel data to estimate the effects of heat on economic output. Hsiang (2010) found for a panel of 28 Caribbean-Basin countries from 1970 to 2006 that annual output decreased by 2.4% per 1.8°F (1°C) increase in the average annual ambient temperature and the effects were driven by temperature changes during the hottest season (September through November). Furthermore, the study highlighted the similarity between their estimated output effects of temperature and the worker productivity effects of temperature reported in the "ergonomics and physiology" literature as evidence for labor productivity being an important channel underlying the economic effects of heat exposure. Dell et al. (2012) found for a panel of 124 countries from 1950 to 2003 that higher temperatures affected growth rates as well as level of output, but only in poor countries, defined as "having below-median PPP-adjusted per capita GDP in the first year the country enters the dataset." They found that 1.8°F (1°C) higher annual average ambient temperature in poor countries was associated with 2.04%p lower annual average growth in industrial output (growth in value added in mining, manufacturing, construction, electricity, water, and gas sectors). Some studies also found a nonlinear effect of temperature on economic output, implying that higher temperature negatively affects poor countries that tend to be hot and positively affects rich countries that tend to be cold (Heal and Park, 2016, p. 356). Heal and Park (2013) found for a panel of 134 countries from 1950 to 2006 that the response of annual real GDP per capita to annual average ambient temperature is nonlinear, that is, an inverted U-shaped response peaking at around 59°F–68°F (15°C–20°C). Burke et al. (2015) found for a panel of 166 countries from 1960 to 2010 an inverted U-shaped response of annual average GDP per capita to annual average temperate peaking at 55.4°F (13°C).

There are several caveats with studies reporting region-level output effects of heat exposure.

First, there is uncertainty regarding the extent to which labor productivity alone can explain the decline in output due to heat exposure (Lai et al., 2023). On the one hand, several studies highlighted labor productivity as an important if not the main channel through which heat exposure negatively affects output (e.g., Hsiang, 2010; Somanathan et al., 2021; Dell et al., 2014). On the other hand, due to the less frequent measurements of output (e.g., weekly, monthly, yearly), it is unclear if the results were driven by reductions in labor supply, labor productivity, labor demand, capital productivity, firm investment, increase in firm costs, or "some combination of all of these" (Behrer et al., 2021). For example, the estimated changes in output could be capturing demand-side factors either positively or negatively correlated with temperature (e.g., demand for ice cream increases with temperature; demand for outdoor recreation decreases with temperature) (Behrer and Park, 2017, p. 16). Changes in payroll may also not necessarily capture only changes in labor productivity but also capture changes in labor supply and increased firm costs (e.g., increased costs due to higher utilization of air-conditioning reducing firm profits or net income) (Behrer and Park, 2017, p. 13).

Second, although some of these studies found effects of heat-exposure on nonagricultural output, these observed associations may be in part due to the non-agricultural sectors facing less demand as a spillover effect of agricultural yield reductions from the agricultural sector (Dell et al., 2012, p. 85; Heal and Park, 2016, p. 9).

II. Studies Borrowing Exposure-Response Functions from Occupational Health Literature.

Section VIII.I.II.D.II. discussed studies that directly estimated the relationship between heat exposure and economic output and tried to uncover the underlying the potential mechanisms such as labor productivity.

This section discusses other studies that borrowed heat exposure-work capacity response (exposure-response) functions that were derived by existing studies in the occupational health literature. Applying these functions to the worker population of interest (e.g., outdoor workers nationwide), these studies derived economy-wide labor productivity loss and the associated economic cost in terms of lost wages or lost output.

As discussed in the section VIII.I.II.B.I.a., exposure-response functions in the occupational health literature fall into two groups. The first group of exposure-response functions are based on empirical data (e.g., Hothaps function derived in Kjellstrom et al., 2014; PWC function derived in Foster et al., 2021). The second group of exposure-response functions are based on recommended work-rest ratios in existing work-rest guidelines by NIOSH, ACGIH, and ISO (e.g., Kjellstrom et al., 2009b; Dunne et al., 2013).

These empirically-derived or guideline-based exposure-response functions from the occupational health literature were applied by several studies to macroeconomic data and models to estimate the economic impact of heat exposure. These studies fall into three groups: the first group of studies (e.g., Orlov et al., 2019; Morabito et al., 2020, Nelson et al., 2024) borrowed the empirically-derived functions; the second group of studies (e.g., DARA, 2012; Vanos et al., 2019; Takakura et al., 2017; Atlantic Council, 2022; de Lima et al., 2021) borrowed the guideline-based functions ; and the third group of studies (e.g., Kjellstrom et al., 2018; ILO, 2019; Atlantic Council, 2021; Romanello et al., 2023; Dasgupta et al., 2021) borrowed and combined empirically-derived functions with the guideline-based functions.

There are some caveats with studies relying on existing exposure-response functions to estimate the economic impact of heat exposure. First, empirically-derived exposure-response functions are context-specific (e.g., the Hothaps function is based on data from acclimatized outdoor workers in hotter regions; the PWC function is based on data from unacclimatized young adults in indoor climatic chambers). Studies relying on empirically-derived functions are effectively assuming that the average worker behaves as predicted by these context-specific functions.

Second, existing work-rest guidelines were designed to increase work-rest ratios to minimize heat-related illnesses (Borg et al., 2021, p. 12) and were never intended to estimate the casual effect of heat exposure on work capacity (Foster et al., 2021, p. 1216). Studies relying on guideline-based exposure-response functions effectively assumed that the average worker behaves according to the recommended work-rest ratios. Therefore, these studies reported larger economic costs associated with lost work capacity from heat than what is reported by empirical studies (Borg et al., 2021, p. 12).

E. Worker Utility.

Higher temperatures not only reduce labor supply and labor productivity, but also "cause discomfort" (Graff Zivin and Neidell, 2014, p. 1) or "make work more arduous" for those able to work (Rode et al., 2022, p. 3). Several studies have indeed found evidence that workers dislike working in the heat, suggesting the negative effects of heat exposure on worker utility.

Some studies found evidence of the negative effect of heat exposure on worker utility based on worker surveys. Krishnamurthy et al. (2017) reported that about a quarter of surveyed steel factory workers in India reported social impacts on their personal lives attributable to occupational heat stress. Reported impacts include the time and resources spent coping with the heat and the excessive exhaustion impeding the engagement in family and social interactions outside work. Such responses highlight a potential

mechanism through which heat increases disutility of labor. LoPalo (2023) also found that in higher temperatures, household survey interviewers worked longer hours (by starting earlier in the day and spending more time on each interview) to avoid working during hotter times of the day and to also meet their daily target number of completed interviews, suggesting a loss in the welfare of the interviewer through a loss of leisure hours.

Some workers even reported intentions to change jobs due to heat exposure, as expressed in an online survey conducted by Zander et al. (2015), showing that 27% of the surveyed Australian workers exposed to heat said they would eventually change jobs because of heat at their workplace. In contrast, only 8% of the surveyed workers who are sometimes exposed to heat said they considered this option, and those rarely exposed only expressed this 2% of the time. On the other hand, Kahn (2016) highlighted an example of market failure where employers having monopsony power in local labor markets can still hire workers at low wages for "unpleasant" jobs exposed to heat without adequate worker protection measures in place, such as large warehouses without air-conditioning (p. 171).

Interpreting their empirically-estimated decline in labor supply in higher temperatures as workers choosing to work less in the heat at the cost of foregoing pay (discussed above in section VIII.I.II.A.), Rode et al. (2022) derived the willingness-to-pay to avoid the increased disutility of working in higher temperatures (defined as the increase in the wage rate that is needed to offset the increased disutility of labor).

F. Summary of Section VIII.I.II.

The literature documents effects of heat exposure on outcomes with economic consequences. Effects are observed in a variety of occupational settings, suggesting that the effects of heat exposure are widespread across a broad range of tasks that rely on physical or cognitive skills and that heat exposure affects workers in both indoor and

outdoor settings. In particular, the literature recognizes labor productivity as a potential channel through which heat exposure affects economic outcomes.

III. Workplace Characteristics and Labor Productivity Effects of Heat Exposure.

The literature's varying estimates of the effect of heat exposure on labor productivity could be attributed to differences in workplace characteristics, such as incentive structures and availability of adaptation measures (Park et al., 2021, p. 8, footnote 13). These workplace characteristics should be considered when interpreting the variation in estimates of the labor productivity-related effects of heat exposure in the literature (Heal and Park, 2016, p. 350). This section focuses on studies that reported labor productivity (discussed in section VIII.I.II.B., above) but also includes some studies that are potentially related to labor productivity, such as studies on mental performance (discussed in section VIII.I.II.C., above) or studies on economic output effects that are potentially linked to labor productivity (discussed in section VIII.I.II.D.I., above).

A. Incentive Structures.

Depending on the physical and behavioral aspects of the workplace, workers and management could be incentivized to change the level of effort, affecting the estimated labor productivity effect of heat exposure. Workplace factors that affect incentives include wage structure (e.g., piece-rate, hourly rate, annual salary), management techniques, mechanization, and other factors not accounted for by laboratory studies (Somanathan et al., 2021).

One of the most analyzed workplace factors in the literature is piece-rate pay. Quiller et al. (2017) found null effects of heat on labor productivity (measure by weight of fruit bins collected per hour) for a sample of piece-rate paid tree fruit harvesters in Washington State, after adjusting for confounders such as price paid per bin and shift duration. Mitchell et al. (2018) used accelerometer data from farm workers in California to find, even after adjusting for confounders, negative effects of heat on labor

productivity (measured by physical activity intensity, i.e., step counts per minute, converted into metabolic equivalents) and that the effects were less negative for male workers paid by piece-rate. Such small or zero labor productivity effects could reflect compensatory effort on part of workers incentivized to be as productive as possible, the health and safety consequences of which should not be overlooked (Park et al., 2021, p. 8, footnote 13). Piece-rate workers being incentivized to work fast and take few rest breaks even under heat exposure have been evidenced in focus group discussions with U.S. farmworkers (Wadsworth et al., 2019; Lam et al., 2013).

Several studies also found that, due to physiological constraints, piece-rate workers cannot increase their effort infinitely in the heat. Stevens (2017) found that higher piece-rates induced increases in labor productivity of blueberry pickers in California at ambient temperatures below 60°F but not at higher temperatures. Masuda et al. (2021) also found in a field experiment in Indonesia that increasing the piece-rate did not increase effort, as measured by the proportion of time spent in moderate and vigorous activity through an accelerometer. This evidence is consistent with workers facing binding physiological constraints that prevent them from exerting additional effort in response to higher piece-rates at high temperatures.

In their findings of the labor productivity effects of environmental conditions, some studies also addressed the possibility that piece-rate workers' labor productivity could decline further if they are subject to State minimum wage laws (e.g., Stevens, 2017 in the context of heat; Graff Zivin and Neidell, 2012 in the context of ozone pollution). Hypothetically, compared to when not guaranteed a minimum wage, higher temperatures could lead piece-rate workers to exert less effort and therefore result in greater decline in labor productivity.

From data on Demographic and Health Surveys (DHS) interviewers from 46 developing countries, LoPalo (2023) found nuanced adjustments in effort by DHS

interviewers. DHS interviewers are paid a fixed daily wage (i.e., not piece-rate) but are still monitored by supervisors to ensure they meet the target number of completed interviews. Under this contractual structure, higher temperatures result in lower labor productivity in terms of number of completed interviews per hour—interviewers are able to maintain the same daily number of completed interviews but at the cost of a longer shift from trying to avoid working in the heat (by starting work earlier and spending more time on each interview). They also found that data quality problems (e.g., missing responses) become more frequent on hotter days, suggesting that workers shift effort away from production quality, which is less noticeable to supervisors, to production quantity, which is more noticeable.

B. Adaptation.

Regarding adaptation measures[132] alleviating the negative labor productivity-related effects of heat exposure, the most analyzed in the literature are the adoption of engineering controls. Using microdata from selected manufacturing plants in India, Somanathan et al. (2021) found that climate controls in the workplace eliminated declines in labor productivity due to elevated temperatures but did not eliminate declines in labor

[132] Some studies reporting economic output effects (discussed above in section VIII.I.II.D.I.) found heterogeneous effects of temperature depending on regional climate. They found that hotter regions displayed smaller declines in output to higher temperatures, suggesting that their findings could reflect adaptation in these regions. For example, Chen and Yang (2019) found lower sensitivity in the response of value added per worker to higher temperatures among plants associated with a single firm in warmer locations in China and raised the possibility of adaptation measures such as avoiding work during hottest times of the day playing a role. Zhang et al. (2023) used Chinese province-level panel data of construction labor productivity (defined as the ratio of the total value of output to the number of laborers in construction enterprises) and quarterly weather to find an inverted U-shaped relationship between quarterly construction labor productivity and quarterly average ambient temperature that peaked at higher temperatures in hotter regions (79.25°F (26.25°C) in eastern regions versus 68°F (20°C) for central and western regions). They conjectured that workers in hotter regions are more adapted to high temperatures so that the peak temperature after which their labor productivity started to decline was higher. Behrer and Park (2017) used U.S. county-level panel data of annual non-agricultural payroll per capita and daily weather to find that the negative effect of an additional hot day on annual payroll per capita was smaller in hotter counties (in the top quartile of the U.S. average ambient temperature distribution). They suggested that such attenuated effects of heat exposure in hotter regions can be explained by the larger presence of air-conditioning in these regions, as evidenced by region-level data on percentage of households and commercial buildings with air-conditioning. Heal and Park (2013) also found in country-level panel data that annual real GDP per capita was less negatively affected by heat exposure in hot countries where air-conditioning was more prevalent.

supply (based on worker attendance records). The authors conjectured declines in labor supply persisted despite climate-controlled conditions at work because workers presumably continued to be exposed to high temperature at home and outside. Adhvaryu et al. (2020) found in line-level production data from Indian garment factories that the introduction of LED lighting (that replaced compact fluorescent lighting which generates more heat) helped to alleviate the negative effect of high outdoor temperatures on production line efficiency. Using panel data of individual-level cognitive test scores administered at respondents' homes for adults as well as children as part of a nationally representative biennial longitudinal survey in China, Zhang et al. (2024) found that their estimated effect of higher temperatures on math test scores was less negative by 36.6% for households with air-conditioning.

Some studies that found negative effects of heat exposure on athletic performance also evaluated the effects of acclimatization.[133] Using athlete-competition level panel data on collegiate track and field performances, Sexton et al. (2022) found that hotter average ambient temperatures at the home institution in the week prior to the competition ("precompetition temperatures") mitigated performance loss from high competition temperatures. They reported that for hot competitions with daily average ambient temperatures exceeding 70°F (21.1°C), performance loss from high competition temperature decreases by 1.6%–3.5% per 1.8°F (1°C) increase in temperature difference between the precompetition and competition temperatures. On the other hand, using athlete-contest level panel data of Chinese professional archers, Qiu and Zhao (2022) did not find evidence that heat exposure within several months prior to a competition

[133] In the context of labor supply, Graff Zivin and Neidell (2014) found that their estimated negative effect of heat exposure on labor supply was smaller in August compared to June, suggesting that workers became less sensitive to heat exposure as higher temperatures became more common. As another test for effects of acclimatization, they also found that the negative effect of heat exposure on labor supply was smaller in "warm counties" compared to "cool counties" (defined as counties in the highest and lowest third of historical July–August temperatures, respectively), although the estimated difference was not statistically significant.

improved competition performance in the heat. Qiu and Zhao (2022) however found evidence of benefits of "longer-term acclimatization"; athletes that trained in the southern provinces of China, where hot days are more common, were less affected by heat exposure than those trained in the northern provinces. From player-match level panel data of professional tennis players, Burke et al. (2023) also did not find evidence of benefits of acclimatization; players who played their previous match in higher temperatures did worse in their current match. Burke et al. (2023) also did not find evidence of benefits of "long-term exposure to heat"; players born or residing in locations of higher temperatures did not appear to be less affected by higher temperatures during the match. Burke et al. (2023) conjectured that their lack of evidence of benefits of acclimatization compared to Sexton et al. (2022) could be because their proxy of acclimatization captured players playing an actual match in high temperatures, while acclimatization could be "more effective during repeated episodes of more restrained effort, as emphasized in most sports heat acclimatization protocols (p. 12)."

C. Summary of Section VIII.I.III.

To summarize, workplace incentives and availability of adaptation measures affect the estimated labor productivity-related effects of heat exposure documented in the literature.

IV. Conclusion.

The available literature on the effects of heat exposure on non-health outcomes suggests that heat exposure can lead to decreased labor productivity as well as to reduced labor supply, mental performance, economic output, and worker utility. It also indicates that existing workplace characteristics such as incentive structures and adoption of adaptation measures should be considered when evaluating these negative non-health consequences of heat exposure.

J. Appendix C. Heat Exposure Methodology Used in Distributional Analysis.

The following steps were taken to quantify the fraction of workers benefiting from the proposed standard in different demographic and economic categories.

I. ACS Data Processing.

The analysis uses data from the Census Bureau's American Community Survey (ACS) from 2018 to 2022 (Ruggles et al., 2024). 2022 is the most recent available year of ACS data. ACS data provide worker-level information on demographic and economic characteristics. The following demographic and economic characteristics are recorded in the ACS: age; race and ethnicity; sex; total family income; industry; occupation; the presence of a disability related to cognition, physical activity, mobility, self-care, vision, or hearing; and U.S. citizenship. In addition, LGBTQ+ status was inferred from cases where an individual was living (married or unmarried) with a same-sex partner.

Only data for employed workers 16 years or older was used. The ACS variables were processed as follows. Age was grouped into 10-year bins (with age 65+ as the top bin). Race and ethnicity variables were coded into the groups Hispanic, Black, Asian (including Pacific Islander), White (non-Hispanic), and other groups. Total family income was converted into deciles. Presence of a disability was coded into a single indicator variable for the presence of any disability. Sex and the presence of a same-sex partner required no further processing.

II. Merging ACS Data with Heat Exposure Measures.

Calculations of workers likely to be affected by the proposed standard from Section VIII.B., Profile of Affected Industries were next merged with the ACS data. Fractions of workers exposed to heat by industry and occupation was used. In Section VIII.B., Profile of Affected Industries, exposure was calculated at the 4-digit NAICS level and with detailed (6-digit) SOC codes. To consistently merge with the ACS, these affected workers were aggregated to the 2-digit NAICS code by 4-digit SOC code

level.[134] The aggregation was done by calculating weighted average fraction of workers exposed to heat in outdoor settings and indoor settings (separately due to process heat or inadequate climate control) in each industry-occupation pair. The weights were number of workers in each 4-digit by 6-digit category, as calculated in Section VIII.B., Profile of Affected Industries. The worker-level ACS data were then merged with the industry-by-occupation exposure fractions.

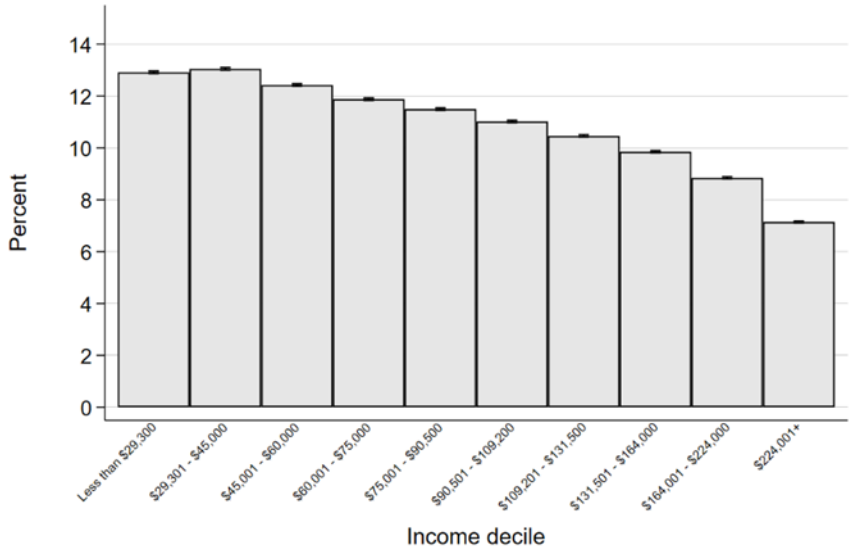
III. Calculate Exposure by Demographic and Economic Group.

For each dimension of heterogeneity described above, the average share of exposed workers was calculated. The average exposure was weighted by the person-weights in the ACS to generate representative values for the U.S.

The result is a figure like figure VIII.J.1. shown below. The figure shows the percent of workers exposed to outdoor heat across total family income deciles. The deciles are given on the x-axis along with the range of income they represent, and the y-axis is the percentage of workers. The figure VIII.J.1. shows that about 13 percent of workers in low-income deciles are exposed to outdoor heat on the job while about 7 percent of workers in the highest income decile are exposed.

Figure VIII.J.1. Example of Workers with Heat Exposure in Outdoor Work Settings by Total Family Income Decile

[134] ACS includes 4-digit NAICS codes and detailed (6-digit) SOC codes for some industries and occupations. However, given that ACS uses different industry and occupation definitions than NAICS and SOC, many industries and occupations are only consistently coded at the 2- or 4-digit level respectively. For example, in the ACS, all construction workers are only classified at the 2-digit NAICS level (NAICS 23). Aggregation to the 2-digit NAICS code and 4-digit SOC code level ensures consistency across workers.


Percent
14
12
10
8
6
4
2
0
Less than $29,300
$29,301 - $45,000
$45,001 - $60,000
$60,001 - $75,000
$75,001 - $90,500
$90,501 - $109,200
$109,201 - $131,500
$131,501 - $164,000
$164,001 - $224,000
$224,001+
Income decile

K. Appendix D. Definitions of Core Industry Categories Used in Cost Analysis.

Table VIII.K.1. In-Scope Core Industries by Core Industry Categories.

Core Industry Category	4-Digit NAICS	NAICS Title
Agriculture, Forestry, and Fishing	111100	Oilseed and Grain Farming
Agriculture, Forestry, and Fishing	111200	Vegetable and Melon Farming
Agriculture, Forestry, and Fishing	111300	Fruit and Tree Nut Farming
Agriculture, Forestry, and Fishing	111400	Greenhouse, Nursery, and Floriculture Production
Agriculture, Forestry, and Fishing	111900	Other Crop Farming
Agriculture, Forestry, and Fishing	112100	Cattle Ranching and Farming
Agriculture, Forestry, and Fishing	112200	Hog and Pig Farming
Agriculture, Forestry, and Fishing	112300	Poultry and Egg Production
Agriculture, Forestry, and Fishing	112400	Sheep and Goat Farming
Agriculture, Forestry, and Fishing	112500	Aquaculture
Agriculture, Forestry, and Fishing	112900	Other Animal Production
Agriculture, Forestry, and Fishing	113100	Timber Tract Operations
Agriculture, Forestry, and Fishing	113200	Forest Nurseries and Gathering of Forest Products
Agriculture, Forestry, and Fishing	113300	Logging
Agriculture, Forestry, and Fishing	114100	Fishing
Agriculture, Forestry, and Fishing	114200	Hunting and Trapping
Agriculture, Forestry, and Fishing	115100	Support Activities for Crop Production
Agriculture, Forestry, and Fishing	115200	Support Activities for Animal Production
Agriculture, Forestry, and Fishing	115300	Support Activities for Forestry
Building Materials and Equipment Suppliers	423300	Lumber and Other Construction Materials Merchant Wholesalers
Building Materials and Equipment Suppliers	423700	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers
Building Materials and Equipment Suppliers	423900	Miscellaneous Durable Goods Merchant Wholesalers
Building Materials and Equipment Suppliers	444100	Building Material and Supplies Dealers
Building Materials and Equipment Suppliers	532400	Commercial and Industrial Machinery and Equipment Rental and Leasing
Commercial Kitchens	311800	Bakeries and Tortilla Manufacturing

Core Industry Category	4-Digit NAICS	NAICS Title
Commercial Kitchens	722300	Special Food Services
Commercial Kitchens	722400	Drinking Places (Alcoholic Beverages)
Commercial Kitchens	722500	Restaurants and Other Eating Places
Construction	236100	Residential Building Construction
Construction	236200	Nonresidential Building Construction
Construction	237100	Utility System Construction
Construction	237200	Land Subdivision
Construction	237300	Highway, Street, and Bridge Construction
Construction	237900	Other Heavy and Civil Engineering Construction
Construction	238100	Foundation, Structure, and Building Exterior Contractors
Construction	238200	Building Equipment Contractors
Construction	238300	Building Finishing Contractors
Construction	238900	Other Specialty Trade Contractors
Construction	541300	Architectural, Engineering, and Related Services
Drycleaning and Commercial Laundries	812300	Drycleaning and Laundry Services
Landscaping and Facilities Support	561200	Facilities Support Services
Landscaping and Facilities Support	561700	Services to Buildings and Dwellings
Landscaping and Facilities Support	561900	Other Support Services
Landscaping and Facilities Support	812200	Death Care Services
Landscaping and Facilities Support	812900	Other Personal Services
Maintenance and Repair	811100	Automotive Repair and Maintenance
Maintenance and Repair	811300	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
Maintenance and Repair	811400	Personal and Household Goods Repair and Maintenance
Manufacturing	311100	Animal Food Manufacturing
Manufacturing	311200	Grain and Oilseed Milling
Manufacturing	311300	Sugar and Confectionery Product Manufacturing
Manufacturing	311400	Fruit and Vegetable Preserving and Specialty Food Manufacturing
Manufacturing	311500	Dairy Product Manufacturing
Manufacturing	311600	Animal Slaughtering and Processing
Manufacturing	311700	Seafood Product Preparation and Packaging
Manufacturing	311900	Other Food Manufacturing

Core Industry Category	4-Digit NAICS	NAICS Title
Manufacturing	312100	Beverage Manufacturing
Manufacturing	312200	Tobacco Manufacturing
Manufacturing	313100	Fiber, Yarn, and Thread Mills
Manufacturing	313200	Fabric Mills
Manufacturing	313300	Textile and Fabric Finishing and Fabric Coating Mills
Manufacturing	314100	Textile Furnishings Mills
Manufacturing	314900	Other Textile Product Mills
Manufacturing	315100	Apparel Knitting Mills
Manufacturing	315200	Cut and Sew Apparel Manufacturing
Manufacturing	315900	Apparel Accessories and Other Apparel Manufacturing
Manufacturing	316100	Leather and Hide Tanning and Finishing
Manufacturing	316200	Footwear Manufacturing
Manufacturing	316900	Other Leather and Allied Product Manufacturing
Manufacturing	321100	Sawmills and Wood Preservation
Manufacturing	321200	Veneer, Plywood, and Engineered Wood Product Manufacturing
Manufacturing	321900	Other Wood Product Manufacturing
Manufacturing	322100	Pulp, Paper, and Paperboard Mills
Manufacturing	322200	Converted Paper Product Manufacturing
Manufacturing	323100	Printing and Related Support Activities
Manufacturing	324100	Petroleum and Coal Products Manufacturing
Manufacturing	325100	Basic Chemical Manufacturing
Manufacturing	325200	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing
Manufacturing	325300	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
Manufacturing	325400	Pharmaceutical and Medicine Manufacturing
Manufacturing	325500	Paint, Coating, and Adhesive Manufacturing
Manufacturing	325600	Soap, Cleaning Compound, and Toilet Preparation Manufacturing
Manufacturing	325900	Other Chemical Product and Preparation Manufacturing
Manufacturing	326100	Plastics Product Manufacturing
Manufacturing	326200	Rubber Product Manufacturing
Manufacturing	327100	Clay Product and Refractory Manufacturing
Manufacturing	327200	Glass and Glass Product Manufacturing
Manufacturing	327300	Cement and Concrete Product Manufacturing
Manufacturing	327400	Lime and Gypsum Product Manufacturing

Core Industry Category	4-Digit NAICS	NAICS Title
Manufacturing	327900	Other Nonmetallic Mineral Product Manufacturing
Manufacturing	331100	Iron and Steel Mills and Ferroalloy Manufacturing
Manufacturing	331200	Steel Product Manufacturing from Purchased Steel
Manufacturing	331300	Alumina and Aluminum Production and Processing
Manufacturing	331400	Nonferrous Metal (except Aluminum) Production and Processing
Manufacturing	331500	Foundries
Manufacturing	332100	Forging and Stamping
Manufacturing	332200	Cutlery and Handtool Manufacturing
Manufacturing	332300	Architectural and Structural Metals Manufacturing
Manufacturing	332400	Boiler, Tank, and Shipping Container Manufacturing
Manufacturing	332500	Hardware Manufacturing
Manufacturing	332600	Spring and Wire Product Manufacturing
Manufacturing	332700	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing
Manufacturing	332800	Coating, Engraving, Heat Treating, and Allied Activities
Manufacturing	332900	Other Fabricated Metal Product Manufacturing
Manufacturing	333100	Agriculture, Construction, and Mining Machinery Manufacturing
Manufacturing	333200	Industrial Machinery Manufacturing
Manufacturing	333300	Commercial and Service Industry Machinery Manufacturing
Manufacturing	333400	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing
Manufacturing	333500	Metalworking Machinery Manufacturing
Manufacturing	333600	Engine, Turbine, and Power Transmission Equipment Manufacturing
Manufacturing	333900	Other General Purpose Machinery Manufacturing
Manufacturing	335100	Electric Lighting Equipment Manufacturing
Manufacturing	335200	Household Appliance Manufacturing
Manufacturing	335300	Electrical Equipment Manufacturing
Manufacturing	335900	Other Electrical Equipment and Component Manufacturing
Manufacturing	336100	Motor Vehicle Manufacturing
Manufacturing	336200	Motor Vehicle Body and Trailer Manufacturing
Manufacturing	336300	Motor Vehicle Parts Manufacturing
Manufacturing	336400	Aerospace Product and Parts Manufacturing
Manufacturing	336500	Railroad Rolling Stock Manufacturing
Manufacturing	336600	Ship and Boat Building
Manufacturing	336900	Other Transportation Equipment Manufacturing

Core Industry Category	4-Digit NAICS	NAICS Title
Manufacturing	337100	Household and Institutional Furniture and Kitchen Cabinet Manufacturing
Manufacturing	337200	Office Furniture (including Fixtures) Manufacturing
Manufacturing	337900	Other Furniture Related Product Manufacturing
Manufacturing	339100	Medical Equipment and Supplies Manufacturing
Manufacturing	339900	Other Miscellaneous Manufacturing
Oil and Gas	211100	Oil and Gas Extraction
Oil and Gas	213100	Support Activities for Mining
Oil and Gas	486100	Pipeline Transportation of Crude Oil
Oil and Gas	486200	Pipeline Transportation of Natural Gas
Oil and Gas	486900	Other Pipeline Transportation
Postal and Delivery Services	491100	Postal Service
Postal and Delivery Services	492100	Couriers and Express Delivery Services
Postal and Delivery Services	492200	Local Messengers and Local Delivery
Recreation and Amusement	711200	Spectator Sports
Recreation and Amusement	713100	Amusement Parks and Arcades
Recreation and Amusement	713900	Other Amusement and Recreation Industries
Recreation and Amusement	721200	RV (Recreational Vehicle) Parks and Recreational Camps
Sanitation and Waste Removal	562100	Waste Collection
Sanitation and Waste Removal	562200	Waste Treatment and Disposal
Sanitation and Waste Removal	562900	Remediation and Other Waste Management Services
Telecommunications	517100	Wired and Wireless Telecommunications (except Satellite)
Telecommunications	517400	Satellite Telecommunications
Telecommunications	517800	All Other Telecommunications
Temporary Help Services	561300	Employment Services
Transportation	481100	Scheduled Air Transportation
Transportation	481200	Nonscheduled Air Transportation
Transportation	482100	Rail Transportation
Transportation	483100	Deep Sea, Coastal, and Great Lakes Water Transportation
Transportation	483200	Inland Water Transportation
Transportation	484100	General Freight Trucking
Transportation	484200	Specialized Freight Trucking
Transportation	485100	Urban Transit Systems

Core Industry Category	4-Digit NAICS	NAICS Title
Transportation	485900	Other Transit and Ground Passenger Transportation
Transportation	488100	Support Activities for Air Transportation
Transportation	488200	Support Activities for Rail Transportation
Transportation	488300	Support Activities for Water Transportation
Transportation	488400	Support Activities for Road Transportation
Transportation	488900	Other Support Activities for Transportation
Utilities	221100	Electric Power Generation, Transmission and Distribution
Utilities	221200	Natural Gas Distribution
Utilities	221300	Water, Sewage and Other Systems
Warehousing	493100	Warehousing and Storage

Table VIII.K.2. In-Scope Non-Core Industries Used in Cost Analysis.

4-Digit NAICS	NAICS Title
334100	Computer and Peripheral Equipment Manufacturing
334200	Communications Equipment Manufacturing
334300	Audio and Video Equipment Manufacturing
334400	Semiconductor and Other Electronic Component Manufacturing
334500	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
334600	Manufacturing and Reproducing Magnetic and Optical Media
423100	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers
423200	Furniture and Home Furnishing Merchant Wholesalers
423400	Professional and Commercial Equipment and Supplies Merchant Wholesalers
423500	Metal and Mineral (except Petroleum) Merchant Wholesalers
423600	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers
423800	Machinery, Equipment, and Supplies Merchant Wholesalers
424100	Paper and Paper Product Merchant Wholesalers
424200	Drugs and Druggists' Sundries Merchant Wholesalers
424300	Apparel, Piece Goods, and Notions Merchant Wholesalers
424400	Grocery and Related Product Merchant Wholesalers

4-Digit NAICS	NAICS Title
424500	Farm Product Raw Material Merchant Wholesalers
424600	Chemical and Allied Products Merchant Wholesalers
424700	Petroleum and Petroleum Products Merchant Wholesalers
424800	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers
424900	Miscellaneous Nondurable Goods Merchant Wholesalers
425100	Wholesale Trade Agents and Brokers
441100	Automobile Dealers
441200	Other Motor Vehicle Dealers
441300	Automotive Parts, Accessories, and Tire Retailers
444200	Lawn and Garden Equipment and Supplies Retailers
445100	Grocery and Convenience Retailers
445200	Specialty Food Retailers
445300	Beer, Wine, and Liquor Retailers
449100	Furniture and Home Furnishings Retailers
449200	Electronics and Appliance Retailers
455100	Department Stores
455200	Warehouse Clubs, Supercenters, and Other General Merchandise Retailers
456100	Health and Personal Care Retailers
457100	Gasoline Stations
457200	Fuel Dealers
458100	Clothing and Clothing Accessories Retailers
458200	Shoe Retailers
458300	Jewelry, Luggage, and Leather Goods Retailers
459100	Sporting Goods, Hobby, and Musical Instrument Retailers
459200	Book Retailers and News Dealers
459300	Florists
459400	Office Supplies, Stationery, and Gift Retailers
459500	Used Merchandise Retailers
459900	Other Miscellaneous Retailers
485200	Interurban and Rural Bus Transportation
485300	Taxi and Limousine Service

4-Digit NAICS	NAICS Title
485400	School and Employee Bus Transportation
485500	Charter Bus Industry
487100	Scenic and Sightseeing Transportation, Land
487200	Scenic and Sightseeing Transportation, Water
487900	Scenic and Sightseeing Transportation, Other
488500	Freight Transportation Arrangement
512100	Motion Picture and Video Industries
512200	Sound Recording Industries
513100	Newspaper, Periodical, Book, and Directory Publishers
513200	Software Publishers
516100	Radio and Television Broadcasting Stations
516200	Media Streaming Distribution Services, Social Networks, and Other Media Networks and Content Providers
518200	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services
519200	Web Search Portals, Libraries, Archives, and Other Information Services
521100	Monetary Authorities-Central Bank
522100	Depository Credit Intermediation
522200	Nondepository Credit Intermediation
522300	Activities Related to Credit Intermediation
523100	Securities and Commodity Contracts Intermediation and Brokerage
523200	Securities and Commodity Exchanges
523900	Other Financial Investment Activities
524100	Insurance Carriers
524200	Agencies, Brokerages, and Other Insurance Related Activities
525100	Insurance and Employee Benefit Funds
525900	Other Investment Pools and Funds
531100	Lessors of Real Estate
531200	Offices of Real Estate Agents and Brokers
531300	Activities Related to Real Estate
532100	Automotive Equipment Rental and Leasing
532200	Consumer Goods Rental
532300	General Rental Centers

4-Digit NAICS	NAICS Title
533100	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)
541100	Legal Services
541200	Accounting, Tax Preparation, Bookkeeping, and Payroll Services
541400	Specialized Design Services
541500	Computer Systems Design and Related Services
541600	Management, Scientific, and Technical Consulting Services
541700	Scientific Research and Development Services
541800	Advertising, Public Relations, and Related Services
541900	Other Professional, Scientific, and Technical Services
551100	Management of Companies and Enterprises
561100	Office Administrative Services
561400	Business Support Services
561500	Travel Arrangement and Reservation Services
561600	Investigation and Security Services
611100	Elementary and Secondary Schools
611200	Junior Colleges
611300	Colleges, Universities, and Professional Schools
611400	Business Schools and Computer and Management Training
611500	Technical and Trade Schools
611600	Other Schools and Instruction
611700	Educational Support Services
621100	Offices of Physicians
621200	Offices of Dentists
621300	Offices of Other Health Practitioners
621400	Outpatient Care Centers
621500	Medical and Diagnostic Laboratories
621600	Home Health Care Services
621900	Other Ambulatory Health Care Services
622100	General Medical and Surgical Hospitals
622200	Psychiatric and Substance Abuse Hospitals
622300	Specialty (except Psychiatric and Substance Abuse) Hospitals

4-Digit NAICS	NAICS Title
623100	Nursing Care Facilities (Skilled Nursing Facilities)
623200	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities
623300	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly
623900	Other Residential Care Facilities
624100	Individual and Family Services
624200	Community Food and Housing, and Emergency and Other Relief Services
624300	Vocational Rehabilitation Services
624400	Child Care Services
711100	Performing Arts Companies
711300	Promoters of Performing Arts, Sports, and Similar Events
711400	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures
711500	Independent Artists, Writers, and Performers
712100	Museums, Historical Sites, and Similar Institutions
713200	Gambling Industries
721100	Traveler Accommodation
721300	Rooming and Boarding Houses, Dormitories, and Workers' Camps
811200	Electronic and Precision Equipment Repair and Maintenance
812100	Personal Care Services
813100	Religious Organizations
813200	Grantmaking and Giving Services
813300	Social Advocacy Organizations
813400	Civic and Social Organizations
813900	Business, Professional, Labor, Political, and Similar Organizations
999200	State Government
999300	Local Government

IX. Technological Feasibility

A. Introduction.

The Occupational Safety and Health Administration (OSHA) is proposing a *Heat Injury and Illness Prevention* standard that will require employers, whose employees are occupationally exposed to hazardous heat, to develop and implement a heat injury and illness prevention plan. As part of the plan, this proposed standard will require employers to implement control measures to mitigate the risk to workers from occupational exposure to heat when temperatures exceed specified triggers.

As discussed in Section II., Pertinent Legal Authority, OSHA must prove, by substantial evidence in the rulemaking record, that its standards are technologically and economically feasible, which the Supreme Court has defined as "capable of being done, executed, or effected" (*American Textile Mfrs. Inst. v. Donovan (Cotton Dust),* 452 U.S. 490, 508-09 (1981)). A standard is technologically feasible if the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be expected to be developed (*United Steelworkers v. Marshall (Lead I),* 647 F.2d 1189, 1272 (D.C. Cir, 1980), *cert. denied,* 453 U.S. 913 (1981); *Am. Iron & Steel Inst. v. Occupational Safety & Health Admin. (Lead II)*, 939 F.2d 975, 980 (D.C. Cir. 1991)). OSHA has reviewed the requirements that would be imposed by the proposed Heat Injury and Illness Prevention standard and assessed the technological feasibility of complying with its requirements. As a result of this review, OSHA has preliminarily determined that achieving compliance with the proposed standard is technologically feasible.

B. Methodology.

For this proposed standard, OSHA evaluated the provisions to identify which requirements proposed the implementation of engineering control measures or would address facility and equipment related aspects of heat illness prevention, as opposed to those that would establish programs, processes, or procedures. OSHA also reviewed the workplace control practices currently in place across the affected industries as well as the recommended practices of industry trade associations and standards-setting organizations.

For this technological feasibility analysis, OSHA grouped establishments by indoor work settings based on the similarity of worker exposure sources (i.e., equipment or processes that generate heat versus ambient heat) and outdoor work settings, including mobile or transient sites, with exposure primarily to ambient heat and heat-generating processes. These work settings, and examples of occupations found in these settings, are outlined in table IX-1 below.

Table IX-1 Facility Types Analyzed in OSHA's Preliminary Technological Feasibility Analysis		
Work Setting	**Heat Source**	**Example Facility Types / Occupations**
Indoors	Heat Generating Processes	• Commercial Laundry and Drycleaning • Commercial Kitchens • Foundries • Manufacturing (Paper Mills, Wood Processing, Chemical Processing)
	Ambient Heat	• Maintenance and Repair Service • Warehouses • Sales Related Industries
Outdoors	Ambient Heat at Fixed Locations	• Airline Ground Workers • Building Material and Equipment Suppliers • Maintenance and Repair Service • Recreation and Amusement • Sales Related Industries
	Ambient Heat at Transient and Mobile Work Sites	• Agriculture, Forestry, and Fishing • Construction • Landscaping and Facilities Support • Logging/Forestry • Oil and Gas Extraction and Support Service • Postal and Delivery Services • Sanitation and Waste Removal • Transportation (Land, Water, and Rail), including Scenic and Sightseeing • Telecommunications and Utility Workers
	Heat Generating Processes	• Asphalt Paving • Cement Kilns

C. Environmental Monitoring.

The proposed rule includes requirements for employers to monitor environmental conditions in order to determine whether certain controls to protect employees exposed to heat at or above the trigger level, expressed in terms of heat index or wet bulb globe temperature (WBGT), need to be implemented. The proposed rule also requires employers utilizing fans in indoor work areas or break areas to identify any such areas where the ambient temperature (AT) exceeds 102°F in order to evaluate whether fan use may be harmful. As part of OSHA's assessment of the technological feasibility of these proposed requirements, the agency must determine whether available methods exist for measuring heat index, WBGT, and AT. As explained below, all three metrics can be monitored via instruments currently on the market.

I. Heat Index.

Heat Index (HI) is meant to reflect the temperature that the body "feels," by combining ambient temperature and either dew point temperature, or more commonly relative humidity (RH) (Anderson et al., 2013; NWS, 2024c; Steadman, 1979). The underlying formula for heat index is complex and uses several assumptions, including human body mass and height, clothing, amount of physical activity, individual heat tolerance, sunlight and ultraviolet radiation exposure, and wind speed. In the HI formula, the coefficients have been determined through empirical studies and mathematical modeling to approximate how humidity influences the effect of temperature. Different coefficients can vary depending on the unit of temperature and the formula might differ slightly between regions or meteorological agencies.

While calculating HI involves a fairly complex equation, methods for determining the HI using the ambient temperature (AT) and RH are widely available and simple to use. The most accurate way to determine the HI at work sites is through the use of direct read monitoring devices. These types of devices are readily available on the market (ERG, 2024b). The handheld devices, commonly called heat-stress monitors or heat index monitors, measure the AT, RH, and dew point, and provide the HI. These devices provide real-time, on-site measurements and can be used both indoors and outdoors. Conversely employers could use psychrometers and thermometers to measure AT and RH, then calculate the HI using any of the tools described below. Both psychrometers and thermometers are available in digital and analog versions. For outdoor work sites, employers could also use local forecast weather data to obtain the AT and RH. This information can then be used to estimate the HI for a particular location using available charts and calculators. However, because local forecast conditions may not reflect actual working conditions indoors, OSHA is not proposing to permit the use of forecast data to determine indoor HI.

The National Weather Service (NWS) has two charts available on their website which employers can use to determine the HI, the Heat Index Chart and the Heat Index Chart for Low Humidity Locations.[135] The Heat Index Charts can be used for environments with RH ranging from 5% to 100%. To find the HI using the chart the employer must first determine the AT and RH. The HI is located in the cell where the two values meet on the chart. The National Weather Service (NWS) also has a calculator available on their website that allows users to calculate HI by entering in the temperature and humidity or dew point.[136] However, this calculator notes that results using temperatures and RH outside of the range of the NWS heat index chart may not be accurate.

Another way employers can determine the HI is through the OSHA-NIOSH Heat Safety Tool,[137] which allows users to access HI data from a mobile phone. The Heat Safety Tool pulls hourly forecasts specific to the inputted outdoor location from the NWS to estimate the local heat index. This tool is available for both Android and Apple mobile devices and can be downloaded from the app stores, as well as the OSHA website. As previously mentioned, while the tool is useful for outdoor work environments, local weather data may not accurately reflect indoor working conditions or situations where heat is also generated as part of the work process.

OSHA has preliminarily concluded that conducting exposure assessments to determine the HI is technologically feasible for most operations, most of the time.[138] HI is simple, easy-to-understand, and easily accessible. For indoor workplaces employers will need to take on-site measurements to determine the HI. This can be done using either

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[135] The NWS charts contain risk categories that may not align with the proposed rule as OSHA is not relying on the risk categories noted in the chart.
[136] *https://www.wpc.ncep.noaa.gov/html/heatindex.shtml.*
[137] *https://www.osha.gov/heat/heat-app.*
[138] OSHA notes that Oregon currently uses HI thresholds in its state standard, which is further evidence that the measurements are feasible. OR Admin. Code 437-002-0156 (indoor and outdoor) and 437-004-1131 (agriculture).

direct reading instruments currently on the market or by measuring AT and RH with psychrometers and thermometers and using charts or online calculators to calculate the HI. OSHA seeks additional information and comments on the feasibility of measuring HI in different environments, including indoor environments and where heat-generating processes occur.

II. Wet Bulb Globe Temperature (WBGT).

WBGT is a measure of heat exposure that incorporates the impact of sunlight and wind, in addition to temperature and humidity. It was derived in the 1950s to track exposure and limit heat-related illness (HRI) among the U.S. Armed Services (Budd, 2008). WBGT is calculated as the weighted average of globe temperature, wet bulb temperature, and dry bulb temperature, and accounts for AT, RH, wind speed, and solar radiation. WBGTs are measured with specialized equipment currently available on the market.

Indeed, both NIOSH REL's and ACGIH TLV's for heat stress are based on WBGT readings. Also, OSHA currently collects WBGT readings during inspections to evaluate the potential hazard from exposure to heat in accordance with procedures for performing workplace assessments in the OSHA Technical Manual (OTM), section III., chapter 4.

A standard WBGT instrument has a 0.15-meter, or 6-inch, black globe to measure globe temperature and a wetted thermometer to measure the natural wet bulb temperature (Budd, 2008). Various WBGT monitors have been developed, many of which use a smaller black globe and/or a relative humidity sensor in place of a wetted thermometer. Relative humidity measurements are used to calculate wet bulb temperature based on psychometric principles. Some well-known WBGT monitors include the QUESTemp series by TSI and smaller handheld devices such as that made by Kestrel (ERG, 2024b).

Although several accurate WBGT monitoring devices are available, OSHA notes that some lower-cost devices may not be sufficient to accurately measure employees' heat exposure. Non-standard monitors can be found for a lower cost, but they may not fully align with traditional WBGT thermometer measurements. Some devices may be designed to be more conservative in their measurements than others. In a review of WBGT, Budd (2008) identified key limitations of this standard equipment to measure WBGT. Four of the main concerns were inconsistent equilibration times, insufficiently robust calibration procedures, and the use of non-standard globe thermometers and natural wet bulb thermometers. Smaller bulbs typically result in shorter equilibration times, which make readings more sensitive to short-term changes in environmental conditions than larger bulbs. However, few peer-reviewed studies have been published evaluating these potential sources of error and OSHA anticipates technology has likely improved since Budd's evaluation in 2008. Given these technical considerations—including equilibration times and the need for robust calibration procedures—the use of WBGT on-site will require training to properly operate. The extent of the training would vary depending on the type of monitor.

OSHA has preliminarily determined that instruments to accurately monitor WBGT are commercially available. OSHA seeks additional comments on the use of WBGT and to identify situations in which WBGT would or would not be practical or pose challenges for employers to measure.

III. Ambient Temperature (AT).

AT is the air temperature measured using a thermometer. The primary types of thermometers used for measuring AT are liquid-in-glass thermometers, electrical thermocouples, and resistance thermometers (thermistors). Each of these types of thermometers are commercially available in a wide variety of designs. The States with permanent outdoor occupational heat standards, California and Washington, currently use

fixed value thresholds of AT, further indicating the feasibility of this metric (California Occupational Safety & Health Administration, 8 CCR 3395; Washington Division of Occupational Safety and Health, WA Admin. Code 296-62-095). Based on the widespread public availability of thermometers to measure AT, OSHA has preliminarily determined that it is technologically feasible for employers to assess AT in their workplace.

IV. Preliminary Findings on Environmental Monitoring.

Several different types of instruments and methods to determine the Heat Index and WBGT are commercially available. These include the Kestrel and QuesTemp currently used by OSHA, in addition to various mobile device applications supported by NWS and NIOSH. At outdoor work sites, employers have the option of tracking local heat index forecasts provided by the NWS or other reputable sources in lieu of measuring for Heat Index or WBGT. In addition, thermometers to measure AT are widely available. Because the technology necessary to comply with the proposed standard currently exists and is commercially available, OSHA preliminarily concludes that the proposed standard's monitoring requirements are technologically feasible.

D. Engineering Controls.

Engineering controls are measures that reduce, isolate, or remove a hazard from the workplace. These engineering controls can be used to reduce exposure to heat without relying on changes in employee behavior. Therefore, engineering controls are often the most effective type of control to address workplace hazards and can also be a cost-effective layer of protection. The following are some examples of engineering controls that may reduce heat stress:

- Use air-conditioning,
- Increase general ventilation,

- Provide cooling fans,[139]
- Run local exhaust ventilation where heat is produced (e.g., laundry vents),
- Use reflective shields to block radiant heat,
- Insulate hot surfaces (e.g., furnace walls),
- Stop leaking steam,
- Provide shade for outdoor work sites.

Under the proposed standard, when exposures to heat exceed specified triggers, employers must implement feasible controls to reduce employee's exposures to heat. The requirements for the use of engineering controls differ based on the location of work, whether indoors or outdoors. For indoor work sites, employers are required to provide a break area and ensure that work areas exceeding the trigger are equipped with air-conditioning, fans and ventilation, or in the case of radiant heat, other controls to reduce heat exposure. For outdoor work sites, employers are required to provide a break area with either shade or air-conditioning.

I. Workers Exposed to Heat Generating Process.

As shown in Table IX-1—Facility Types Analyzed in OSHA's Preliminary Technological Feasibility Analysis, employees in both indoor and outdoor work operations can be exposed to heat from work processes. Radiant heat can be generated by equipment and processes such as, but not limited to, cement kilns, asphalt paving equipment, commercial laundry machines, ovens in kitchen and bakery operations, foundries and other furnaces, and steam pipes. Under the proposed rule, OSHA is requiring employers to cool each indoor work area using either controls that increase evaporative heat loss from the worker (such as air-conditioning or fans) or through controls that remove the worker's exposure to radiant heat in the workspace. Because

[139] It should be noted that under certain conditions the use of fans may contribute to heat strain (Morris, 2021). See further discussion in the *Explanation of Proposed Requirements* for paragraph (e)(6), Evaluation of fan use.

OSHA anticipates that the use of fans, dehumidifiers, and air-conditioning to control exposures from heat generating processes will be implemented in a similar manner to those controlling for ambient temperature exposures, the discussion on feasibility of those controls is contained in Section IX.D.II.A, Indoor Workspaces. OSHA requests comments on the appropriateness of this determination and seeks information on situations where the use of fans and air-conditioning would differ.

The engineering approaches to controlling radiant heat gain to the worker can be divided into two categories, those that reduce the amount of radiant heat in the workspace or those that shield the worker from the radiant heat source itself. Researchers suggest the following actions for reducing radiant heat exposures: interpose line-of-sight barriers; insulation, reflective shield and/or metallic reflecting screen, heat reflective clothing; mechanical ventilation (fans, blowers, chillers, etc.), air-conditioning where possible, and locating hot process away from work areas (NIOSH, 2016; Chesson, 2012).

Reducing radiant heat in the workspaces typically requires at least one of the following actions: lowering the process temperature, which may not be compatible with the temperature requirement of the manufacturing processes; relocating or isolating the heat source; insulating or cooling the heat source; or changing the emissivity of the hot surface by coating the material. Engineering controls for shielding the work from the radiant heat requires placing line-of-sight radiant reflective barriers or shielding between the heat source and the worker.

Of these control methods, radiant reflective shielding is generally the easiest to install. NIOSH notes that radiant reflective shielding can reduce the radiant heat load by as much as 80% to 85% (NIOSH, 2016). Employers who choose to install shielding will need to consider work process flows so that placement does not interfere with the work. Remotely operated tongs, metal chain screens, or air or hydraulically activated doors that are opened only as needed are some of the possibilities.

Isolating the source could involve construction of walls or other containment around hot equipment or process such as erecting barriers around a kiln that control heat transfer to nearby work areas (NIOSH, 2016). Morris et al. noted that "investigations into reducing the solar (radiative) heat load on workers is promising, revealing that work capacity can be more than doubled with the removal of an external radiative load," and further explained that radiation screens can be used within manufacturing shops to shield workers from heat originating from hot machinery (Morris et al., 2020). Another example of isolating the source would be installing insulation around pipes and similar equipment in the workplace that emits heat. Similarly, because leaks from steam valves and steam lines in manufacturing processes can contribute to heat stress by increasing water vapor in the air, eliminating these sources of water vapor can help reduce the overall vapor pressure in the air and thereby increase evaporative heat loss by facilitating the rate of evaporation of sweat from the skin (NIOSH, 2016). OSHA requests comments and data on other methods employers have utilized to isolate radiant heat from heat-generating processes.

Examples of waste heat recovery technology include recovery of heat from steam through condensation that would otherwise be released into the workspace. Heat recovery systems improve energy efficiency by utilizing heat transfer from hot liquids or gases and recover heat that would otherwise go to waste. Some commercial building ventilation systems use heat exchangers to transfer heat from exhaust air to the fresh intake air (NIOSH, 2016).

With regards to modifying the process or operation, OSHA notes that lowering the process temperature may not be compatible with process requirements. However, there might be ways of using materials with lower melting points or chemicals with faster curing times thereby reducing overall radiant heat production. This might also include

modifying the process and work practices by limiting the time required to complete certain tasks or automating certain tasks, such as collecting samples.

Table IX-2 Heat Generating Process Controls	
Controls	**Examples**
Local exhaust ventilation (LEV) at heat-generating sources	• LEV designed and installed at points of high heat or moisture production (such as exhaust hoods in laundry rooms or steam presses, commercial kitchen exhaust hoods). • Similar to LEV used to capture air contaminants. Dampeners and hood vary depending on moisture level of air.

Installation of waste heat recovery technology	• Used with LEV to convert heat to energy that is fed back into the system.
	  ○ Regenerative and recuperative burners: Capture and use the waste heat from the hot flue gas from the combustion process.
	  ○ Tube heat exchangers: Recover low to medium waste heat are mainly used for heating liquids.

Isolating the source of radiant heat	• Process enclosures around heat producing components. • Containment of heat producing equipment in rooms without workers.

Shielding or barriers that are radiant-reflecting or heat-absorbing	• Shielding to stop radiant heat from reaching workstations.
	  ○ Reflective Shield: Stainless steel, aluminum or other bright metal surfaces reflect heat back towards the source.
	  ○ Absorbent shields: Water-cooled jackets made of black-surfaced aluminum absorb and carry away heat.

Thermal insulation on hot surfaces (e.g., steam pipes)	• Reducing the radiant heat emission from hot surfaces.
	  ○ Covering hot surfaces with sheets of low emissivity material or paint that reduces the amount of heat radiated from this hot surface into the workplace.
	• Insulating Hot Surfaces.
	  ○ Insulation reduces the heat exchange between the source of heat and the work environment.

Increasing the distance between workers and the heat source	• Moving the workstation further away from the heat source. • Repositioning controls a cooler location.

A. Preliminary Feasibility Finding for Heat Generating Processes.

The proposed rule does not specify which of the engineering controls must be used for indoor workplaces. It only requires that employers implement other measures that reduce employee exposure to radiant heat in the work area as an alternative option to the use of fans or air-conditioning. OSHA has preliminarily determined that there are a

number of technologically feasible engineering controls available to employers. Employers are free to choose any combination that effectively reduces exposures. Based on the discussion above, OSHA has preliminarily determined that there are no technological hurdles to compliance with this requirement for indoor workplaces.

OSHA acknowledges the limited information available on working outdoors near heat generating processes. OSHA seeks information and data on whether and under what circumstances the control options used to reduce exposure to radiant heat in indoor work areas might also be feasible for outdoor work settings.

II. Workers exposed to Ambient Heat.

A. Indoor Workplaces.

Employees in indoor workplaces, such as maintenance facilities, and warehousing, can be exposed to HRIs when ambient temperatures increase. See Table IX-1—Facility Types Analyzed in OSHA's Preliminary Technological Feasibility Analysis. Due to factors such as building materials, insulation, and reduced air movement, the air temperatures in indoor workplaces without air-conditioning can in some cases exceed the temperature outdoors. The proposed rule would require that employers reduce these exposures by utilizing controls to cool the work area and provide a break area that is air-conditioned or has an alternate means of providing air movement and, if appropriate, humidity control to promote evaporative and convective cooling.

In response to the advance notice of proposed rulemaking (ANPRM) and previous Requests for Information (RFI), OSHA received numerous comments on the use of engineering controls for preventing heat-related injury and illness in both indoor and outdoor work settings. The most mentioned engineering controls were the provision of air-conditioning, fans, swamp coolers (i.e., evaporative coolers), portable air-conditioners, access to air-conditioned zones, air-conditioned tents/trailers and shaded areas. (e.g., Document ID 0094; 0206; 0278, Att. 1; 0392; 0448, Att. 1; 0523, Att. 1;

0551; 0562; 0588; 0610, Att. 1; 0637, Att. 1: 0679, Att. 1). Some commenters mentioned specific types of devices that could be used, such as portable air-conditioning units and evaporative coolers. (e.g., Document ID 0445; 0595, Att. 1; 0612, Att. 1). For preventing humid working conditions, commenters suggested the use of dehumidifiers. (Document ID 0661, Att. 1). OSHA discusses of the feasibility of these controls below.

Some commenters suggested other controls, such as architectural controls like altering roofs to reflect solar radiation using reflective materials, green roofs, rooftop sprinklers, or painting roofs white. Also suggested was the use of light-colored building material, green infrastructure, pervious pavements, external awnings, and window coverings to aid in mitigating indoor heat. While OSHA understands that the use of these controls may assist an employer in reducing ambient heat exposures in the workplace, this analysis focuses on the engineering controls outlined specifically in the regulatory text of the proposed rule. OSHA notes, however, that the proposed standard does not prohibit the use of other controls in addition those specified in the standard.

I. Air-Conditioning.

Air-conditioning is one of the options to control heat in the workplace and is the most effective way to reduce heat strain because it reduces the heat exposure directly (Day et al., 2019; Jay et al., 2019; Morris et al., 2020; Morrissey et al., 2021b). Air-conditioning technology is widely available and currently in use in many workplaces. However, OSHA understands that the use of air-conditioning to address heat hazards may not be practical in all occupational settings, such as outdoors or in large factories, and alternative control strategies need to be implemented (Foster et al., 2020; Mekjavic et al., n.d.; Morris et al., 2020).

HEAT-SHIELD, a research program funded by the European Union, evaluated strategies for the reduction of heat illness in the manufacturing industry (Mekjavic et al., n.d.). Researchers from the Heat Shield project successfully implemented several heat

stress mitigating strategies within a manufacturing plant producing automobile rear lights. To aid in enhanced evaporative heat loss by the workers, the production hall was fitted with a system of ducts to increase the cooling air flow to the production hall and local workstations. The ducts were installed so that the air flow in the plant could be individually adjusted at the local workstations; alternatively, individual workers could also use an electrical fan in proximity to their workstation to increase the air flow (Mekjavic et al., n.d.). The study does not indicate what method of cooling was used to cool the air provided (conditioned, evaporative cooling, etc.). However, OSHA believes that similar designs could be implemented in manufacturing facilities using conditioned air.

In response to the ANPRM, some commenters stated that temperature controls or air-conditioning systems are not feasible in many industrial settings and in large industrial plants that include tens of thousands of square feet of floor space, specifically foundries, forge shops, and other workplaces with hot work processes (e.g., Document ID 0277). Bakeries and dairy product manufacturers were specifically mentioned as having unique circumstances because of the need to offset carbon monoxide and heat emitted during the baking or production process for employee safety, and due to food safety concerns (Document ID 0699, Att. 1). Another commenter added that environmental temperature controls may not be feasible in some areas that are designed to be open or partially open to the outside. Installing air-conditioning in all work areas would not be physically possible and could be cost prohibitive (Document ID 0657, Att. 1; 0684, Att. 1; 710, Att. 1; 0724, Att. 1). This sentiment was also echoed in available literature. Mekjavic et al. noted that due to design elements of some manufacturing facilities, such as minimal insulation, the economic burden renders the installation of facility wide air-conditioning as not possible (Mekjavic et al., n.d.). OSHA understands this concern and

is therefore not requiring all employers to install air-conditioning throughout their facility.

However, OSHA recognizes that air-conditioning can be installed in some indoor locations and is effective at reducing the exposure to ambient heat in the workplace. A feasibility study presented at the 10th International Livestock Environment Symposium compared the costs and benefits of air-conditioning to an evaporative cooling system in a large dairy barn (measuring 43.3m by 25.6m) (Li et al., 2018). The researchers simulated summer conditions in barns across Tampa, FL; Sacramento, CA; Syracuse, NY; and Madison, WI. They determined that air-conditioning was capable of maintaining maximum indoor temperatures of 23°C to 27.4°C (74.3°F to 81.3°F) (Li et al., 2018).

Another study conducted by Morrissey et al. (2021b) provided a flow chart for selecting appropriate heat controls and included air-conditioning as a recommended option for all work sites with access to power. Anderson and Souza (2017) specifically identify air-conditioning (i.e., bulk air cooling, spot air coolers, and air-conditioned cabins) as a heat management strategy for underground mines. In addition, several commenters on the ANPRM noted that some indoor facilities do provide areas for employees to take breaks in temperature-controlled environments, indicating that an air-conditioned break area is capable of being installed for cooling in indoor work environments (Document ID 0612, p. 2; 0680, p. 10; 0691, pp. 10-11; 0777, Att. 2, p. 33; 1071, p. 2; 1072, pp. 1, 4).

Despite common statements of its efficacy in review articles and studies, air-conditioning as a control to reduce heat exposure at the workplace is not commonly evaluated in the occupational setting. It is unclear if the very definition of air-conditioning (an approach that directly removes heat) or feasibility limitations might explain the limited nature of this body of literature. Therefore, OSHA is seeking

information regarding the current use of air-conditioning in the industries covered under the scope of the rulemaking.

II. Humidity Control.

For indoor work sites, OSHA is proposing to require employers who do not provide air-conditioned break areas or workspaces to implement humidity control (when appropriate) in conjunction with some form of air movement in those spaces. An article by D. Jeff Burton, P.E. CIH, published in the Occupational Health and Safety magazine reviewed the use of dehumidification to maintain acceptable indoor air quality in occupational settings (Burton, 2006). In addition to dehumidification approaches utilizing existing HVAC systems, the article noted that stand-alone dehumidifiers are commercially available and can be used where HVAC systems do not effectively control humidity (Burton, 2006). Indeed, OSHA expects that in most cases employers will use one of the many stand-alone dehumidifier models on the market to achieve the humidity control required by the proposed standard. In addition, in facilities with processes that produce moisture, exhaust systems can often be used to remove moist air and eliminate humidity gain.

III. Fans.

Another engineering control identified by OSHA is the use of fans to help circulate air. Fans do not necessarily lower temperature but can make it easier for the body to dissipate heat. Depending on the work setting, fans can be used before work, during work, or during rest breaks. Information contained in the rulemaking docket indicates fans can be easily implemented in a variety of work environments. Large ceiling fans can be installed to increase air movement. In certain facilities, pedestal fans can be used to provide air movement at workstations. Some commenters mentioned that they use fans for air circulation in indoor facilities (e.g., Document ID 0277, 0283). During the SBREFA hearings, one SER reported that they open the doors in the mornings and use

large ceiling fans to draw cooler air into the building, and then shut the doors in the afternoons to reduce the infiltration of hot outside air into the building. (Document ID 1081, p. 29).

Several studies evaluated by OSHA indicate that fan usage in industrial settings is prevalent. A recent J. J. Keller Center for Market Insights Pulse Poll indicates that 65% of employers provide fans, ventilation, or reflective shields to help control exposures to heat stress (JJ Keller, 2022).

As mentioned above, HEAT-SHIELD evaluated strategies for the reduction of heat illness in the manufacturing industry (Mekjavic et al., n.d.). To aid in enhanced evaporative heat loss by the workers, the production hall was fitted with a system of ducts to increase the cooling air flow to the production hall and local workstations. In addition, some workers utilized electrical fans in proximity to their individual workstations to increase the air flow (Mekjavic et al., n.d.).

A 2021 study by Morris et al. determined that facilitated ventilation, through the use of electric fans, supports convective and/or evaporative heat loss and lowers occupational heat strain at a considerably lower operation and production cost compared to air-conditioning. The authors noted that fans were also easier to personalize cooling by directing air flow towards specific workers, rather than cooling an entire area; they could be transported to remote workspaces and could be used both during work and at specific cooling areas where workers take intermittent cooling breaks (Morris et al., 2021).

Fans have even been incorporated into chairs as demonstrated by Watanabe et al. (2009). In this study, researchers evaluated thermal comfort using chairs with attached fans under various climactic conditions, while participants performed light office tasks such as word processing. One control chair and two “fan chair” designs were assessed; each “fan chair” had a fan under the seat and behind the backrest and received a positive response from the worker. Morris et al. (2020) also noted the relevance of chair fans,

stating that "miniature electrical fans could be incorporated into chairs, for seated workers, to deliver effective cooling while minimizing disturbances to the work environment" (Morris et al., 2020).

There is an additional body of research investigating fans as a heat control in large dairy barns due to the sensitivity of cow productivity to heat stress. Although not directly applicable to HRI reduction in humans, as with air-conditioning described above, this research provides insight into the extent to which industrial fans can be installed in large barn or warehouse-like structures (Calegari et al., 2012; Correa-Calderon et al., 2004; Davidson et al., 2021; Drwencke et al., 2020; Ortiz et al., 2010; Shiao et al., 2011; Urdaz et al., 2006).

Evidence of the existing use of fans in occupational settings can be seen in existing State requirements and in some collective bargaining agreements. For example, Minnesota's standard governing indoor ventilation and temperature includes a provision for providing indoor ventilation and acceptable temperature ranges in places of employment to prevent employee exposure to indoor environmental heat conditions (MN Admin. Code 5205.0110). In addition, comments from the Teamsters in response to the ANPRM included examples of collective bargaining agreements that demonstrate steps employers have taken to address occupational HRIs (Document ID 0707, pp. 14-17). Items included provisions for work area ventilation when the plant is hot and the installation of fans to reduce excess heat or humidity in work rooms. Employers covered under these agreements may already be in compliance with some of the requirements of the proposal.

Although fan use can be effective at reducing heat stress, fans may introduce additional hazards in some workplaces due to the increase in air movement. In indoor settings where air contamination is a concern, the use of fans may interfere with existing ventilation and increase worker exposure to hazards. OSHA acknowledges that in some

cases, the work site may need to be evaluated to ensure that the use of fans does not interfere with existing ventilation designed for the control of dust and other air contaminants. OSHA seeks comments on work settings where the use of fans is not feasible due to contamination concerns and requests additional information on what controls, including the use of air-conditioning, employers use to prevent heat-related illnesses in these settings.

In addition, research has shown that under certain conditions (e.g., high temperatures), fan use can increase the hazard of heat strain. See Section V.C., Risk Reduction for a more detailed discussion of fan use alone during elevated temperature events. OSHA requests comments on indoor work settings that may experience temperatures above 102°F and seeks information on what controls employers implement when fan use is contraindicated or when temperatures exceed 102°F.

IV. Evaporative Coolers.

Another engineering control, evaporative coolers, work by using a fan to pass air over a pad or ceramic surface saturated with water. The evaporation of the water reduces the air temperature. In warm dry climates, evaporative coolers can be used to lower air temperatures as much as 20°F (USGS). They consume much less energy than air-conditioning and can be used in buildings with openings to the outside. However, because evaporative coolers cool through increasing air humidity, they are not as effective at relative humidity above 60%.

A NIOSH Health Hazard Evaluation (HHE) conducted in September 2006 demonstrates the feasibility of evaporative cooler use in indoor workspaces. The evaluation was conducted at a glass manufacturing facility in Indiana. In the hot end of the glass-making process, raw materials (recycled glass, sand, soda ash, and limestone) were melted together in a gas furnace at temperatures of 2,300°F to 2,800°F (Dowell & Tapp, 2007). The company used various controls in the hot end of the plant during the hot

summer months to reduce the risk of heat-related illness. The controls included fans which supplied cooler air from the basement of the facility (man coolers), and evaporative cooling fans (swamp coolers) (Dowell & Tapp, 2007).

Furthermore, portable evaporative coolers are also commercially available for use expanding the ability for implementation in various work settings. These coolers can lower air temperatures by up to 18°C (33°F) and cover up to 6,500 sq ft area, requiring only a power outlet and water supply.

V. Preliminary Feasibility Finding for Indoor Workplaces.

OSHA has determined that requirements for the use of engineering controls indoors under the proposed standard are technologically feasible for most operations, most of the time. For break areas, the proposed rule allows employers to utilize available air-conditioning systems or a combination of air movement and humidity control to promote evaporative cooling. The latter can be achieved with widely available fans and humidity control devices. For indoor work areas, OSHA has provided the employer with multiple control options for compliance with the proposed rule, allowing them to tailor the controls to the individual workplaces. Information obtained through the SBREFA process, comments, and research into existing control use indicate that many employers are already utilizing some combination of the required control options. OSHA seeks additional comments on its assumptions and other control options for these workers. Based on the discussion above, OSHA has determined that there are no technological hurdles to compliance with this requirement in the proposed rule.

B. Outdoor Workplaces.

For outdoor workplaces, the primary sources of exposure to heat hazards are ambient heat and direct sunlight. Under the proposed rule, OSHA is requiring employers to provide a break area with shade or air-conditioning.

I. Shade.

As discussed in Section V., Risk Assessment, access to shade can reduce the risk of HRI by decreasing exposure to solar radiation and, in turn, reducing overall heat load. Research has found that total heat exchange is greater in shaded conditions than sunny conditions (Otani et al., 2021), indicating that access to shaded areas may reduce HRI. For outdoor workers exposed to direct sunlight, a commonly used engineering control is the use of a shelter or canopy to provide a shaded area for rest breaks. A wide variety of portable pop-up canopies are commercially available that can be easily set up and moved around for mobile work sites. Note that the proposed rule would not allow mobile equipment or machinery to be used to provide shade for rest breaks due to the potential safety hazards from unintended or accidental start up and movement of the equipment and the potential for equipment to release radiant heat.

Working or resting in the shade can reduce the risk of HRI by decreasing exposure to solar radiation and reducing overall heat load. This control is applicable to all outdoor industries and is a key component of OSHA's "Water. Rest. Shade." Heat Campaign guidance. The feasibility of providing shade for rest periods is demonstrated by OSHA enforcement data. During inspections conducted under the 2023 Heat National Emphasis Program, OSHA Compliance Officers completed a questionnaire regarding work site conditions. Over 1,300 responses were received indicating that 96% of employers inspected provided access to cool shaded areas (OSHA, 2023b). Several States, including California, Oregon, Colorado and Washington, have also incorporated requirements to provide shade into their heat-specific standards.[140] While the scope of coverage varies by State, these standards require employers to provide workers with shade structures for rest breaks to recover from the heat. In addition, Maryland and Nevada proposed rules that would also require employers to provide access to shade.[141]

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[140] (CA 8 CCR 3395; OR Admin. Code 437-002-0156 and 437-004-1131; CO 7 CCR 1103-15:3; and WA Admin. Code 296-62-09535).

[141] Maryland COMAR 09.12.32; and Nevada Proposed Regulation LCB File No. R053-20.

The addition of shaded break areas has been demonstrated as an integral part of a heat health plan to improve worker performance in the agricultural sector (Bodin et al., 2016; Morris et al., 2020; Glaser et al., 2022). Bodin et al. (2016) implemented a water, rest, and shade campaign with 56 Salvadoran sugarcane workers two months into the harvest season. Workers were provided a canopy for shaded breaks, insulated water bladders, and fixed break times. A qualitative study of the intervention reported consistent use of the shaded canopies and high worker satisfaction. A similar study of sugar cane workers conducted in 2022 indicated that workers were provided with break periods under adequate natural shade or tents that were designed to be moved easily to accompany the mobile workforce throughout each day. Tents were constructed from a netted fabric, open on two sides to provide adequate ventilation, and provided with stools for seated, shaded rest (Glaser et al., 2022).

OSHA acknowledges that providing stationary shading outdoors may be difficult in some settings, particularly where work crews are highly mobile, such as in agricultural work. Even so, several studies indicate the widespread use of shade among agricultural workers. Fleischer et al. (2013) conducted a cross-sectional survey on HRI symptoms and working conditions in Georgia in 2011. Of the 405 farmworkers who completed the survey, 27% reported not having access to shade, indicating that some form of shade is available in the majority of these work environments. A study by Bethel et al. (2017) comparing conditions for outdoor agricultural workers in Oregon and Washington found that workers in Oregon more frequently reported the presence of shade structures[142] and workers in Washington more often reported access to shade from trees[143]. In Oregon, workers more frequently reported using shade structures and cars with air-conditioning

[142] 29% use in Oregon vs. 5% in Washington.
[143] 92% in Washington vs. 47% in Oregon.

compared with workers in Washington[144]. However, the study was subject to several limitations. First, different methods of data collection were used in Oregon and Washington, which could have led to information bias. Participants in Washington completed a self-administered survey on touchscreen tablets at the work site, whereas participants in Oregon completed a personal interview administered by research staff at the housing facility. Second, participants were recruited differently in the two States, via outreach workers in Oregon and via employers and supervisors in Washington. Next, the conditions in which participants in the two States worked were vastly different. Specifically, participants in Washington primarily picked tree fruit in orchard settings, which provided a natural form of shade, whereas participants in Oregon primarily harvested blueberries with little shade (Bethel et al., 2017).

The Fair Food Program is a partnership between growers and agriculture workers that includes safety and health standards which require participating employers to provide shade, water, bathrooms, and rest breaks. According to their 2021 report, 100% of Participating Growers have purchased and distributed shade structures to their crews, and they have observed steady increases in the quality of shade units at many growers' operations, including custom designs built to withstand field conditions. (Fair Foods Standards Council, 2021)

During the SBREFA hearings, some SERs with outdoor settings reported using engineering controls such as natural shade (e.g., trees and dense vegetation), pop-up canopies, umbrellas, and portable shades. Some SERs with outdoor settings said they believed some engineering controls including shade and fans were infeasible for their workplace. (Document ID 1081, p. 30).

II. Air-Conditioning for outdoor workers.

[144] In Oregon, 26% of workers reported using shade structures and 14% used cars with air conditioning, compared to 3% and 6% (respectively) in Washington.

Access to air-conditioning for outdoor work settings is primarily provided through the use of vehicles, trailers, and near-by buildings. OSHA understands that the use of air-conditioning has limited applications for outdoor workplaces. However, evidence in the docket indicates that it is feasible for a variety of outdoor situations.

A 2018 study by Methner and Eisenberg evaluated the risk of HRI for employees engaged in strenuous work in an extremely hot outdoor environment, a park during summer months. Worker tasks included landscaping, demolition, and bricklaying. Park policy included the use of motor vehicles with air-conditioning as a cool-down area for breaks in remote locations where access to cooled buildings was limited (Methner and Eisenberg, 2018). As mentioned above Bethel et al. (2017) found that some workers in Oregon and Washington have access to cars with air-conditioning (14% vs. 3%).

The use of portable air-conditioning units and vehicles with air-conditioning for cooling is also supported by multiple ANPRM commentors. In response to OSHA's request for information on control options for outdoor work, the City of Phoenix commented that portable air-conditioning units are available and have received positive responses from employees. The International Brotherhood of Electrical Workers (IBEW), AFL-CIO also indicated that employees in the utilities industry use a wide variety of cooling methods including air-conditioning in trucks or trailers.

During the SBREFA hearings, many SERs with outdoor work settings reported having air-conditioned vehicles or trailers on site that workers can use to cool down. When SERs were polled at two sessions, September 12th and 13th, on the types of engineering controls that are used "to mitigate the impact of heat exposure to employees that work outdoors," two-thirds (66.7%) of the 30 responders reported using an "air-conditioned space." (Document ID 1081, p. 30).

OSHA requests comments on additional ways employers have utilized air-conditioning for outdoor workers and obstacles encountered, if any.

III. Preliminary Feasibility Finding for Outdoor Workplaces.

OSHA has preliminarily determined that requirements for the use of engineering controls for outdoor break areas under the proposed standard are technologically feasible for most operations, most of the time. Information obtained through the SBREFA process, comments, and research into existing control use indicate that many employers are already utilizing some form of shade or air-conditioned space for employee cooling. For those remaining employers, OSHA anticipates they can quickly come into compliance through the implementation of shade or air-conditioned vehicles, trailers and other spaces, as described above. OSHA seeks additional comments on its assumptions and other control options for these workers. Based on the discussion above, OSHA has determined that there are no technological hurdles to compliance with this requirement.

C. Mobile Workplaces.

Options for the use of engineering controls for mobile work sites where the work is not performed at a fixed location are similar to other outdoor work sites. Portable canopies can be used to provide a shaded area for breaks. Where electricity is available, trailers with air-conditioning can be used as cool-down areas for rest breaks. Air-conditioned vehicle cabs can also be used.

OSHA found several examples in which employers agreed to provide shade for outdoor workers as part of contract negotiations around working conditions. As previously mentioned, the Teamsters submitted comments on the ANPRM that included examples of language from collective bargaining agreements demonstrating steps employers have taken to address occupational HRIs. Language included requirements for construction drivers, employees suffering from heat illness believing a preventative recovery period is needed or feeling the need to protect themselves from overheating, are required to be provided access to an area with shade that is either open to the air or

provided with ventilation for a period of no less than five minutes (Document ID 0707, p. 16).

I. Preliminary Feasibility Finding for Mobile Workplaces.

OSHA has preliminarily determined that there are no technological hurdles for the implementation of controls for workers with mobile work sites. Based on the discussion above, OSHA has preliminarily determined that it is technologically feasible, using commercially available products and technology, for employers with mobile work sites to provide workers with shaded or air-conditioned break areas. OSHA seeks comment on this determination and additional data and information on other feasible control options available for these mobile work sites.

E. Preliminary Feasibility Findings.

OSHA has reviewed the requirements that would be imposed by the proposed standard and has determined that achieving compliance with the proposed standard is technologically feasible most of the time, in most of the establishments and operations covered by the standard. As discussed above, the proposed rule is largely programmatic and offers the employer several control options. Under the proposed rule, employers can determine the controls best suited for their unique work environment in order to comply with the requirements for controls at break areas and work areas. Not all practices, procedures, or controls identified in this technological feasibility analysis will be necessary at all establishments: the proposed standard provides flexibility for employers to tailor their procedures, practices, and controls to the needs of their facility based on an assessment specific to that facility. Moreover, readily available and currently used technology is capable of meeting these requirements.

As part of this analysis, OSHA reviewed the heat injury and illness prevention practices currently in place across the affected industries as well as the recommended practices of industry trade associations and standards-setting organizations. On the basis

of current compliance found by OSHA, widespread familiarity with the concepts and procedures contained in the proposed rule, and the availability of control options, OSHA has determined the requirements of the proposed rule are capable of being done by most employers, most of the time and therefore preliminarily determined that compliance with the proposed rule is technologically feasible.

F. Requests for Comments.

OSHA requests comments on the appropriateness of the preliminary determinations contained in this analysis.

Regarding the feasibility of monitoring, OSHA seeks additional comments and information regarding:

- The feasibility of measuring HI in indoor environments and where heat-generating processes occur.
- The use of WBGT including the identification of situations in which WBGT would or would not be practical or pose challenges for employers to measure.

Regarding the feasibility of controls, OSHA seeks additional comments and information on the following:

- Whether there are other controls or technologies that may be available to protect workers against heat hazards.
- The technological feasibility of other engineering control options not discussed here for indoor, outdoor, and mobile work sites.
- The feasibility of dehumidification as a control option for indoor workplaces.
- Areas where employers have determined that isolation of heat producing equipment is not feasible and alternatives employers have utilized to reduce employee exposures.
- The current use of air-conditioning in the industries covered under the scope of the rulemaking.

- Additional ways employers have utilized air-conditioning for outdoor workers and obstacles encountered, if any.
- The current use and application of fans in both indoor and outdoor settings.
- Work settings where the use of fans is not feasible due to contamination concerns and information on what controls, including the use of air-conditioning, employers use to prevent HRIs in these settings.
- Indoor work settings without heat-generating processes that may experience temperatures above 102°F and information on what controls employers implement when fan use is contraindicated or when temperatures exceed 102°F.

X. Additional Requirements

A. Unfunded Mandates Reform Act, 2 U.S.C. 1501 et seq.

OSHA reviewed this proposed rule according to the Unfunded Mandates Reform Act of 1995 (UMRA) (2 U.S.C. 1501 et seq.) and Executive Order 12875 (58 FR 58093). Section 202 of the UMRA, 2 U.S.C. 1532, requires agencies to assess the anticipated costs and benefits of a rule that includes a Federal mandate that may result in expenditures in any one year by State, local, and Tribal governments, in the aggregate, or by the private sector, of at least $100 million, adjusted annually for inflation. In 2024, that threshold is $183 million.

Although OSHA may include compliance costs for affected State Plan governmental entities in its analysis of the expected impacts associated with a proposal, this proposed rule does not place a mandate on State or local government, for purposes of the UMRA. See the discussion below in Section X.H., Federalism.

The OSH Act does not cover Tribal governments in the performance of traditional governmental functions, but it does cover Tribal governments when they engage in activities of a commercial or service character (see *Menominee Tribal Enters. v. Solis*, 601 F.3d 669 (7th Cir. 2010); *Reich v. Mashantucket Sand & Gravel*, 95 F.3d 174, 180

(2nd Cir. 1996)). However, the cost of the proposed rule for these covered activities by a Tribal government would not meet the threshold established in the UMRA. As noted below, OSHA also reviewed this rulemaking in accordance with Executive Order 13175 on Consultation and Coordination with Indian Tribal Governments (65 FR 67249 (November 9, 2000)) and determined that it does not have ‘‘tribal implications’’ as defined in that Executive Order.

Based on the analysis presented in the Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis, Section VIII. of this preamble, OSHA concludes that the proposed rule would impose a Federal mandate on the private sector of $100 million or more annually, adjusted for inflation. The Preliminary Economic Analysis constitutes the written statement containing a qualitative and quantitative assessment of the anticipated costs and benefits required under section 202(a) of the UMRA (2 U.S.C. 1532(a)).

B. Consultation and Coordination with Indian Tribal Governments/Executive Order 13175.

OSHA reviewed this proposed rule in accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 65 FR 67249 (Nov. 6, 2000), and determined that it does not have ‘‘tribal implications’’ as defined in that order. As explained above, the OSH Act does not cover Tribal governments in the performance of traditional governmental functions, so except to the extent a tribe is engaged in activities covered by this proposed rule that would fall outside of a traditional government function (i.e., activities of a commercial or service character), the proposed rule would not have substantial direct effects on one or more Indian tribes in their sovereign capacity, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes (see E.O. 13175 section 1(a)).

Section 5 of the Executive Order requires agencies to consult with Tribal officials early in the process of developing regulations that: (1) have Tribal implications, impose substantial direct compliance costs on Indian governments, and are not required by statute; or (2) have Tribal implications and preempt Tribal law (E.O. 13175 section 5(b), (c)). The Executive Order requires that such consultation occur to the extent practicable.

On May 15, 2024, OSHA held a listening session with Tribal representatives regarding this Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings rulemaking. OSHA provided an overview of the rulemaking effort and sought comment on what, if any, Tribal implications would result from the rulemaking. A summary of the meeting and list of attendees can be viewed in the docket (DOL, 2024a).

C. Consultation with the Advisory Committee on Construction Safety and Health.

Under 29 CFR parts 1911 and 1912, OSHA must consult with the Advisory Committee on Construction Safety and Health (ACCSH), established pursuant to section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704), in setting standards for construction work. Specifically, 29 CFR 1911.10(a) requires the Assistant Secretary to provide ACCSH with any proposal (along with pertinent factual information) and give ACCSH an opportunity to submit recommendations. See also 29 CFR 1912.3(a).

At a public meeting on April 24, 2024, OSHA presented to ACCSH its framework for a proposed rule for heat injury and illness prevention in outdoor and indoor work settings. The Committee then passed unanimously a motion recommending that OSHA proceed expeditiously with proposing a standard on heat injury and illness prevention. The Committee also recommended that OSHA consider the feedback and questions discussed by Committee members during the meeting in formulating the proposed rule (see the minutes from the meeting, Docket No. 2024-0002). OSHA has considered the Committee's feedback in the development of this proposal.

D. Environmental Impacts.

OSHA reviewed the proposed rule according to the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.), the regulations of the Council on Environmental Quality (CEQ) (40 CFR chapter V, subchapter A), and the Department of Labor's NEPA procedures (29 CFR part 11). Pursuant to 29 CFR 11.10 and consistent with CEQ regulations, the promulgation, modification, or revocation of any safety standard is categorically excluded from the requirement to prepare an environmental assessment under NEPA absent extraordinary circumstances indicating the need for such an assessment. OSHA finds that this proposed rule presents no such extraordinary circumstances.

E. Consensus Standards.

OSHA must consider adopting existing national consensus standards that differ substantially from OSHA's proposed standard if the consensus standard would better effectuate the purposes of the Act (see 29 U.S.C. 655(b)(8); see also National Technology Transfer and Advancement Act of 1995, Public Law 104–113, section 12(d), 15 U.S.C. 272 Note). Whenever an OSHA rule differs substantially from a national consensus standard, OSHA must publish in the *Federal Register* a statement of the reasons why the rule will better effectuate the purposes of the Act than the national consensus standard (29 U.S.C. 655(b)(8)). In the development of the proposed rule, OSHA reviewed the ANSI/ASSP national consensus Standard for Heat Stress Management in Construction and Demolition Operations, A10.50-2024. Many of the proposed provisions are consistent with the ANSI/ASSP standard, although there are some differences in the details of the provisions, particularly in the scope of the standard, as well as requirements for measurements, heat trigger levels, hydration, rest breaks, medical surveillance, PPE, recordkeeping, and a qualified person.

Regarding the scope of the standard, while the ANSI/ASSP standard applies only to employers in construction and demolition operations, the OSHA proposed standard applies to all employers in general industry, construction, maritime, and agriculture, with some exceptions (as discussed in Section VII.A., Paragraph (a) Scope and application, in Section VII., Explanation of Proposed Requirements). While both the ANSI/ASSP standard and the OSHA proposed standard would require employers to develop a written heat stress management program and acclimatization plan, the ANSI/ASSP standard requires a competent person to perform a heat stress task hazard analysis and indicates that workers' heat exposure should be assessed by use of the WBGT index or other heat stress index that accounts for climatic and metabolic heat sources and modification of heat transfer from the worker by extra clothing or PPE. The OSHA proposed standard requires that employers monitor heat conditions but allows employers more flexibility to determine workers' heat exposure. For example, in outdoor work areas, the OSHA proposed standard allows employers to track local heat index forecasts or measure heat index or WBGT, while for indoor work areas the OSHA proposed standard requires the employer to identify work areas with hazardous heat exposure and develop and implement a monitoring plan that includes measurement of heat index or WBGT. For workplaces in which employees where vapor-impermeable clothing, the employer's HIIPP must specify procedures to protect employees while wearing vapor-impermeable clothing. OSHA is allowing employers this additional flexibility to determine workers' heat exposure through multiple options based on feedback from public commenters and small entity representatives that WBGT can be technically challenging to measure accurately and that, for outdoor work areas, weather forecasts are readily available and easy to monitor (see Section IX., Technological Feasibility). In addition, with the exception of Minnesota, none of the current or proposed heat-specific State regulations rely on WBGT.

With respect to the heat trigger levels at which certain control measures are specified, the ANSI/ASSP standard and OSHA proposed standard also deviate slightly. While the ANSI/ASSP standard sets an action level of WBGT adjusted for clothing type (clothing-adjusted WBGT) of 70°F or heat index adjusted for radiant heat (adjusted heat index) of 80°F, the OSHA proposed standard specifies an initial heat trigger of WBGT equal to the NIOSH RAL or a heat index (unadjusted) of 80°F. The ANSI/ASSP standard's moderate hazard action level is a clothing-adjusted WBGT of 80°F or an adjusted heat index of 95°F, while the OSHA proposed standard specifies a high heat trigger of WBGT equal to NISOH REL or a heat index (unadjusted) of 90°F. Additionally, the ANSI/ASSP standard has an extreme hazard action level of a clothing-adjusted WBGT of 87°F or an adjusted heat index of 110°F, at which point ANSI/ASSP recommends stopping work that requires high strenuous workload. While the ANSI/ASSP and OSHA initial and high heat triggers are similar, OSHA is not specifying a third trigger in its proposed standard. This decision is in line with recommendations from the SBAR Panel to keep the heat triggers simple to understand (see SBAR Panel findings and recommendations, Section VIII., Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis). Adding a third trigger could also add considerable costs. As explained in Section V.B., Basis for Initial and High Heat Trigger, OSHA's proposed triggers are based on observational and laboratory evidence and, the agency believes, represent a highly sensitive and appropriate screening threshold for heat stress controls in the workplace. OSHA has preliminarily determined that these thresholds are protective for workers and achievable for employers.

With regards to hydration, both the ANSI/ASSP standard and the OSHA proposed standard would require that employees have access to suitably cool water that is free of charge, in close proximity to working areas, and of sufficient quantity. The ANSI/ASSP standard, however, additionally requires that employees shall have access to electrolyte

replenishment beverages when they are involved with heavy work activities for greater than two hours. The OSHA proposed standard does not have this requirement, as the agency heard from an ACCSH member that electrolyte replenishment beverages can contain sugar that cannot be consumed by all workers. NIOSH, in its hydration fact sheet, recognizes that sports drinks with balanced electrolytes can replace salt lost in sweat, but similarly notes that heavy consumption will add calories due to the added sugar. NIOSH also points out, "In general, eating regular meals with adequate water is sufficient to maintain water and electrolyte balance" (NIOSH, 2017a). As a result, the OSHA proposed rule does not require employers to provide electrolyte replenishment beverages but OSHA notes in this preamble that employers may provide electrolyte replenishment beverages in addition to water if they choose to do so (see Section VII., Explanation of Proposed Requirements). OSHA also requests comment on whether the agency should require the provision of electrolyte supplements/solutions in addition to water.

Another deviation between the ANSI/ASSP standard and the OSHA proposed standard exists in the requirement for rest breaks. While both the ANSI/ASSP standard and the OSHA proposed standard require employers to provide shaded rest and hydration break areas at or above the action level or initial heat trigger, respectively, the ANSI/ASSP standard recommends, but does not require, scheduled rest breaks at the moderate hazard action level (a clothing-adjusted WBGT or 80°F or an adjusted heat index of 95°F). OSHA's proposed standard requires employers to provide a rest break if needed to prevent overheating at or above the initial heat trigger, as well as a rest break of at least 15 minutes every two hours at or above the high heat trigger. Rest breaks, particularly in combination with water and shade, have been shown in multiple scientific studies to reduce the risk of heat-related fatality and HRI (see Section V.C., Risk Reduction) and therefore OSHA is requiring rest breaks in the proposed standard.

Regarding medical surveillance, the ANSI/ASSP standard indicates that a medical surveillance program (e.g., a comprehensive work and medical history, a comprehensive physical exam, an assessment of any personal risk factors, and the ability to wear PPE) should be established for all workers covered by the standard, while the OSHA proposed standard does not have a medical surveillance requirement. Similarly, while both the ANSI/ASSP standard and the OSHA proposed standard require that an employee exhibiting signs or symptoms of heat illness be monitored and not left alone or sent home without being offered on-site first aid and, if necessary, emergency medical services, the ANSI/ASSP standard further requires that a supervisor or team member be trained in first aid and certified in cardiopulmonary resuscitation (CPR) and the use of the automated external defibrillator (AED) when a medical professional is not available on-site. Due to the widespread scope of the OSHA proposed standard, the agency believes that a requirement for medical surveillance or for certification of supervisors or team members in CPR and AED would be impractical and could add considerable costs. In addition, OSHA also heard a comment from a construction industry representative during the ACCSH consultation that requiring medical surveillance would also be logistically difficult (see the minutes from the meeting, Docket No. 2024-0002).

With respect to PPE, the ANSI/ASSP standard requires the implementation of heat stress controls following the hierarchy of controls, with engineering controls implemented first, followed by administrative controls, and then cooling PPE. While the OSHA proposed standard specifies the use of engineering controls and administrative controls, it does not require the use of cooling PPE. OSHA believes that cooling PPE—such as a cooling vest—has the potential to become hazardous as the cooling properties dissipate. As a result, the OSHA proposed standard requires that employers who choose to provide cooling PPE to their employees ensure that the cooling properties of the PPE

are maintained at all times during use (see Section VII.E., Paragraph (e) Requirements at or above the Initial Heat Trigger).

With regards to recordkeeping, the ANSI/ASSP standard requires employers to keep a written inventory of local conditions at the work site that affect or increase the potential for heat stress only as long as the hazard exists or as required by law. The OSHA proposed standard is more specific, requiring that employers maintain written or electronic records of indoor work area measurements for 6 months (see Section VII.I., Paragraph (i) Recordkeeping). OSHA believes this specificity increases clarity for employers.

Finally, the ANSI/ASSP standard requires a qualified person "who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project." The ANSI/ASSP standard requires that the qualified person assist with the development and review of the heat stress management program, the use and interpretation of the WBGT, and the development and review of the first aid and emergency action plan, as well as providing guidance or in-person support to the competent person on implementation of the program as needed. The OSHA proposed standard does not have a requirement for a qualified person. Due to the widespread scope of the proposed standard, OSHA does not believe that it would be feasible to require all covered employers to hire a qualified person as contemplated by the ANSI/ASSP standard. Instead, the proposed standard requires the designation of one or more heat safety coordinators who are trained in and responsible for ensuring compliance with all requirements of the employer's HIIPP. OSHA also plans to provide compliance assistance materials such as a model HIIPP and other materials.

OSHA also notes that there are some requirements in its proposed standard that are not required by the ANSI/ASSP standard. Specifically, the OSHA proposed standard contains a hazard alert provision that requires employers to notify employees that the high heat trigger has been met or exceeded (see Section VII.F., Paragraph (f) Requirements at or above the High Heat Trigger). The OSHA proposed standard also requires that employers place warning signs at indoor areas with ambient temperatures that regularly exceed 120°F (see Section VII.F., Paragraph (f) Requirements at or above the High Heat Trigger). OSHA believes that these additional requirements are important for the protection of workers from heat hazards in the workplace.

OSHA has preliminarily determined that the proposed standard would be highly effective at addressing the risk of occupational heat exposure while remaining workable across the many different work contexts covered by the proposal. As such, OSHA believes that the standard as proposed will best effectuate the OSH Act's purpose of ensuring safe and healthful working conditions.

F. Incorporation by Reference.

OSHA is proposing to incorporate by reference NIOSH Publication No. 2016-106. Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments, February 2016. In this publication, NIOSH provides recommendations for an occupational standard for workers exposed to heat, including the NIOSH Recommended Alert Limit (RAL) and Recommended Exposure Limit (REL). OSHA is proposing the RAL as an option for the initial heat trigger and the REL as an option for the high heat trigger (see Section VII.B., Paragraph (b) Definitions).

NIOSH Publication No. 2016-106 is available to download for free on NIOSH's website (https://www.cdc.gov/niosh/docs/2016-106) and linked from OSHA's website (https://www.osha.gov/heat-exposure/standards). It is also available in the rulemaking docket for this proposed standard (Docket ID OSHA-2021-0009-0050).

G. Protection of Children from Environmental Health Risks and Safety Risks.

Executive Order 13045, on Protection of Children from Environmental Health Risks and Safety Risks, as amended by Executive Orders 13229 and 13296, requires that Federal agencies provide additional evaluation of economically significant regulatory actions that concern an environmental health or safety risk that an agency has reason to believe may disproportionately affect children. This proposed rule is intended to protect United States workers from occupational hazards. OSHA has preliminarily determined that the proposed rule will not disproportionately affect children or have any adverse impact on children. Because workers in the industries covered by this proposed rule may include older children, the proposed rule could have a protective effect on these older children in the workforce by reducing the possibility of heat-related injury or illness. Accordingly, E.O. 13045, Protection of Children from Environmental Health Risks and Safety Risks, requires no further agency action or analysis.

H. Federalism.

The agency reviewed this proposed rule in accordance with Executive Order 13132 on Federalism (64 FR 43255, (August 10, 1999)), which, among other things, is intended to "ensure that the principles of federalism established by the Framers guide the executive departments and agencies in the formulation and implementation of policies." The E.O. generally allows Federal agencies to preempt State law only as provided by Congress or where State law conflicts with Federal law. In such cases, Federal agencies must limit preemption of State law to the extent possible. The E.O. also requires that agencies consult with States on rules that have "federalism implications," which are those that have "substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government."

This proposed rule complies with E.O. 13132. The hazards addressed by this proposed rule and its goal of protecting workers from exposure to hazardous heat are national in scope and the proposed rule does not include "federalism implications" as defined in the E.O. Under section 18 of the OSH Act (29 U.S.C. 667), Congress expressly provided that States may adopt, with Federal approval, a plan for the development and enforcement of occupational safety and health standards. OSHA refers to the occupational safety and health plans that have been submitted by States and approved by OSHA as "State Plans." Occupational safety and health standards developed by States with OSHA-approved State Plans must be at least as effective in providing safe and healthful employment and places of employment as the Federal standards. Subject to these requirements, these States are free to develop and enforce their own occupational safety and health standards. The choice to adopt a State Plan is part of the statutory scheme and is not mandatory, so there are no federalism implications for States that choose to do so.

In States without OSHA-approved State Plans, the States are not employers under to the OSH Act and the proposed rule would therefore not have a substantial direct effect on them (29 U.S.C. 652(5)). The following section addresses the effect of the proposed rule on States with OSHA-approved State Plans.

I. Requirements for States with OSHA-Approved State Plans.

When Federal OSHA promulgates a new standard or a more stringent amendment to an existing standard, States and U.S. Territories with OSHA-approved State Plans must either amend their standards to be identical to or "at least as effective as" the new standard or amendment or show that an existing State Plan standard covering this area is already "at least as effective" as the new Federal standard or amendment (29 CFR 1953.5(b)). State Plan adoption must be completed within six months of the promulgation date of the final Federal rule.

Of the 29 States and Territories with OSHA-approved State Plans, 22 cover both public and private-sector employees: Alaska, Arizona, California, Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, and Wyoming. The remaining seven States and Territories cover only State and local government employees: Connecticut, Illinois, Maine, Massachusetts, New Jersey, New York, and the Virgin Islands.

OSHA preliminarily concludes that this proposed rule would increase protections beyond those provided by most current standards in State Plans. Therefore, within six months of any final rule's promulgation date, States with OSHA-approved State Plans would be required to adopt standards that are identical to or "at least as effective" as this rule, unless they demonstrate that such amendments are not necessary because their existing permanent standards are already "at least as effective" in protecting workers. OSHA seeks comment on this assessment of its proposal.

J. OMB Review Under the Paperwork Reduction Act of 1995

A. Overview.

The proposed Heat Injury and Illness Prevention Standard contains collection-of -information requirements that are subject to the Office of Management and Budget (OMB) review and approval under the Paperwork Reduction Act of 1995 (PRA), 44 U.S.C. 3501 et seq. and its implementing regulations at 5 CFR part 1320. The PRA defines a collection-of-information as the obtaining, causing to be obtained, soliciting, or requiring the disclosure to third parties or the public of facts or opinions by or for an agency regardless of form or format. (See 44 U.S.C. 3502(3)(A)). The collection of information requirements specified in the proposal would reduce the risk of death, serious injury, and illness by ensuring that employers develop and implement a worksite heat injury and illness prevention plan (HIIPP), review and evaluate the effectiveness of the

HIIPP, designate one or more heat safety coordinators to implement and monitor the HIIPP, and develop and implement a heat illness emergency response plan to respond to employees experiencing signs and symptoms of heat related illnesses for indoor and outdoor conditions. OSHA is requesting OMB approval of the proposed Information Collection Request (ICR) and a new OMB Control Number for this ICR currently under OMB Control Number 1218-0NEW.

Under the PRA, a Federal agency cannot conduct or sponsor a collection of information unless OMB approves it, and the agency displays a currently valid OMB control number (44 U.S.C. 3507). Also, notwithstanding any other provision of law, no employer shall be subject to penalty for failing to comply with a collection of information if the collection of information does not display a currently valid OMB control number (44 U.S.C. 3512).

B. Solicitation of Comments.

In accordance with the PRA (44 U.S.C. 3506(c)(2) and 3507(d)), OSHA submitted the collection-of-information requirements identified in the NPRM to OMB for review. The agency solicits comments on the collection-of-information requirements and estimated burden hours associated with these requirements, including comments on the following items:

- Whether the proposed collections of information are necessary for the proper performance of the agency's functions, including whether the information is useful;
- The accuracy of OSHA's estimate of the burden (time and cost) of the proposed collections of information, including the validity of the methodology and assumptions used;
- The quality, utility, and clarity of the information collected; and

- Ways to minimize the compliance burden on employers, for example, by using automated or other technological techniques for collecting and transmitting information (78 FR 56438).

C. Proposed Collection of Information Requirements.

As required by 5 CFR 1320.5(a)(1)(iv) and 1320.8(d)(1), the following paragraphs provide information about this ICR.

1. *Title*: Heat Injury and Illness Prevention Standard (29 CFR 1910.148).
2. *Description of the ICR*: The proposal would add new collection-of-information requirements to protect indoor and outdoor workers from hazardous heat.
3. *Brief Summary of the Collection of Information Requirements*: The proposed Heat Injury and Illness Prevention Standard ICR adds new collection-of-information requirements that would ensure that employers develop and implement a worksite heat injury and illness prevention plan, review and evaluate the effectiveness of the HIIPP, designate one or more heat safety coordinators to implement and monitor the HIIPP, and develop and implement a heat illness emergency response plan for employees experiencing signs and symptoms of heat related illnesses for indoor and outdoor workers. Specifically, the proposed collection-of-information requirements contained in the proposed rule for the Heat Injury and Illness Prevention Standard are listed in table X.J-1.

Table X.J-1 – Proposed Collection-of-Information Requirements for Heat Injury and Illness Prevention.

	Section	Collection-of-Information Requirements
1	**§ 1910.148(c)(1) through (4)**	Paragraphs (c)(1) through (4) would require employers to develop and implement a heat injury and illness prevention plan (HIIPP), which must include a list of covered activities, the policies and procedures necessary to comply with the proposed standard, the heat metric the employer will use to comply with paragraph (d), and policies and procedures related to the use of vapor-impermeable clothing, if applicable. For employers with more than 10 employees, the HIIPP must be in writing.

	Section	Collection-of-Information Requirements
2	**§ 1910.148(c)(5)**	Paragraph (c)(5) would require the employer to designate one or more heat safety coordinators to implement and monitor the HIIPP.
3	**§ 1910.148(c)(6) and (7)**	Paragraphs (c)(6) and (7) would require the employer to seek the input and involvement of non-managerial employees in the development and implementation of the HIIPP, and to review and evaluate the effectiveness of the HIIPP at least annually and whenever a heat-related illness or injury occurs that results in days away from work, medical treatment beyond first aid, or loss of consciousness.
4	**§ 1910.148(c)(8) and (9)**	Paragraphs (c)(8) and (9) would require the employer to make the HIIPP readily available at the work site in a language each employee, supervisor, and heat safety coordinator understands.
5	**§ 1910.148(d)(3)**	Paragraph (d)(3) would require the employer, at indoor work sites, to identify each work area(s) where there is a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger. For each work area identified, the employer would be required to develop and implement a monitoring plan that includes measuring heat index or wet bulb globe temperature. Employers would also be required to evaluate any affected work area(s) and update their monitoring plan whenever there is a change in production, processes, equipment, controls, or a substantial increase in outdoor temperature which has the potential to increase heat exposure indoors. The employer would be required to seek the input and involvement of non-managerial employees when identifying work areas with a reasonable expectation of exposure at or above the initial heat trigger and in developing and updating monitoring plans.
6	**§ 1910.148(e)(7)**	Paragraph (e)(7) would require the employer, when the initial heat trigger is met or exceeded, to implement an acclimatization protocol for each new employee and each returning employee (i.e., who has been away from work for more than 14 days) during their first week on the job. Employers would be required to choose either a plan that would incorporate the control measures required when the high heat trigger is met or exceeded, or a gradual acclimatization plan that would slowly increase the employee's exposure to heat each day. The requirement would not apply if the employer can demonstrate that the employee consistently worked under the same or similar conditions within the past 14 days.

	Section	Collection-of-Information Requirements
7	**§ 1910.148(e)(9)**	Paragraph (e)(9) would require the employer, when the initial heat trigger is met or exceeded, to maintain a means of effective, two-way communication with employees and regularly communicate with employees.
8	**§ 1910.148(f)(4)**	Paragraph (f)(4) would require the employer, prior to the work shift or upon determining that the high heat trigger is met or exceeded, to notify employees of the importance of drinking plenty of water, employees' right to take rest breaks if needed and required rest breaks, how to seek help and the procedures to take in a heat emergency, and, for mobile work sites, the location of break area(s) and drinking water.
9	**§ 1910.148(f)(5)**	Paragraph (f)(5) would require the employer to place a legible, visible, and understandable warning sign at indoor work areas with ambient temperatures that regularly exceed 120°F.
10	**§ 1910.148(g)(1)**	Paragraph (g)(1) would require employers, as part of their HIIPP, to develop and implement a heat emergency response plan that includes a list of emergency phone numbers, a description of how employees can contact a supervisor and emergency medical services, individual(s) designated to ensure that heat emergency procedures are invoked when appropriate, a description of how to transport employees to a place where they can be reached by emergency medical services, clear and precise directions to the work site, and procedures for responding to an employee experiencing signs and symptoms of heat-related illness or a heat emergency.
11	**§ 1910.148(g)(3)**	Paragraph (g)(3) would require the employer, if an employee is experiencing signs and symptoms of a heat emergency, to take immediate actions to reduce the employee's body temperature and immediately contact emergency medical services, as well as relieving them from duty, monitoring them, ensuring they are not left alone, and offering them on-site first aid and medical services. h
12	**§ 1910.148(i)(1)**	Paragraph (i)(1) would require employers to have written or electronic records of on-site measurements at indoor work areas, and to retain those records for 6 months. .

4. *OMB Control Number*: 1218-0NEW.

5. *Affected Public:* Business or other for-profit.

6. *Number of Respondents*: 2,535,775.

7. *Frequency of Responses*: On occasion, annually.

8. *Number of Responses*: 1,699,783,434.

9. *Average Time Per Response*: Varies.

10. *Estimated total burden hours*: 27,803,599.

11. *Estimated costs (capital-operation and maintenance)*: $24,040,064.

D. Submitting Comments.

Members of the public may comment on the collection of information requirements in this proposed standard by sending their comments to the Office of Information and Regulatory Affairs, Attn: OMB Desk Officer for the Department of Labor, OSHA Regulation Identifier Number (RIN) (1218-AD39), by e-mail: *OIRA_submission@omb.eop.gov*. Please limit the comments to only those addressing the collection of information requirements in the proposed Heat Injury and Illness Prevention standard (i.e., proposed § 1910.148). OSHA encourages commenters also to submit their comments on these collection of information requirements to the rulemaking docket (OSHA-2021-0009), along with their comments on other parts of the proposed standard. For instructions on submitting these comments to the docket, see the sections of this *Federal Register* document titled **DATES** and **ADDRESSES**. Comments submitted in response to this document are public records; therefore, OSHA cautions commenters about submitting personal information, such as Social Security numbers and dates of birth.

E. Docket and Inquiries.

To access the docket to read or download comments and other materials related to this paperwork determination, including the complete ICR, use the procedures described

under the section of this document titled **ADDRESSES**. You may obtain an electronic copy of the complete ICR by going to the website at *https://www.reginfo.gov/public/do/PRAMain*, then select “Department of Labor” under "Currently Under Review", then click on “submit”. This will show all of the Department’s ICRs currently under review, including the ICRs submitted for proposed rulemakings. To make inquiries, or to request other information, contact Ms. Seleda Perryman, Directorate of Standards and Guidance, Occupational Safety and Health Administration, U.S. Department of Labor; telephone (202) 693-4131; e-mail *perryman.seleda.m@dol.gov*.

XI. Authority and Signature:

This document was prepared under the direction of Douglas L. Parker, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Ave. NW, Washington, DC 20210. It is issued under the authority of sections 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653,655, and 657); 5 U.S.C. 553, Secretary of Labor’s Order No. 8-2020 (85 FR 58383), and 29 CFR part 1911.

References

Adam-Poupart, A., Smargiassi, A., Busque, M.-A., Duguay, P., Fournier, M., Zayed, J., & Labrèche, F. (2015). Effect of summer outdoor temperatures on work-related injuries in Quebec (Canada). *Occupational and Environmental Medicine*, *72*(5), 338–345. https://doi.org/10.1136/oemed-2014-102428

Adams, S. J., Heywood, J. S., & Rothstein, R. (2009). *Teachers, Performance Pay, and Accountability: What education should learn from other sectors*.

Adhvaryu, A., Kala, N., & Nyshadham, A. (2020). The Light and the Heat: Productivity Co-Benefits of Energy-Saving Technology. *The Review of Economics and Statistics*, *102*(4), 779–792. https://doi.org/10.1162/rest_a_00886

Alele, F. O., Malau-Aduli, B. S., Malau-Aduli, A. E. O., & J. Crowe, M. (2020). Epidemiology of Exertional Heat Illness in the Military: A Systematic Review of Observational Studies. *International Journal of Environmental Research and Public Health*, *17*(19), 7037. https://doi.org/10.3390/ijerph17197037

Allan, J. R., & Gibson, T. M. (1979). Separation of the Effects of Raised Skin and Core Temperature on Performance of a Pursuit Rotor Task. *Aviation, Space, and Environmental Medicine*, 678–682.

Alsharif, M. (2023, July 21). *Construction worker accused of being on drugs died of heatstroke while working in hot Texas sun, lawsuit says*. https://www.nbcnews.com/news/us-news/construction-worker-accused-drugs-died-heatstroke-working-hot-texas-su-rcna95565

Amazon.com, Inc. (2024a). *Dehumidifiers for Room: 41 oz 3300 Cubic Feet*. Amazon.com

Amazon.com, Inc. (2024b). *Utopia Bedding Flat Sheet—Soft Brushed Microfiber Fabric*. Amazon.com

Amazon.com, Inc. (2024c). *Yaheetech 12x12 Pop Up Canopy Easy Set-up Tent*. Amazon.com

American Conference of Governmental Industrial Hygienists (ACGIH). (2017). Heat Stress and Strain. In *2017 TLVs and BEIs: Based on the documentation of the threshold limit values for chemical substances and physical agents & biological exposure indices*. American Conference of Governmental Industrial Hygienists. http://www.acgih.org/forms/store/ProductFormPublic/2017-tlvs-and-beis

American Conference of Governmental Industrial Hygienists (ACGIH). (2021). *Heat Stress and Strain Notice of Intended Change for TLV*. American Conference of Governmental Industrial Hygienists.

American Conference of Governmental Industrial Hygienists (ACGIH). (2023). *2023 TLVs and BEIs: Based on the documentation of the threshold limit values for chemical substances and physical agents & biological exposure indices*. American Conference of Governmental Industrial Hygienists.

American Samoa Department of Commerce. (2023). *American Samoa Statistical Yearbook 2021*. https://www.doc.as.gov/post/news-release-american-samoa-statistical-yearbook-2021

Anderson, G. B., Bell, M., & Peng, R. D. (2013). Methods to Calculate the Heat Index as an Exposure Metric in Environmental Health Research. *Environmental Health Perspectives*, *121*(10), Article 10. https://doi.org/10.1289/ehp.1206273

Anderson, R., & De Souza, E. (2017). Heat stress management in underground mines. *International Journal of Mining Science and Technology*, *27*(4), Article 4. https://doi.org/10.1016/j.ijmst.2017.05.020

ANSI/ASSP. (2024). *A10.50-2024 Standard for Heat Stress Management in Construction and Demolition Operations*. https://store.assp.org/PersonifyEbusiness/Store/Product-Details/productId/260687328

Arbury, S., Jacklitsch, B., Farquah, O., Hodgson, M., Lamson, G., Martin, H., & Profitt, A. (2014). Heat Illness and Death Among Workers—United States, 2012–2013. *Morbidity and Mortality Weekly Report (MMWR)*, *63*(31), 661–665.

Arbury, S., Lindsley, M., & Hodgson, M. (2016). A Critical Review of OSHA Heat Enforcement Cases: Lessons Learned. *Journal of Occupational & Environmental Medicine*, *58*(4), 359–363. https://doi.org/10.1097/JOM.0000000000000640

Armed Forces Health Surveillance Board (AFHSB). (2017). *Rhabdomyolysis; Exertional*. AFHSB Surveillance Case Definitions.

Armed Forces Health Surveillance Center. (2013). Update: Exertional rhabdomyolysis, active component, U.S. Armed Forces, 2008-2012. *Medical Surveillance Monthly Report (MSMR)*, *20*(3), 21–24.

Armed Forces Health Surveillance Center. (2018). Update: Exertional rhabdomyolysis, active component, U.S. armed forces, 2013–2017. *Medical Surveillance Monthly Report (MSMR)*, *25*(4), 13–17.

Armed Forces Health Surveillance Division. (2020). Update: Exertional hyponatremia, active component, U.S. Armed Forces, 2004-2019. *Medical Surveillance Monthly Report (MSMR)*, *27*(4), 15–19.

Armed Forces Health Surveillance Division. (2021). Update: Exertional hyponatremia, active component, U.S. Armed Forces, 2005-2020. *Medical Surveillance Monthly Report (MSMR)*, *28*(4), 21–26.

Armed Forces Health Surveillance Division. (2022a). Update: Exertional hyponatremia, active component, U.S. Armed Forces, 2006-2021. *Medical Surveillance Monthly Report (MSMR)*, *29*(4), 21–26.

Armed Forces Health Surveillance Division. (2022b). Update: Heat illness, active component, U.S. Armed Forces, 2021. *Medical Surveillance Monthly Report (MSMR)*, *29*(4), 8–14.

Armed Forces Health Surveillance Division. (2023a). Exertional hyponatremia among active component members of the U.S. Armed Forces, 2007-2022. *Medical Surveillance Monthly Report (MSMR)*, *30*(4), 13–17.

Armed Forces Health Surveillance Division. (2023b). Update: Exertional rhabdomyolysis, active component, U.S. armed forces, 2018-2022. *Medical Surveillance Monthly Report (MSMR)*, *30*(4), 8–12.

Armstrong, L. E. (1989). Heat Exhaustion. *U.S. Army Research Institute of Environmental Medicine*.

Armstrong, L. E., Casa, D. J., Millard-Stafford, M., Moran, D. S., Pyne, S. W., & Roberts, W. O. (2007). Exertional Heat Illness during Training and Competition. *American College of Sports Medicine Position Stand. Medicine & Science in Sports & Exercise*, *39*(3), 556–572. https://doi.org/10.1249/MSS.0b013e31802fa199

Armstrong, L. E., De Luca, J. P., & Hubbard, R. (1989). *Time course of recovery and heat acclimation ability of prior heatstroke patients. Symposium: Exertional Heatstroke: An International Perspective. Annual meeting of the American College of Sports Medicine*. Heat Research Division, U.S. Army Research Institute of Environmental Medicine.

Arnold, T. J., Arcury, T. A., Sandberg, J. C., Quandt, S. A., Talton, J. W., Mora, D. C., Kearney, G. D., Chen, H., Wiggins, M. F., & Daniel, S. S. (2020). Heat-Related Illness Among Latinx Child Farmworkers in North Carolina: A Mixed-Methods Study. *NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy*, *30*(2), 111–126. https://doi.org/10.1177/1048291120920571

Ashenfelter, O. C., Farber, H., & Ransom, M. R. (2010). Labor Market Monopsony. *Journal of Labor Economics*, *28*(2), 203–210. https://doi.org/10.1086/653654

Ashford, N. (2007). Workers' Compensation. In *Environmental and Occupational Medicine* (4th ed., pp. 1712–1719). Lippincott-Raven.

Ashford, N. A., Ayers, C., & Stone, R. F. (1985). Using Regulation to Change the Market for Innovation. *Harvard Environmental Law Review*, *9*(2), 419–466.

Ashford, N., & Caldart, C. (1996). *Technology, Law, and the Working Environment* (Revised). Island Press.

Asplund, C. A., O'Connor, F. G., & Noakes, T. D. (2011). Exercise-associated collapse: An evidence-based review and primer for clinicians. *British Journal of Sports Medicine*, *45*(14), 1157–1162. https://doi.org/10.1136/bjsports-2011-090378

ASTM International. (2021). *Standard Guide for Managing Heat Stress and Heat Strain in Foundries*.

Astrand, I. (1960). Aerobic work capacity in men and women with special reference to age. *Acta Physiologica Scandinavica. Supplementum*, *49*(169), 1–92.

Atan, L., Andreoni, C., Ortiz, V., Silva, E. K., Pitta, R., Atan, F., & Srougi, M. (2005). High kidney stone risk in men working in steel industry at hot temperatures. *Urology*, *65*(5), 858–861. https://doi.org/10.1016/j.urology.2004.11.048

Atlantic Council. (2021). *Extreme Heat: The Economic and Social Consequences for the United States*. Atlantic Council.

Atlantic Council. (2022). *Methodology for Extreme Heat: The Economic and Social Consequences for Global Cities*. Atlantic Council.

Auffhammer, M. (2018). Quantifying Economic Damages from Climate Change. *Journal of Economic Perspectives*, *32*(4), 33–52. https://doi.org/10.1257/jep.32.4.33

Ballester, J., Quijal-Zamorano, M., Méndez Turrubiates, R. F., Pegenaute, F., Herrmann, F. R., Robine, J. M., Basagaña, X., Tonne, C., Antó, J. M., & Achebak, H. (2023). Heat-related mortality in Europe during the summer of 2022. Nature Medicine, 29(7), 1857–1866. https://doi.org/10.1038/s41591-023-02419-z

Barbic, F., Casazza, G., Zamunér, A. R., Costantino, G., Orlandi, M., Dipaola, F., Capitanio, C., Achenza, S., Sheldon, R., & Furlan, R. (2014). Driving and Working with Syncope. *Autonomic Neuroscience: Basic & Clinical*, *184*, 46–52. https://doi.org/10.1016/j.autneu.2014.05.006

Barbic, F., Dipaola, F., Casazza, G., Borella, M., Minonzio, M., Solbiati, M., Raj, S., Sheldon, R., Quinn, J., Costantino, G., & Furlan, R. (2019). Syncope in a Working-Age Population: Recurrence Risk and Related Risk Factors. *Journal of Clinical Medicine*, *8*(2), 150. https://doi.org/10.3390/jcm8020150

Bar-Or, O., Lundegren, H. M., & Buskirk, E. R. (1969). Heat tolerance of exercising obese and lean women. *Journal of Applied Physiology*, *26*(4), 403–409. https://doi.org/10.1152/jappl.1969.26.4.403

Barrow, M. W., & Clark, K. A. (1998). Heat-related illnesses. *American Family Physician*, *58*(3), 749–756, 759.

Barthwal, V., Jain, S., Babuta, A., Jamir, C., Sharma, A. K., & Mohan, A. (2022). Health impact assessment of Delhi's outdoor workers exposed to air pollution and extreme weather events: An integrated epidemiology approach. *Environmental Science and Pollution Research*, *29*(29), 44746–44758. https://doi.org/10.1007/s11356-022-18886-9

Barwood, M. J., Davey, S., House, J. R., & Tipton, M. J. (2009). Post-exercise cooling techniques in hot, humid conditions. *European Journal of Applied Physiology*, *107*(4), 385–396. https://doi.org/10.1007/s00421-009-1135-1

Basu, R., Rau, R., Pearson, D., & Malig, B. (2018). Temperature and Term Low Birth Weight in California. *American Journal of Epidemiology*, *187*(11), 2306–2314. https://doi.org/10.1093/aje/kwy116

Basu, R., & Samet, J. M. (2002). Relation between Elevated Ambient Temperature and Mortality: A Review of the Epidemiologic Evidence. *Epidemiologic Reviews*, *24*(2), 190–202. https://doi.org/10.1093/epirev/mxf007

Bates, G. P., & Miller, V. S. (2008). Sweat rate and sodium loss during work in the heat. *Journal of Occupational Medicine and Toxicology*, *3*(1), 4. https://doi.org/10.1186/1745-6673-3-4

Bedno, S. A., Urban, N., Boivin, M. R., & Cowan, D. N. (2014). Fitness, obesity and risk of heat illness among army trainees. *Occupational Medicine*, *64*(6), 461–467. https://doi.org/10.1093/occmed/kqu062

Behrer, A. P., & Park, J. (2017). *Will We Adapt? Temperature, Labor and Adaptation to Climate Change* [Working paper].

Behrer, A. P., Park, R. J., Wagner, G., Golja, C. M., & Keith, D. W. (2021). Heat has larger impacts on labor in poorer areas. *Environmental Research Communications*, *3*(9), 095001. https://doi.org/10.1088/2515-7620/abffa3

Bell, N. S., Amoroso, P. J., Senier, L., Williams, J. O., & Yore, M. M. (2004). The Total Army Injury and Health Outcomes Database (TAIHOD): Uses and Limitations as a

Research Tool for Force Health Protection Research. *U.S. Army Research Institute of Environmental Medicine. USARIEM TECHNICAL NOTE TN05-01*.
Belval, L. N., Casa, D. J., Adams, W. M., Chiampas, G. T., Holschen, J. C., Hosokawa, Y., Jardine, J., Kane, S. F., Labotz, M., Lemieux, R. S., McClaine, K. B., Nye, N. S., O'Connor, F. G., Prine, B., Raukar, N. P., Smith, M. S., & Stearns, R. L. (2018). Consensus Statement- Prehospital Care of Exertional Heat Stroke. *Prehospital Emergency Care*, *22*(3), 392–397. https://doi.org/10.1080/10903127.2017.1392666

Bendak, S., Jouaret, R., & Rashid, H. (2022). Effects of high ambient temperature on construction workers performance: A longitudinal empirical study. *Journal of Safety Research*, *81*, 197–202. https://doi.org/10.1016/j.jsr.2022.02.011

Bergeron, M. F. (2003). Heat cramps: Fluid and electrolyte challenges during tennis in the heat. *Journal of Science and Medicine in Sport*, *6*(1), 19–27.

Bergeron, M. F. (2007). Exertional Heat Cramps: Recovery and Return to Play. *Journal of Sport Rehabilitation*, *16*(3), 190–196. https://doi.org/10.1123/jsr.16.3.190

Bergeron, M. F. (2008). Muscle Cramps during Exercise—Is It Fatigue or Electrolyte Deficit? *Current Sports Medicine Reports*, *7*(4), S50–S55.

Berko, J., Ingram, D., Saha, S., & Parker, J. (2014). Deaths Attributed to Heat, Cold, and Other Weather Events in the United States, 2006-2010. *National Health Statistics Reports*, *76*.

Bernard, T. E., Ashley, C. D., Garzon, X. P., Kim, J.-H., & Coca, A. (2017). Prediction of WBGT-based clothing adjustment values from evaporative resistance. *Industrial Health*, *55*(6), 549–554. https://doi.org/10.2486/indhealth.2017-0121

Bernard, T. E., & Iheanacho, I. (2015). Heat Index and Adjusted Temperature as Surrogates for Wet Bulb Globe Temperature to Screen for Occupational Heat Stress. *Journal of Occupational and Environmental Hygiene*, *12*(5), 323–333. https://doi.org/10.1080/15459624.2014.989365

Bethel, J., & Harger, R. (2014). Heat-Related Illness among Oregon Farmworkers. *International Journal of Environmental Research and Public Health*, *11*(9), 9273–9285. https://doi.org/10.3390/ijerph110909273
Bethel, J. W., Spector, J. T., & Krenz, J. (2017). Hydration and Cooling Practices Among Farmworkers in Oregon and Washington. *Journal of Agromedicine*, *22*(3), Article 3. https://doi.org/10.1080/1059924X.2017.1318100

Better, O. S., Shabtai, M., Kedar, S., Melamud, A., Berenheim, J., & Chaimovitz, C. (1980). Increased Incidence of Nephrolithiasis (N) in Lifeguards (LG) in Israel. In S. G. Massry, E. Ritz, & H. Jahn (Eds.), *Phosphate and Minerals in Health and Disease* (Vol. 128, pp. 467–472). Springer US. https://doi.org/10.1007/978-1-4615-9167-2_51

Billikopf, G. E., & Norton, M. (1992). Pay method affects vineyard pruner performance. *California Agriculture*, *46*(5), 12–13. https://doi.org/10.3733/ca.v046n05p12

Binkley, H. M., Beckett, J., Casa, D. J., Kleiner, D. M., & Plummer, P. E. (2002). National Athletic Trainers' Association Position Statement: Exertional Heat Illnesses. *Journal of Athletic Training*, *37*(3), 329–343.

Boal, W. M., & Ransom, M. R. (1997). Monopsony in the Labor Market. *Journal of Economic Literature*, *35*(1), 86–112.

Boden, L. I., & Ozonoff, A. (2008). Capture–Recapture Estimates of Nonfatal Workplace Injuries and Illnesses. *Annals of Epidemiology*, *18*(6), 500–506. https://doi.org/10.1016/j.annepidem.2007.11.003

Bodin, T., García-Trabanino, R., Weiss, I., Jarquín, E., Glaser, J., Jakobsson, K., Lucas, R. A. I., Wesseling, C., Hogstedt, C., & Wegman, D. H. (2016). Intervention to reduce heat stress and improve efficiency among sugarcane workers in El Salvador: Phase 1. *Occupational and Environmental Medicine*, *73*(6), 409–416. https://doi.org/10.1136/oemed-2016-103555

Boersma, P., Black, L. I., & Ward, B. W. (2020). Prevalence of Multiple Chronic Conditions Among US Adults, 2018. *Preventing Chronic Disease*, *17*. https://doi.org/10.5888/pcd17.200130

Bonauto, D., Anderson, R., Rauser, E., & Burke, B. (2007). Occupational heat illness in Washington State, 1995–2005. *American Journal of Industrial Medicine*, *50*(12), 940–950. https://doi.org/10.1002/ajim.20517

Bonauto, D., Fan, J., Largo, T., Rosenman, K., Green, M., Walters, J., Materna, B., Flattery, J., St. Louis, T., Yu, L., Fang, S., Davis, L., Valiante, D., Cummings, K., Hellsten, J., & Prosperie, S. (2010). Proportion of workers who were work-injured and payment by workers' compensation systems—10 states, 2007. *MMWR. Morbidity and Mortality Weekly Report*, *59*(29), 897–900.

Bonauto, D., & Spector, J. (2024). Communication with David Bonauto and June Spector on June 17, 2024.

Bonde, J. P. (1992). Semen quality in welders exposed to radiant heat. *British Journal of Industrial Medicine*, *49*, 5–10.

Bonell, A., Sonko, B., Badjie, J., Samateh, T., Saidy, T., Sosseh, F., Sallah, Y., Bajo, K., Murray, K. A., Hirst, J., Vicedo-Cabrera, A., Prentice, A. M., Maxwell, N. S., & Haines, A. (2022). Environmental heat stress on maternal physiology and fetal blood flow in pregnant subsistence farmers in The Gambia, west Africa: An observational cohort study. *The Lancet Planetary Health*, *6*(12), e968–e976. https://doi.org/10.1016/S2542-5196(22)00242-X

Boonruksa, P., Maturachon, T., Kongtip, P., & Woskie, S. (2020). Heat Stress, Physiological Response, and Heat-Related Symptoms among Thai Sugarcane Workers. *International Journal of Environmental Research and Public Health*, *17*(17), 6363. https://doi.org/10.3390/ijerph17176363

Borg, M. A., Xiang, J., Anikeeva, O., Pisaniello, D., Hansen, A., Zander, K., Dear, K., Sim, M. R., & Bi, P. (2021). Occupational heat stress and economic burden: A review of

global evidence. *Environmental Research*, *195*, 110781. https://doi.org/10.1016/j.envres.2021.110781

Borghi, L., Meschi, T., Amato, F., Novarini, A., Romanelli, A., & Cigala, F. (1993). Hot Occupation and Nephrolithiasis. *The Journal of Urology*, *150*, 1757–1760.

Borjas, G. (2000). *Labor Economics* (2nd ed.). Irwin McGraw-Hill.

Bouchama, A., Abuyassin, B., Lehe, C., Laitano, O., Jay, O., O'Connor, F. G., & Leon, L. R. (2022). Classic and exertional heatstroke. *Nature Reviews Disease Primers*, *8*(1), 8. https://doi.org/10.1038/s41572-021-00334-6

Bouchama, A., & Knochel, J. P. (2002). Heat Stroke. *New England Journal of Medicine*, *346*(25), 1978–1988. https://doi.org/10.1056/NEJMra011089

Brake, D. J., & Bates, G. P. (2003). Fluid losses and hydration status of industrial workers under thermal stress working extended shifts. *Occupational and Environmental Medicine*, *60*(2), 90–96. https://doi.org/10.1136/oem.60.2.90

Brebner, D. F., Kerslake, D. McK., & Waddell, J. L. (1958). The effect of atmospheric humidity on the skin temperatures and sweat rates of resting men at two ambient temperatures. *The Journal of Physiology*, *144*(2), 299–306. https://doi.org/10.1113/jphysiol.1958.sp006102

Bröde, P., Fiala, D., Lemke, B., & Kjellstrom, T. (2018). Estimated work ability in warm outdoor environments depends on the chosen heat stress assessment metric. *International Journal of Biometeorology*, *62*(3), 331–345. https://doi.org/10.1007/s00484-017-1346-9

Buchheit, M., Voss, S. C., Nybo, L., Mohr, M., & Racinais, S. (2011). Physiological and performance adaptations to an in-season soccer camp in the heat: Associations with heart rate and heart rate variability. *Scandinavian Journal of Medicine & Science in Sports*, *21*(6). https://doi.org/10.1111/j.1600-0838.2011.01378.x

Budd, G. M. (2008). Wet-bulb globe temperature (WBGT)—Its history and its limitations. *Journal of Science and Medicine in Sport*, *11*(1), Article 1. https://doi.org/10.1016/j.jsams.2007.07.003

Budhathoki, N. K., & Zander, K. K. (2019). Socio-Economic Impact of and Adaptation to Extreme Heat and Cold of Farmers in the Food Bowl of Nepal. *International Journal of Environmental Research and Public Health*, *16*(9), 1578. https://doi.org/10.3390/ijerph16091578

Burdett, K., & Mortensen, D. T. (1998). Wage Differentials, Employer Size, and Unemployment. *International Economic Review*, *39*(2), 257–273. https://doi.org/10.2307/2527292

Burdon, C. A., Johnson, N. A., Chapman, P. G., & O'Connor, H. T. (2012). Influence of Beverage Temperature on Palatability and Fluid Ingestion During Endurance Exercise: A Systematic Review. *International Journal of Sport Nutrition and Exercise Metabolism*, *22*(3), 199–211. https://doi.org/10.1123/ijsnem.22.3.199

Bureau of Economic Analysis (BEA). (n.d.). *Table 1.1.9. Implicit price deflators for Gross Domestic Product*. Retrieved January 25, 2024, from https://apps.bea.gov/iTable/?reqid=19

Bureau of Economic Analysis (BEA). (2024). *Gross Domestic Product, Fourth Quarter and Year 2023*. https://www.bea.gov/news/2024/gross-domestic-product-fourth-quarter-and-year-2023-advance-estimate

Bureau of Labor Statistics (BLS). (n.d.). *Injuries, Illnesses, and Fatalities Latest Numbers*. Retrieved November 16, 2023, from https://www.bls.gov/iif/latest-numbers.htm

Bureau of Labor Statistics (BLS). (2012). *Census of Fatal Occupational Injuries*. https://www.bls.gov/iif/overview/cfoi.htm

Bureau of Labor Statistics (BLS). (2020a). Productivity Measures: Business Sector and Major Subsectors. In *Handbook of Methods*. https://www.bls.gov/opub/hom/msp/home.htm

Bureau of Labor Statistics (BLS). (2020b). *Survey of Occupational Injuries and Illnesses Data Quality Research*. https://www.bls.gov/iif/data-quality-research/data-quality.htm

Bureau of Labor Statistics (BLS). (2021). *BLS Occupational Requirements Survey Handbook of Methods*. https://www.bls.gov/opub/hom/ors/home.htm

Bureau of Labor Statistics (BLS). (2023a). *American Time Use Survey*. https://www.bls.gov/tus/tables.htm

Bureau of Labor Statistics (BLS). (2023b). *Databases, tables & calculators by subject. Nonfatal cases involving days away from work: Selected characteristics (2011 forward)*. https://data.bls.gov/PDQWeb/cs

Bureau of Labor Statistics (BLS). (2023c). *Occupational Employment and Wage Statistics*. https://www.bls.gov/oes/tables.htm

Bureau of Labor Statistics (BLS). (2023d). *Occupational Requirements Survey*. https://www.bls.gov/ors/data.htm

Bureau of Labor Statistics (BLS). (2023e). *OIICS Version 3.0 Manual*.

Bureau of Labor Statistics (BLS). (2023f). *Quarterly Census of Employment and Wages*. https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables

Bureau of Labor Statistics (BLS). (2023g). *Survey of Occupational Injuries and Illnesses, Biennial Case and Demographic Numbers and Rates by Case Type (2021-2022)*. https://data.bls.gov/gqt/InitialPage

Bureau of Labor Statistics (BLS). (2023h). *Survey of Occupational Injuries and Illnesses, Case and Demographic Numbers for days away from work cases (2011-2020)*. https://data.bls.gov/gqt/InitialPage

Bureau of Labor Statistics (BLS). (2024a). *2022 U.S. Business Response Survey*. https://www.bls.gov/brs/data-overview.htm

Bureau of Labor Statistics (BLS). (2024b). *Employer Costs for Employee Compensation – December 2023* (USDL-24-0485). https://www.bls.gov/news.release/pdf/ecec.pdf

Bureau of Labor Statistics (BLS). (2024c). *Fatal occupational injuries by selected worker characteristics and selected event or exposure, all U.S., all ownerships, 1992–2022*. https://data.bls.gov/gqt/InitialPage

Bureau of Labor Statistics (BLS) JOLTS. (2023, November 1). *Table 2. Hires levels and rates by industry and region, seasonally adjusted*. https://www.bls.gov/news.release/jolts.t02.htm

Bureau of Labor Statistics (BLS) JOLTS. (2024). *Job Openings and Labor Turnover Survey*.

Bureau of Reclamation. (2015). Hoover Dam: Fatalities at Hoover Dam: 1931 and Earlier. Bureau of Reclamation. *Bureau of Reclamation*. https://www.usbr.gov/lc/hooverdam/history/essays/fat1931.html

Burke, M., Hsiang, S. M., & Miguel, E. (2015). Global non-linear effect of temperature on economic production. *Nature*, *527*(7577), 235–239. https://doi.org/10.1038/nature15725

Burke, M., Tanutama, V., Heft-Neal, S., Hino, M., & Lobell, D. (2023). *Game, Sweat, Match: Temperature and Elite Worker Productivity* [Working paper]. National Bureau of Economic Research.

Burton, D. J. (2006, October 1). *Dehumidification in Hot and Humid Climates*. Occupational Health & Safety. https://ohsonline.com/articles/2006/10/dehumidification-in-hot-and-humid-climates.aspx

Bynum, G. D., Pandolf, K. B., Schuette, W. H., Goldman, R. F., Lees, D. L., Whang-Peng, J., Atkinson, E. R., & Bull, J. M. (1978). Induced hyperthermia in sedated humans and the concept of critical thermal maximum. *American Journal of Physiology*, *235*(5), R228–R236.

Cachon, G., Gallino, S., & Olivares, M. (2012). Severe Weather and Automobile Assembly Productivity. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2099798

Cai, X., Lu, Y., & Wang, J. (2018). The impact of temperature on manufacturing worker productivity: Evidence from personnel data. *Journal of Comparative Economics*, *46*(4), 889–905. https://doi.org/10.1016/j.jce.2018.06.003

Calegari, F., Calamari, L., & Frazzi, E. (2012). Misting and fan cooling of the rest area in a dairy barn. *International Journal of Biometeorology*, *56*(2), Article 2. https://doi.org/10.1007/s00484-011-0432-7

California Code of Regulations (CCR), Tit. 8, § 3396) (Proposed Regulatory Text) (2023). https://www.dir.ca.gov/oshsb/documents/Indoor-Heat-proptxt.pdf

Calkins, M. M., Bonauto, D., Hajat, A., Lieblich, M., Seixas, N., Sheppard, L., & Spector, J. T. (2019). A case-crossover study of heat exposure and injury risk among outdoor construction workers in Washington State. *Scandinavian Journal of Work, Environment & Health*, *45*(6), 588–599. https://doi.org/10.5271/sjweh.3814

Cao, K.-X., Deng, Z.-C., Liu, M., Huang, Y.-X., Yang, J.-C., & Sun, L.-H. (2023). Heat Stress Impairs Male Reproductive System with Potential Disruption of Retinol Metabolism and Microbial Balance in the Testis of Mice. *The Journal of Nutrition*, *153*(12), 3373–3381. https://doi.org/10.1016/j.tjnut.2023.10.017

Card, D. (2022). Who set your wage?. American Economic Review, 112(4), 1075-1090.

Card, D., Cardoso, A. R., Heining, J., & Kline, P. (2018). Firms and labor market inequality: Evidence and some theory. Journal of Labor Economics, 36(S1), S13-S70.

Carter, J. B. (1999). Effectiveness of rest pauses and cooling in alleviation of heat stress during simulated fire-fighting activity. *Ergonomics*, *42*(2), 299–313. https://doi.org/10.1080/001401399185667

Carter, R., Cheuvront, S. N., & Sawka, M. N. (2007). A Case Report of Idiosyncratic Hyperthermia and Review of U.S. Army Heat Stroke Hospitalizations. *Journal of Sport Rehabilitation*, *16*(3), 238–243. https://doi.org/10.1123/jsr.16.3.238

Carter, R., Cheuvront, S. N., Williams, J. O., Kolka, M. A., Stephenson, L. A., Sawka, M. N., & Amoroso, P. J. (2005). Epidemiology of Hospitalizations and Deaths from Heat Illness in Soldiers. *Medicine & Science in Sports & Exercise*, *37*(8), 1338–1334. https://doi.org/10.1249/01.mss.0000174895.19639.ed

Carter, R., Garcia, A. M., & Souhan, B. E. (2011). Patients presenting with miliaria while wearing flame resistant clothing in high ambient temperatures: A case series. *Journal of Medical Case Reports*, *5*(1), 474. https://doi.org/10.1186/1752-1947-5-474

Casa, D. J., Armstrong, L. E., Kenny, G. P., O'Connor, F. G., & Huggins, R. A. (2012). Exertional Heat Stroke: New Concepts Regarding Cause and Care. *Current Sports Medicine Reports*, *11*(3), 115–123. https://doi.org/10.1249/JSR.0b013e31825615cc

Casa, D. J., DeMartini, J. K., Bergeron, M. F., Csillan, D., Eichner, E. R., Lopez, R. M., Ferrara, M. S., Miller, K. C., O'Connor, F., Sawka, M. N., & Yeargin, S. W. (2015). National Athletic Trainers' Association Position Statement: Exertional Heat Illnesses. *Journal of Athletic Training*, *50*(9), 986–1000. https://doi.org/10.4085/1062-6050-50.9.07

Casa, D. J., McDermott, B. P., Lee, E. C., Yeargin, S. W., Armstrong, L. E., & Maresh, C. M. (2007). Cold Water Immersion: The Gold Standard for Exertional Heatstroke Treatment. *Exercise and Sport Sciences Reviews*, *35*(3), 141–149. https://doi.org/10.1097/jes.0b013e3180a02bec

Census Bureau. (2021a). *2017 Statistics of U.S. Businesses (SUSB) Annual Data Tables by Establishment Industry*. https://www.census.gov/data/tables/2017/econ/susb/2017-susb-annual.html

Census Bureau. (2021b). *County Business Patterns (CBP): 2021*. https://www.census.gov/content/census/en/data/datasets/2021/econ/cbp/2021-cbp.html

Census Bureau. (2023a). *2021 State & Local Government Finance Historical Datasets and Tables*. https://www.census.gov/data/datasets/2021/econ/local/public-use-datasets.html

Census Bureau. (2023b). *2022 Census of Governments, Survey of Public Employment & Payroll Datasets & Tables*. https://www.census.gov/data/datasets/2022/econ/apes/2022.html

Census Bureau. (2023c). *2022—Public Use Files*. https://www.census.gov/data/datasets/2022/econ/gus/public-use-files.html

Census Bureau. (2023d). *2022 Government Units Survey.* https://www.census.gov/programs-surveys/gus/data/orgpublicusefiles.html

Census Bureau. (2024a). *About this Program*. https://www.census.gov/programs-surveys/susb/about.html

Census Bureau. (2024b). *Statistics of U.S. Businesses Glossary*. https://www.census.gov/programs-surveys/susb/about/glossary.html

Census Bureau, & National Center for Science and Engineering Statistics. (2023). *Annual Business Survey*. https://www.census.gov/data/tables/2023/econ/abs/2023-abs-first-look.html

Centers for Disease Control and Prevention (CDC). (2019). *Prescription drug use in the past 30 days, by sex, race and Hispanic origin, and age: United States selected years 1988-1994 through 2015-2018* (Issue Table 39).

Centers for Disease Control and Prevention (CDC). (2022). *Tips for Preventing Heat-Related Illness*. https://www.cdc.gov/disasters/extremeheat/heattips.html

Centers for Disease Control and Prevention (CDC). (2023, February 8). *Death Investigation Systems*. www.cdc.gov/phlp/publications/coroner/death.html

Centers for Disease Control and Prevention (CDC). (2024a). *Extremes of Temperature*. https://wwwnc.cdc.gov/travel/yellowbook/2024/environmental-hazards-risks/extremes-of-temperature

Centers for Disease Control and Prevention (CDC). (2024b). Heat and Medications—Guidance for Clinicians. https://www.cdc.gov/heat-health/hcp/heat-and-medications-guidance-for-clinicians.html

Cervellin, G., Comelli, I., & Lippi, G. (2010). Rhabdomyolysis: Historical background, clinical, diagnostic and therapeutic features. *Cclm*, *48*(6), 749–756. https://doi.org/10.1515/CCLM.2010.151

Chan, A. P. C., Yi, W., Wong, D. P., Yam, M. C. H., & Chan, D. W. M. (2012). Determining an optimal recovery time for construction rebar workers after working to

exhaustion in a hot and humid environment. *Building and Environment*, *58*, 163–171. https://doi.org/10.1016/j.buildenv.2012.07.006

Chan, M. (2011). Fatigue: The most critical accident risk in oil and gas construction. *Construction Management and Economics*, *29*(4), 341–353. https://doi.org/10.1080/01446193.2010.545993

Chapman, C. L., Johnson, B. D., Vargas, N. T., Hostler, D., Parker, M. D., & Schlader, Z. J. (2020). Both hyperthermia and dehydration during physical work in the heat contribute to the risk of acute kidney injury. *Journal of Applied Physiology*, *128*(4), 715–728. https://doi.org/10.1152/japplphysiol.00787.2019

Charlot, K., Tardo-Dino, P.-E., Buchet, J.-F., Koulmann, N., Bourdon, S., Lepetit, B., Roslonski, M., Jousseaume, L., & Malgoyre, A. (2017). Short-Term, Low-Volume Training Improves Heat Acclimatization in an Operational Context. *Frontiers in Physiology*, *8*, 419. https://doi.org/10.3389/fphys.2017.00419

Chawla, L. S., Eggers, P. W., Star, R. A., & Kimmel, P. L. (2014). Acute Kidney Injury and Chronic Kidney Disease as Interconnected Syndromes. *New England Journal of Medicine*, *371*(1), 58–66. https://doi.org/10.1056/NEJMra1214243

Cheela, V., John, M., Biswas, W., & Sarker, P. (2021). Combating Urban Heat Island Effect—A Review of Reflective Pavements and Tree Shading Strategies. *Buildings*, *11*(3), 93. https://doi.org/10.3390/buildings11030093

Chen, M.-L., Chen, C.-J., Yeh, W.-Y., Huang, J.-W., & Mao, I.-F. (2003). Heat Stress Evaluation and Worker Fatigue in a Steel Plant. *AIHA Journal*, *64*(3), 352–359. https://doi.org/10.1080/15428110308984827

Chen, X., & Yang, L. (2019). Temperature and industrial output: Firm-level evidence from China. *Journal of Environmental Economics and Management*, *95*, 257–274. https://doi.org/10.1016/j.jeem.2017.07.009

Chersich, M. F., Pham, M. D., Areal, A., Haghighi, M. M., Manyuchi, A., Swift, C. P., Wernecke, B., Robinson, M., Hetem, R., Boeckmann, M., & Hajat, S. (2020). Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: Systematic review and meta-analysis. *BMJ*, m3811. https://doi.org/10.1136/bmj.m3811

Chesson, B. (2012). *Working Safely in the Heat—Field Support Initiatives*. SPE-156735-MS. https://doi.org/10.2118/156735-MS

Chicas, R., Xiuhtecutli, N., Dickman, N. E., Flocks, J., Scammell, M. K., Steenland, K., Hertzberg, V., & McCauley, L. (2021). Cooling Interventions Among Agricultural Workers: Qualitative Field-Based Study. *Hispanic Health Care International*, *19*(3), 174–181. https://doi.org/10.1177/1540415321993429

Cho, H. (2017). The effects of summer heat on academic achievement: A cohort analysis. *Journal of Environmental Economics and Management*, *83*, 185–196. https://doi.org/10.1016/j.jeem.2017.03.005

Chong, D., Zhu, N., Luo, W., Zhang, Z., & Pan, X. (2020). Effects of heat acclimation on individual safety performance in hyperthermal indoor environments. *Building and Environment*, *168*, 106537. https://doi.org/10.1016/j.buildenv.2019.106537

Clifford, J., Kerslake, D. McK., & Waddell, J. L. (1959). The effect of wind speed on maximum evaporative capacity in man. *The Journal of Physiology*, *147*(2), 253–259. https://doi.org/10.1113/jphysiol.1959.sp006240

CNMI Department of Commerce. (2017). *2015 Commonwealth of the Northern Marianas Islands Statistical Yearbook*. https://ver1.cnmicommerce.com/wp-content/uploads/2017/11/2015-Yearbook-11222017.pdf

Coca, S. G., Singanamala, S., & Parikh, C. R. (2012). Chronic kidney disease after acute kidney injury: A systematic review and meta-analysis. *Kidney International*, *81*(5), 442–448. https://doi.org/10.1038/ki.2011.379

Code of Maryland Regulations 09 12 32: Heat Stress Standards. (2024). *MD Draft Heat Stress Standard*. https://www.dllr.state.md.us/labor/dliheatstressillnessprevstandarddraft.pdf

Colacito, R., Hoffmann, B., & Phan, T. (2019). Temperature and Growth: A Panel Analysis of the United States. *Journal of Money, Credit and Banking*, *51*(2–3), 313–368. https://doi.org/10.1111/jmcb.12574

Colmer, J. (2021). Temperature, Labor Reallocation, and Industrial Production: Evidence from India. *American Economic Journal: Applied Economics*, *13*(4), 101–124. https://doi.org/10.1257/app.20190249

Commandant of the Marine Corps. (2002). *Marine Corps Order 6200.1E W/CH1: Marine Corps heat injury prevention program*. https://www.imef.marines.mil/Portals/68/Docs/IMEF/Surgeon/MCO_6200.1E_W_CH_1_Heat_Injury_Prevention.pdf

Cooper, E. R., Ferrara, M. S., Casa, D. J., Powell, J. W., Broglio, S. P., Resch, J. E., & Courson, R. W. (2016). Exertional Heat Illness in American Football Players: When Is the Risk Greatest? *Journal of Athletic Training*, *51*(8), 593–600. https://doi.org/10.4085/1062-6050-51.8.08

Coris, E. E., Ramirez, A. M., & Van Durme, D. J. (2004). Heat Illness in Athletes: The Dangerous Combination of Heat, Humidity and Exercise. *Sports Medicine*, *34*(1), 9–16. https://doi.org/10.2165/00007256-200434010-00002

Correa-Calderon, A., Armstrong, D., Donald, R., DeNise, S., Enns, M., & Howison, C. (2004). Thermoregulatory responses of Holstein and Brown Swiss Heat-Stressed dairy cows to two different cooling systems. *International Journal of Biometeorology*, *48*(3), Article 3. https://doi.org/10.1007/s00484-003-0194-y

Costantino, A., Maiese, A., Lazzari, J., Casula, C., Turillazzi, E., Frati, P., & Fineschi, V. (2023). The Dark Side of Energy Drinks: A Comprehensive Review of Their Impact on the Human Body. *Nutrients*, *15*(18), 3922. https://doi.org/10.3390/nu15183922

Costrini, A. M., Pitt, H. A., Gustafson, A., & Uddin, D. (1979). Cardiovascular and metabolic manifestations of heat stroke and severe heat exhaustion. *The American Journal of Medicine*, *66*, 296–302.

Cramer, M. N., & Jay, O. (2016). Biophysical aspects of human thermoregulation during heat stress. *Autonomic Neuroscience*, *196*, 3–13. https://doi.org/10.1016/j.autneu.2016.03.001

Crandall, C. G., Wilson, T. E., Marving, J., Vogelsang, T. W., Kjaer, A., Hesse, B., & Secher, N. H. (2008). Effects of passive heating on central blood volume and ventricular dimensions in humans. *The Journal of Physiology*, *586*(1), 293–301. https://doi.org/10.1113/jphysiol.2007.143057

Crowe, J., Joubert, B. R., & Brooks, D. R. (2020). *Third International Workshop on Chronic Kidney Diseases of Uncertain/Non-Traditional Etiology in Mesoamerica and Other Regions*.

Crowe, J., Nilsson, M., Kjellstrom, T., & Wesseling, C. (2015). Heat-Related symptoms in sugarcane harvesters. *American Journal of Industrial Medicine*, *58*(5), 541–548. https://doi.org/10.1002/ajim.22450

Cuddy, M. L. S. (2004). The Effects of Drugs on Thermoregulation: *AACN Clinical Issues: Advanced Practice in Acute and Critical Care*, *15*(2), 238–253. https://doi.org/10.1097/00044067-200404000-00010

Dally, M., Butler-Dawson, J., Krisher, L., Monaghan, A., Weitzenkamp, D., Sorensen, C., Johnson, R. J., Carlton, E. J., Asensio, C., Tenney, L., & Newman, L. S. (2018). The impact of heat and impaired kidney function on productivity of Guatemalan sugarcane workers. *PLOS ONE*, *13*(10), e0205181. https://doi.org/10.1371/journal.pone.0205181

Dally, M., Butler-Dawson, J., Sorensen, C. J., Van Dyke, M., James, K. A., Krisher, L., Jaramillo, D., & Newman, L. S. (2020). Wet Bulb Globe Temperature and Recorded Occupational Injury Rates among Sugarcane Harvesters in Southwest Guatemala. *International Journal of Environmental Research and Public Health*, *17*(21), 8195. https://doi.org/10.3390/ijerph17218195

Dang, B. N., & Dowell, C. H. (2014). Factors Associated With Heat Strain Among Workers at an Aluminum Smelter in Texas. *Journal of Occupational & Environmental Medicine*, *56*(3), 313–318. https://doi.org/10.1097/JOM.0000000000000095

Dantas, G. H. M., De Alkmim Moreira Nunes, R., Casimiro-Lopes, G., Neves, E. B., De Castro, J. B. P., & De Souza Vale, R. G. (2022). Analysis of physiological markers and risk factors for the development of rhabdomyolysis in military personnel: A systematic review. *Reviews on Environmental Health*, *38*(4), 613–620. https://doi.org/10.1515/reveh-2022-0038

DARA. (2012). *Climate Vulnerability Monitor 2nd Edition*.

Dasgupta, S., van Maanen, N., Gosling, S. N., Piontek, F., Otto, C., & Schleussner, C.-F. (2021). Effects of climate change on combined labour productivity and supply: An empirical, multi-model study. *The Lancet Planetary Health*, *5*(7), e455–e465. https://doi.org/10.1016/S2542-5196(21)00170-4

Davidson, B. D., Dado-Senn, B., Padilla, N. R., Fabris, T. F., Casarotto, L. T., Ouellet, V., Toledo, I. M., Dahl, G. E., & Laporta, J. (2021). Late-gestation heat stress abatement in dairy heifers promotes thermoregulation and improves productivity. *Journal of Dairy Science*, *104*, 2357–2368. https://doi.org/10.3168/jds.2020-18998

Day, E., Fankhauser, S., Kingsmill, N., Costa, H., & Mavrogianni, A. (2019). Upholding labour productivity under climate change: An assessment of adaptation options. *Climate Policy*, *19*(3), Article 3. https://doi.org/10.1080/14693062.2018.1517640

De Fleurian, G., Perrin, J., Ecochard, R., Dantony, E., Lanteaume, A., Achard, V., Grillo, J., Guichaoua, M., Botta, A., & Sari-Minodier, I. (2009). Occupational Exposures Obtained by Questionnaire in Clinical Practice and Their Association With Semen Quality. *Journal of Andrology*, *30*(5), 566–579. https://doi.org/10.2164/jandrol.108.005918

de Lima, C. Z., Buzan, J. R., Moore, F. C., Baldos, U. L. C., Huber, M., & Hertel, T. W. (2021). Heat stress on agricultural workers exacerbates crop impacts of climate change. *Environmental Research Letters*, *16*(4), 044020. https://doi.org/10.1088/1748-9326/abeb9f

Debela, M. B., Begosaw, A. M., Deyessa, N., & Azage, M. (2023). The Burdens of Occupational Heat Exposure-related Symptoms and Contributing Factors Among Workers in Sugarcane Factories in Ethiopia: Heat Stress Wet Bulb Globe Temperature Meter. *Safety and Health at Work*, *14*(3), 325–331. https://doi.org/10.1016/j.shaw.2023.08.003

DeGroot, D. W., Henderson, K. N., & O'Connor, F. G. (2023). Cooling Modality Effectiveness and Mortality Associate With Prehospital Care of Exertional Heat Stroke Casualties. *The Journal of Emergency Medicine*, *64*(2), 175–180. https://doi.org/10.1016/j.jemermed.2022.12.015

Dell, M., Jones, B. F., & Olken, B. A. (2012). Temperature Shocks and Economic Growth: Evidence from the Last Half Century. *American Economic Journal: Macroeconomics*, *4*(3), 66–95. https://doi.org/10.1257/mac.4.3.66

Dell, M., Jones, B. F., & Olken, B. A. (2014). What Do We Learn from the Weather? The New Climate-Economy Literature. *Journal of Economic Literature*, *52*(3), 740–798. https://doi.org/10.1257/jel.52.3.740

Dellinger, A. M., Kachur, P. S., Sternberg, E., & Russell, J. (1996). Risk of Heat-Related Injury to Disaster Relief Workers in a Slow-Onset Flood Disaster: *Journal of Occupational & Environmental Medicine*, *38*(7), 689–692. https://doi.org/10.1097/00043764-199607000-00011

Deloitte. (2022). *The turning point: A new economic climate in the United States*.

Demartini, J. K., Casa, D. J., Stearns, R., Belval, L., Crago, A., Davis, R., & Jardine, J. (2015). Effectiveness of Cold Water Immersion in the Treatment of Exertional Heat Stroke at the Falmouth Road Race. *Medicine & Science in Sports & Exercise*, *47*(2), 240–245. https://doi.org/10.1249/MSS.0000000000000409

Department of Agriculture (USDA). (2019). *2017 Census of Agriculture: United States Summary and State Data*. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf

Department of Agriculture (USDA). (2020). *2017 Census of Agriculture: Puerto Rico (2018) Island and Regional Data*. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Outlying_Areas/Puerto_Rico/prv1.pdf

Department of Labor (DOL). (2022). *Findings from the National Agricultural Workers Survey (NAWS) 2019–2020: A Demographic and Employment Profile of United States Farmworkers*.

Department of Labor (DOL). (2023a). *Minimum Length of Meal Period Required Under State Law for Adult Employees in Private Sector 1*.

Department of Labor (DOL). (2023b). *Minimum Paid Rest Period Requirements Under State Law for Adult Employees in Private Sector*.

Department of Labor (DOL) (2024a). *Meeting Notes of the May 15, 2024 Tribal Consultation*.

Department of Labor (DOL). (2024b). *Office of Labor-Management Standards (OLMS)—LM Reports and Constitutions and Bylaws*.

Department of the Army. (2022). *Heat Stress Control and Heat Casualty Management*. Technical Bulletin, Medical 507. https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN35159-TB_MED_507-000-WEB-1.pdf

Department of the Army. (2023). *Prevention of Heat and Cold Casualties. TRADOC Regulation 350–29.* https://adminpubs.tradoc.army.mil/regulations/TR350-29.pdf

Department of the Navy. (2023). Prevention of heat and cold stress injuries (ashore, afloat, and ground forces). In *Manual of Naval Preventive Medicine* (NAVMED P-5010-3 (Rev. 0 8-2023)). https://www.med.navy.mil/LinkClick.aspx?fileticket=3dWaYBQLTeM%3D&tabid=13487&portalid=62&mid=51330

Department of Transportation (DOT). (2021). *Departmental Guidance: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses*. https://www.transportation.gov/sites/dot.gov/files/2021-03/DOT%20VSL%20Guidance%20-%202021%20Update.pdf

Department of Transportation (DOT). (2024). *Departmental Guidance on Valuation of a Statistical Life in Economic Analysis*. https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis

Derrick, E. H. (1934). Heat Cramps and Uremic Cramps, With Special Reference to their Treatment with Sodium Chloride. *Medical Journal of Australia*, *2*(19), 612–616. https://doi.org/10.5694/j.1326-5377.1934.tb91456.x

Deryugina, T., & Hsiang, S. (2014). *Does the Environment Still Matter? Daily Temperature and Income in the United States* (w20750; p. w20750). National Bureau of Economic Research. https://doi.org/10.3386/w20750

DiBeneditto, J. R., & Worobec, S. M. (1985). Exposure to hot environments can cause dermatological problems. *Occupational Health & Safety*, *54*(1), 35–38.

Dickinson, J. G. (1994). Heat Illness in the Services. *Journal of the Royal Army Medical Corps*, *140*(1), 7–12. https://doi.org/10.1136/jramc-140-01-02

Dill, D. B., & Costill, D. L. (1974). Calculation of percentage changes in volumes of blood, plasma, and red cells in dehydration. *Journal of Applied Physiology*, *37*(2), 247–248. https://doi.org/10.1152/jappl.1974.37.2.247

Dillender, M. (2021). Climate Change and Occupational Health: Are There Limits to Our Ability to Adapt? *Journal of Human Resources*, *56*(1), 184–224. https://doi.org/10.3368/jhr.56.1.0718-9594R3

DiscountMugs. (2024). *20 oz. Water Bottles with Push Cap*. DiscountMugs.com

Distefano, L. J., Casa, D. J., Vansumeren, M. M., Karslo, R. M., Huggins, R. A., Demartini, J. K., Stearns, R. L., Armstrong, L. E., & Maresh, C. M. (2013). Hypohydration and Hyperthermia Impair Neuromuscular Control after Exercise. *Medicine & Science in Sports & Exercise*, *45*(6), 1166–1173. https://doi.org/10.1249/MSS.0b013e3182805b83

do Nascimento Mós, J. V., Teixeira, B. E., Murata, L. S., dos Santos, V. M., de Oliveira, E. M., Steidle Neto, A. J., & Nascimento, S. T. (2022). Thermal comfort provided by different shading structures in free-range systems in Brazilian savanna. *International Journal of Biometeorology*, *66*(3), 535–544. https://doi.org/10.1007/s00484-021-02214-w

Dong, X. S., West, G. H., Holloway-Beth, A., Wang, X., & Sokas, R. K. (2019). Heat-related deaths among construction workers in the United States. *American Journal of Industrial Medicine*, *62*(12), 1047–1057. https://doi.org/10.1002/ajim.23024

Donoghue, A. M. (2004). Heat illness in the U.S. mining industry. *American Journal of Industrial Medicine*, *45*(4), 351–356. https://doi.org/10.1002/ajim.10345

Donoghue, A. M., & Sinclair, M. J. (2000). Miliaria Rubra of the Lower Limbs in Underground Miners. *Occupational Medicine*, *50*(6), 430–433. https://doi.org/10.1093/occmed/50.6.430

Donoghue, A. M., Sinclair, M. J., & Bates, G. P. (2000). Heat exhaustion in a deep underground metalliferous mine. *Occupational and Environmental Medicine*, *57*(3), 165–174. https://doi.org/10.1136/oem.57.3.165

Donoghue, E. R., Graham, M. A., Jentzen, J. M., Lifschultz, B. D., Luke, J. L., & Mirchandani, H. G. (1997). Criteria for the Diagnosis of Heat-Related Deaths: National Association of Medical Examiners: Position Paper. *The American Journal of Forensic Medicine and Pathology*, *18*(1), 11–14.

Dowell, C. H., & Tapp, L. C. (2007). *NIOSH: Evaluation of Heat Stress at a Glass Bottle Manufacturer*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH).

Drwencke, A. M., Tresoldi, G., Stevens, M. M., Narayanan, V., Carrazco, A. V., Mitloehner, F. M., Pistochini, T. E., & Tucker, C. B. (2020). Innovative cooling strategies: Dairy cow responses and water and energy use. *Journal of Dairy Science*, *103*, 5440–5454. https://doi.org/10.3168/jds.2019-17351

Dufour, A., & Candas, V. (2007). Ageing and thermal responses during passive heat exposure: Sweating and sensory aspects. *European Journal of Applied Physiology*, *100*(1), 19–26. https://doi.org/10.1007/s00421-007-0396-9

Dukes-Dobos, F. N. (1981). Hazards of heat exposure. A review. *Scandinavian Journal of Work, Environment & Health*, *7*(2), 73–83. https://doi.org/10.5271/sjweh.2560

Dukes-Dobos, F. N., & Henschel, A. (1973). Development of permissible heat exposure limits for occupational work. *Journal of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers*, *15*(5), 57–62.

Dunne, J. P., Stouffer, R. J., & John, J. G. (2013). Reductions in labour capacity from heat stress under climate warming. *Nature Climate Change*, *3*(6), 563–566. https://doi.org/10.1038/nclimate1827

DuPont. (2024). Tyvek FAQs. *Dupont.Com*. https://www.dupont.com/tyvekdesign/design-with-tyvek/dupont-tyvek-faq.html

Eastern Research Group (ERG), Inc. (2022a). *Heat Injury and Illness Prevention: Heat and Productivity Articles*.

Eastern Research Group (ERG), Inc. (2022b). *Heat Injury and Illness Prevention: Rest Breaks and Productivity Articles*.

Eastern Research Group (ERG), Inc. (2022c). *Literature Review: Productivity and Work Breaks*.

Eastern Research Group (ERG), Inc. (2024a). *The History of Heat as an Occupational Hazard*.

Eastern Research Group (ERG), Inc. (2024b). *Heat Index Monitors with Data Storage Market Research*.

Eisenberg, J., Li, J. F., & Feldmann, K. D. (2019). *Evaluation of rhabdomyolysis and heat stroke in structural firefighter cadets* (HHE Report No. 2018-0154-3361). Centers for Disease Control and Prevention.

Eisenberg, J., & Methner, M. (2014). *Evaluation of Heat Stress Heat Strain and Rhabdomyolysis in Park Employees* (2013-0109–3214). Centers for Disease Control and Prevention.

Eisenberg, J., Methner, M., Dowell, C. H., & Mueller, C. (2015). *Evaluation of Heat Stress, Heat Strain and Rhabdomyolysis during Structural Fire Fighter Training* (2012-039–3242). Centers for Disease Control and Prevention.

Eisenberg, M. L., Chen, Z., Ye, A., & Buck Louis, G. M. (2015). Relationship between physical occupational exposures and health on semen quality: Data from the Longitudinal Investigation of Fertility and the Environment (LIFE) Study. *Fertility and Sterility*, *103*(5), 1271–1277. https://doi.org/10.1016/j.fertnstert.2015.02.010

Eldridge, L. P., Wulff Pabilonia, S., Palmer, D., Stewart, J., & Varghese, J. (2022, October). Improving estimates of hours worked for US productivity measurement. *Monthly Labor Review*. https://www.bls.gov/opub/mlr/2022/article/improving-estimates-of-hours-worked-for-us-productivity-measurement.htm

Energy Information Administration (EIA). (2022). *Commercial Buildings Energy Consumption Survey (CBECS): 2018 CBECS Data*. https://www.eia.gov/consumption/commercial/data/2018/

Environmental Protection Agency (EPA). (1993). *A Guide to Heat Stress in Agriculture* (EPA-750-b-92-001). United States Environmental Protection Agency. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20001L0D.TXT

Environmental Protection Agency (EPA). (2002). *Economic Analysis for the Amended Inventory Update Final Rule*.

Environmental Protection Agency (EPA). (2021). Appendix F. Labor. In *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts (EPA 430-R-21-003)*. U.S. Environmental Protection Agency. https://www.epa.gov/cira/social-vulnerability-report

Epstein, Y., Keren, G., Moisseiev, J., Gasko, O., & Yachin, S. (1980). Psychomotor deterioration during exposure to heat. *Aviation, Space, and Environmental Medicine*, *51*(6), 607–610.

Epstein, Y., Moran, D. S., Shapiro, Y., Sohar, E., & Shemer, J. (1999). Exertional Heatstroke: A Case Series. *Medicine and Science in Sports and Exercise*, *31*(2), 224–228.

Epstein, Y., Sohar, E., & Shapiro, Y. (1995). Exertional Heatstroke: A Preventable Condition. *Israel Journal of Medical Sciences*, *31*(7), 454–462.

Epstein, Y., & Yanovich, R. (2019). Heatstroke. *New England Journal of Medicine*, *380*(25), 2449–2459. https://doi.org/10.1056/NEJMra1810762

Ergodyne. (2020). *The Heat is On: A Look at Workplace Heat Stress Prevention*.

Erickson, E. A., Engel, L. S., Christenbury, K., Weems, L., Schwartz, E. G., & Rusiecki, J. A. (2019). Environmental Heat Exposure and Heat-Related Symptoms in United States

Coast Guard Deepwater Horizon Disaster Responders. *Disaster Medicine and Public Health Preparedness*, *13*(3), 561–569. https://doi.org/10.1017/dmp.2018.120

Fagan, K. M., & Hodgson, M. J. (2017). Under-recording of work-related injuries and illnesses: An OSHA priority. *Journal of Safety Research*, *60*, 79–83. https://doi.org/10.1016/j.jsr.2016.12.002

Fair Foods Standards Council. (2021). *Fair Food Program Report, 2021*.

Fakheri, R. J., & Goldfarb, D. S. (2011). Ambient temperature as a contributor to kidney stone formation: Implications of global warming. *Kidney International*, *79*(11), 1178–1185. https://doi.org/10.1038/ki.2011.76

Fall, W., Thelen, M., Modji, K., & McCoy, K. (2024). *Heat-Related Illness on the Job: A Look at Worker's Compensation Claims in Wisconsin (2010-2022)*. Wisconsin Bureau of Environmental and Occupational Health. https://www.dhs.wisconsin.gov/publications/p03497.pdf

Fan, Z. J., Bonauto, D. K., Foley, M. P., & Silverstein, B. A. (2006). Underreporting of Work-Related Injury or Illness to Workers' Compensation: Individual and Industry Factors. *Journal of Occupational and Environmental Medicine*, *48*(9), 914–922. https://doi.org/10.1097/01.jom.0000226253.54138.1e

Federspiel, C. C., Fisk, W. J., Price, P. N., Liu, G., Faulkner, D., Dibartolomeo, D. L., Sullivan, D. P., & Lahiff, M. (2004). Worker performance and ventilation in a call center: Analyses of work performance data for registered nurses. *Indoor Air*, *14*(s8), 41–50. https://doi.org/10.1111/j.1600-0668.2004.00299.x

Figa-Talamanca, I., Dell'Orco, V., Pupi, A., Dondero, F., Gandini, L., Lenzi, A., Lombardo, F., Scavalli, P., & Mancini, G. (1992). Fertility and semen quality of workers exposed to high temperatures in the ceramics industry. *Reproductive Toxicology*, *6*, 517–523.

Financial Oversight and Management Board for Puerto Rico. (2023). *FY24 Certified Budget for the Commonwealth of Puerto Rico*.

Fire Administration (USFA). (2023). *National Fire Department Registry: Download Departments*. https://apps.usfa.fema.gov/registry/download

Firehouse Magazine. (2022a). *2021 Combination Fire Department Run Survey*. https://www.firehouse.com/careers-education/document/21259700/2021-combination-fire-department-run-survey

Firehouse Magazine. (2022b). *National Run Survey 2021—Part 1*. https://www.firehouse.com/careers-education/document/21268861/national-run-survey-2021-part-1

Fisher, A. D., Roberts, N., Bluett, S. J., Verkerk, G. A., & Matthews, L. R. (2008). Effects of shade provision on the behaviour, body temperature and milk production of grazing dairy cows during a New Zealand summer. *New Zealand Journal of Agricultural Research*, *51*(2), 99–105. https://doi.org/10.1080/00288230809510439

Fisk, W. J. (2000). Health and productivity gains from better indoor environments and their relationship with building energy efficiency. *Annual Review of Energy and the Environment*, *25*(1), 537–566. https://doi.org/10.1146/annurev.energy.25.1.537

Fleischer, N. L., Tiesman, H. M., Sumitani, J., Mize, T., Amarnath, K. K., Bayakly, A. R., & Murphy, M. W. (2013). Public Health Impact of Heat-Related Illness Among Migrant Farmworkers. *American Journal of Preventive Medicine*, *44*(3), 199–206. https://doi.org/10.1016/j.amepre.2012.10.020

Flocks, J., Vi Thien Mac, V., Runkle, J., Tovar-Aguilar, J. A., Economos, J., & McCauley, L. A. (2013). Female Farmworkers' Perceptions of Heat-Related Illness and Pregnancy Health. *Journal of Agromedicine*, *18*(4), 350–358. https://doi.org/10.1080/1059924X.2013.826607

Florida Department of Health (DOH). (2011). *Descriptive analysis of occupational heat-related illness treated in Florida hospitals and emergency departments*. Florida Department of Health, Division of Environmental Health. https://www.floridahealth.gov/%5C/environmental-health/occupational-health-surveillance/_documents/occ-heat-related-illness.pdf

Flouris, A. D., Dinas, P. C., Ioannou, L. G., Nybo, L., Havenith, G., Kenny, G. P., & Kjellstrom, T. (2018). Workers' health and productivity under occupational heat strain: A systematic review and meta-analysis. *The Lancet Planetary Health*, *2*(12), e521–e531. https://doi.org/10.1016/S2542-5196(18)30237-7

Flouris, A. D., Ioannou, L. G., Mayor, T. S., & Hernandez, R. C. S. (2020). *D3.5: Report on solutions to mitigate heat stress of construction sector workers*.

Fogleman, M., Fakhrzadeh, L., & Bernard, T. E. (2005). The relationship between outdoor thermal conditions and acute injury in an aluminum smelter. *International Journal of Industrial Ergonomics*, *35*(1), 47–55. https://doi.org/10.1016/j.ergon.2004.08.003

Foster, J., Hodder, S. G., Goodwin, J., & Havenith, G. (2020). Occupational Heat Stress and Practical Cooling Solutions for Healthcare and Industry Workers During the COVID-19 Pandemic. *Annals of Work Exposures and Health*, *64*(9), Article 9. https://doi.org/10.1093/annweh/wxaa082

Foster, J., Smallcombe, J. W., Hodder, S., Jay, O., Flouris, A. D., & Havenith, G. (2022a). Quantifying the impact of heat on human physical work capacity; part II: The observed interaction of air velocity with temperature, humidity, sweat rate, and clothing is not captured by most heat stress indices. *International Journal of Biometeorology*, *66*(3), 507–520. https://doi.org/10.1007/s00484-021-02212-y

Foster, J., Smallcombe, J. W., Hodder, S., Jay, O., Flouris, A. D., Nybo, L., & Havenith, G. (2021). An advanced empirical model for quantifying the impact of heat and climate change on human physical work capacity. *International Journal of Biometeorology*, *65*(7), 1215–1229. https://doi.org/10.1007/s00484-021-02105-0

Foster, J., Smallcombe, J. W., Hodder, S., Jay, O., Flouris, A. D., Nybo, L., & Havenith, G. (2022b). Quantifying the impact of heat on human physical work capacity; part III: The impact of solar radiation varies with air temperature, humidity, and clothing

coverage. *International Journal of Biometeorology*, *66*(1), 175–188. https://doi.org/10.1007/s00484-021-02205-x

Fouillet, A., Rey, G., Laurent, F., Pavillon, G., Bellec, S., Guihenneuc-Jouyaux, C., Clavel, J., Jougla, E., & Hémon, D. (2006). Excess mortality related to the August 2003 heat wave in France. *International Archives of Occupational and Environmental Health*, *80*(1), 16–24. https://doi.org/10.1007/s00420-006-0089-4

Fournel, S., Ouellet, V., & Charbonneau, É. (2017). Practices for Alleviating Heat Stress of Dairy Cows in Humid Continental Climates: A Literature Review. *Animals*, *7*(12), 37. https://doi.org/10.3390/ani7050037

Fowler, D., Mitchell, C., Brown, A., Pollock, T., Bratka, L., Paulson, J., Noller, A., Mauskapf, R., Oscanyan, K., Vaidyanathan, A., Wolkin, A., Taylor, E., & Radcliffe, R. (2013). Heat-related deaths after an extreme heat event—Four states, 2012, and United States, 1999-2009. *MMWR. Morbidity and Mortality Weekly Report*, *62*(22), 433–436.

Freund, J., Joyner, J., Jilka, M., Nittolo, M., Andrew, J., & Wilmore, H. (1987). Thermoregulation during prolonged exercise in heat: Alterations with beta-adrenergic blockade. *Journal of Applied Physiology*, *63*(3), 930–936.

Gagnon, D., Jay, O., Lemire, B., & Kenny, G. P. (2008). Sex-related differences in evaporative heat loss: The importance of metabolic heat production. *European Journal of Applied Physiology*, *104*(5), 821–829. https://doi.org/10.1007/s00421-008-0837-0

Gagnon, D., & Kenny, G. P. (2011). Sex modulates whole-body sudomotor thermosensitivity during exercise. *The Journal of Physiology*, *589*(24), 6205–6217. https://doi.org/10.1113/jphysiol.2011.219220

Gagnon, D., & Kenny, G. P. (2012). Sex differences in thermoeffector responses during exercise at fixed requirements for heat loss. *Journal of Applied Physiology*, *113*(5), 746–757. https://doi.org/10.1152/japplphysiol.00637.2012

Gagnon, D., Romero, S. A., Cramer, M. N., Jay, O., & Crandall, C. G. (2016). Cardiac and Thermal Strain of Elderly Adults Exposed to Extreme Heat and Humidity With and Without Electric Fan Use. *JAMA*, *316*(9), 989. https://doi.org/10.1001/jama.2016.10550

Galer, M. (2019). *The heat center initiative: Heat illness awareness*. https://www.army.mil/article/218736/the_heat_center_initiative_heat_illness_awareness

Games, K. E., Winkelmann, Z. K., McGinnis, K. D., McAdam, J. S., Pascoe, D. D., & Sefton, J. M. (2020). Functional Performance of Firefighters After Exposure to Environmental Conditions and Exercise. *Journal of Athletic Training*, *55*(1), 71–79. https://doi.org/10.4085/1062-6050-75-18

Garcia, C. K., Renteria, L. I., Leite-Santos, G., Leon, L. R., & Laitano, O. (2022). Exertional heat stroke: Pathophysiology and risk factors. *BMJ Medicine*, *1*(1), e000239. https://doi.org/10.1136/bmjmed-2022-000239

García-Trabanino, R., Jarquín, E., Wesseling, C., Johnson, R. J., González-Quiroz, M., Weiss, I., Glaser, J., José Vindell, J., Stockfelt, L., Roncal, C., Harra, T., & Barregard, L. (2015). Heat stress, dehydration, and kidney function in sugarcane cutters in El Salvador

– A cross-shift study of workers at risk of Mesoamerican nephropathy. *Environmental Research*, *142*, 746–755. https://doi.org/10.1016/j.envres.2015.07.007

Gardner, J. W., Kark, J. A., Karnei, K., Sanborn, J. S., Gastaldo, E., Burr, P., & Wenger, C. B. (1996). Risk factors predicting exertional heat illness in male Marine Corps recruits: *Medicine & Science in Sports & Exercise*, *28*(8), 939–944. https://doi.org/10.1097/00005768-199608000-00001

Gardner, J. W., & Kork, J. A. (1994). Fatal Rhabdomyolysis Presenting as Mild Heat Illness in Military Training. *Military Medicine*, *159*(2), 160–163. https://doi.org/10.1093/milmed/159.2.160

Gardner, L., Miller, D. M., Daly, C., Gupta, P. K., House, C., Roiz De Sa, D., Shaw, M.-A., & Hopkins, P. M. (2020). Investigating the genetic susceptibility to exertional heat illness. *Journal of Medical Genetics*, *57*(8), 531–541. https://doi.org/10.1136/jmedgenet-2019-106461

Garg, T., Gibson, M., & Sun, F. (2020a). Extreme temperatures and time use in China. *Journal of Economic Behavior & Organization*, *180*, 309–324. https://doi.org/10.1016/j.jebo.2020.10.016

Garg, T., Jagnani, M., & Taraz, V. (2020b). Temperature and Human Capital in India. *Journal of the Association of Environmental and Resource Economists*, *7*(6), 1113–1150. https://doi.org/10.1086/710066

Garrett, J. W., & Teizer, J. (2009). Human Factors Analysis Classification System Relating to Human Error Awareness Taxonomy in Construction Safety. *Journal of Construction Engineering and Management*, *135*(8), 754–763. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000034

Garrow, Valerie. (2016). *Presenteeism: A review of current thinking*. Institute for Employment Studies (IES).

Garzón-Villalba, X. P., Ashley, C. D., & Bernard, T. E. (2019). Benchmarking Heat Index as an occupational exposure limit for heat stress. *Journal of Occupational and Environmental Hygiene*, *16*(8), 557–563. https://doi.org/10.1080/15459624.2019.1628348

Garzón-Villalba, X. P., Mbah, A., Wu, Y., Hiles, M., Moore, H., Schwartz, S. W., & Bernard, T. E. (2016). Exertional heat illness and acute injury related to ambient wet bulb globe temperature. *American Journal of Industrial Medicine*, *59*(12), 1169–1176. https://doi.org/10.1002/ajim.22650

Garzón-Villalba, X. P., Wu, Y., Ashley, C. D., & Bernard, T. E. (2017). Ability to Discriminate Between Sustainable and Unsustainable Heat Stress Exposures—Part 1: WBGT Exposure Limits. *Annals of Work Exposures and Health*, *61*(6), 611–620. https://doi.org/10.1093/annweh/wxx034

Gauer, R., & Meyers, B. K. (2019). Heat-related illnesses. *American Family Physician*, *99*(8), 482–489.

Gessel, T., & Lin, C. Y. (2020). Exertional Heatstroke in a Marathon Runner Complicated by Concurrent Use of an Antipsychotic Medication Affecting Thermoregulation. *Clinical Journal of Sport Medicine*, *30*(5), e166–e168. https://doi.org/10.1097/JSM.0000000000000750

Gibson, T. M., & Allan, J. R. (1979). Effect on performance of cycling deep body temperature between 37.0 and 37.6 C. *Aviation, Space, and Environmental Medicine*, *50*(9), 935–938.

Gibson, T. M., Lawson, C. J., Green, R. G., & Allan, J. R. (1980). Effect of induced cyclic changes of deep body temperature on performance of a flight simulator. *Aviation, Space, and Environmental Medicine*, *51*(4), 356–360.

Gittleman, M., & Pierce, B. (2013). How Prevalent is Performance-Related Pay in the United States? Current Incidence and Recent Trends. *National Institute Economic Review*, *226*, R4–R16. https://doi.org/10.1177/002795011322600102

Glaser, J., Hansson, E., Weiss, I., Wesseling, C., Jakobsson, K., Ekström, U., Apelqvist, J., Lucas, R., Arias Monge, E., Peraza, S., Hogstedt, C., & Wegman, D. H. (2020). Preventing kidney injury among sugarcane workers: Promising evidence from enhanced workplace interventions. *Occupational and Environmental Medicine*, *77*(8), 527–534. https://doi.org/10.1136/oemed-2020-106406

Glaser, J., Wegman, D. H., Arias-Monge, E., Pacheco-Zenteno, F., Prince, H., Chavarria, D., Martinez-Cuadra, W. J., Jakobsson, K., Hansson, E., Lucas, R. A. I., Weiss, I., & Wesseling, C. (2022). Workplace Intervention for Heat Stress: Essential Elements of Design, Implementation, and Assessment. *International Journal of Environmental Research and Public Health*, *19*(7), Article 7. https://doi.org/10.3390/ijerph19073779

Goodman, A., Klitzman, S., Lau, S., Surick, I., Schultz, S., Myers, W., Dawson, J., Smith, J., Timperi, R., & Grady, G. (1990). Exertional Rhabdomyolysis and Acute Renal Impairment—New York City and Massachusetts 1988. *Morbidity and Mortality Weekly Report (MMWR)*, *39*(42), 751–756.

Government Accountability Office (GAO). (2009). *Enhancing OSHA's Records Audit Process Could Improve the Accuracy of Worker Injury and Illness Data* (GAO 10-10; Report to Congressional Requesters). United States Government Accountability Office. www.gao.gov/pdf/product/new-items-d1010

Goyal, A., Daneshpajouhnejad, P., Hashmi, M. F., & Bashir, K. (2023). Acute Kidney Injury. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK441896/

Graff Zivin, J., Hsiang, S. M., & Neidell, M. (2018). Temperature and Human Capital in the Short and Long Run. *Journal of the Association of Environmental and Resource Economists*, *5*(1), 77–105. https://doi.org/10.1086/694177

Graff Zivin, J., & Neidell, M. (2012). The Impact of Pollution on Worker Productivity. *American Economic Review*, *102*(7), 3652–3673. https://doi.org/10.1257/aer.102.7.3652

Graff Zivin, J., & Neidell, M. (2014). Temperature and the Allocation of Time: Implications for Climate Change. *Journal of Labor Economics*, *32*(1), 1–26. https://doi.org/10.1086/671766

Graff Zivin, J., Song, Y., Tang, Q., & Zhang, P. (2020). Temperature and high-stakes cognitive performance: Evidence from the national college entrance examination in China. *Journal of Environmental Economics and Management*, *104*, 102365. https://doi.org/10.1016/j.jeem.2020.102365

Grandjean, A. C., & Grandjean, N. R. (2007). Dehydration and Cognitive Performance. *Journal of the American College of Nutrition*, *26*(sup5), 549S-554S. https://doi.org/10.1080/07315724.2007.10719657

Grant, R. T., & Holling, H. E. (1938). Further observations on the vascular responses of the human limb to body warming; evidence for sympathetic vasodilator nerves in the normal subject. *Clin Sci*, *3*(3), 273–285.

Groenewold, M. R., & Baron, S. L. (2013). The Proportion of Work-Related Emergency Department Visits Not Expected to Be Paid by Workers' Compensation: Implications for Occupational Health Surveillance, Research, Policy, and Health Equity. *Health Services Research*, *48*(6pt1), 1939–1959. https://doi.org/10.1111/1475-6773.12066

Guam Governor's Office. (2024). *2024 Executive Budget Request*. https://bbmr.guam.gov/wp-bbmr-content/uploads/2023/01/FY2024-EXECUTIVE-BUDGET-REQUEST-E-VIEW-Compressed.pdf

Gubernot, D. (2015). *Occupational Heat-Related Mortality in the United States, 2000-2010: Epidemiology and Policy Recommendations* [The Milken Institute School of Public Health of The George Washington University]. https://scholarspace.library.gwu.edu/concern/gw_etds/sf268523f?locale=en

Gubernot, D. M., Anderson, G. B., & Hunting, K. L. (2015). Characterizing occupational heat-related mortality in the United States, 2000–2010: An analysis using the census of fatal occupational injuries database. *American Journal of Industrial Medicine*, *58*(2), 203–211. https://doi.org/10.1002/ajim.22381

Gun, R. T., & Budd, G. M. (1995). Effects of thermal, personal and behavioural factors on the physiological strain, thermal comfort and productivity of Australian shearers in hot weather. *Ergonomics*, *38*(7), 1368–1384. https://doi.org/10.1080/00140139508925195

Guzman, G., & Kollar, M. (2023). *Income in the United States: 2022* (P60-279; Current Population Reports). U.S. Government Publishing Office.

Hales, C. M., Kohen, D., Servias, J., & Martin, C. B. (2019). Prescription Drug Use Among Adults Aged 40–79 in the United States and Canada. *NCHS Data Brief*, *347*.

Hancock, P. A., & Vasmatzidis, I. (1998). Human occupational and performance limits under stress: The thermal environment as a prototypical example. *Ergonomics*, *41*(8), 1169–1191. https://doi.org/10.1080/001401398186469

Hancock, P. A., & Vasmatzidis, I. (2003). Effects of heat stress on cognitive performance: The current state of knowledge. *International Journal of Hyperthermia*, *19*(3), 355–372. https://doi.org/10.1080/0265673021000054630

Hanna, A. S. (2004). *The Effect of Temperature on Productivity*. National Electrical Contractors Association (NECA).

Hansson, E., Glaser, J., Jakobsson, K., Weiss, I., Wesseling, C., Lucas, R. A. I., Wei, J. L. K., Ekström, U., Wijkström, J., Bodin, T., Johnson, R. J., & Wegman, D. H. (2020). Pathophysiological Mechanisms by which Heat Stress Potentially Induces Kidney Inflammation and Chronic Kidney Disease in Sugarcane Workers. *Nutrients*, *12*(6), 1639. https://doi.org/10.3390/nu12061639

Hansson, E., Jakobsson, K., Glaser, J., Wesseling, C., Chavarria, D., Lucas, R. A. I., Prince, H., & Wegman, D. H. (2024). Impact of heat and a rest-shade-hydration intervention program on productivity of piece-paid industrial agricultural workers at risk of chronic kidney disease of nontraditional origin. *Annals of Work Exposures and Health*, *68*(4), 366–375. https://doi.org/10.1093/annweh/wxae007

Harduar Morano, L. (2016). *Ambient Outdoor Heat and Heat-related Illness in Florida* [The University of North Carolina at Chapel Hill University Libraries]. https://doi.org/10.17615/3STE-T186

Harduar Morano, L. (2023). *Communication with Laurel Harduar Morano on October 18, 2023*.

Harduar Morano, L., Bunn, T. L., Lackovic, M., Lavender, A., Dang, G. T. T., Chalmers, J. J., Li, Y., Zhang, L., & Flammia, D. D. (2015). Occupational heat-related illness emergency department visits and inpatient hospitalizations in the southeast region, 2007–2011. *American Journal of Industrial Medicine*, *58*(10), 1114–1125. https://doi.org/10.1002/ajim.22504

Harduar Morano, L., & Waller, A. E. (2017). Evaluation of the Components of the North Carolina Syndromic Surveillance System Heat Syndrome Case Definition. *Public Health Reports*, *132*(1), 40S-47S. https://doi.org/10.1177/0033354917710946

Harduar Morano, L., & Watkins, S. (2017). Evaluation of Diagnostic Codes in Morbidity and Mortality Data Sources for Heat-Related Illness Surveillance. *Public Health Reports*, *132*(3), 326–335. https://doi.org/10.1177/0033354917699826

Harduar Morano, L., Watkins, S., & Kintziger, K. (2016). A Comprehensive Evaluation of the Burden of Heat-Related Illness and Death within the Florida Population. *International Journal of Environmental Research and Public Health*, *13*(6), 551. https://doi.org/10.3390/ijerph13060551

Hart, G., Anderson, R., Crumpler, C., Shulkin, A., Reed, G., & Knochel, J. (1982). Epidemic classical heat stroke: Clinical characteristics and course of 28 patients. *Medicine*, *61*(3).

Havenith, G., Coenen, J. M. L., Kistemaker, L., & Kenney, W. L. (1998). Relevance of individual characteristics for human heat stress response is dependent on exercise

intensity and climate type. *European Journal of Applied Physiology*, *77*(3), 231–241. https://doi.org/10.1007/s004210050327

Heal, G., & Park, J. (2013). *Feeling the Heat: Temperature, Physiology & the Wealth of Nations* [Working paper]. National Bureau of Economic Research.

Heal, G., & Park, J. (2016). Reflections—Temperature Stress and the Direct Impact of Climate Change: A Review of an Emerging Literature. *Review of Environmental Economics and Policy*, *10*(2), 347–362. https://doi.org/10.1093/reep/rew007

Heiden Associates, Inc. (1989). *A Study of Industry Compliance Costs Under the Final Comprehensive Assessment Information Rule*.

Heinzerling, A., Laws, R. L., Frederick, M., Jackson, R., Windham, G., Materna, B., & Harrison, R. (2020). Risk factors for occupational heat-related illness among California workers, 2000–2017. *American Journal of Industrial Medicine*, *63*(12), 1145–1154. https://doi.org/10.1002/ajim.23191

Heled, Y., Moran, D. S., Mendel, L., Laor, A., Pras, E., & Shapiro, Y. (2004). Human ACE I/D polymorphism is associated with individual differences in exercise heat tolerance. *Journal of Applied Physiology*, *97*(1), 72–76. https://doi.org/10.1152/japplphysiol.01087.2003

Hemp, P. (2004). Presenteeism: At work--but out of it. *Harvard Business Review*, *82*(10), 49–58, 155.

Hendrie, A. L., Brotherhood, J. R., Budd, G. M., Jeffery, S. E., Beasley, F. A., Costin, B. P., Zhien, W., Baker, M. M., Cheney, N. P., & Dawson, M. P. (1997). Project Aquarius 8. Sweating, drinking, and dehydration in men suppressing wildland fires. *International Journal of Wildland Fire*, *7*(2), 145–158.

Hesketh, M., Wuellner, S., Robinson, A., Adams, D., Smith, C., & Bonauto, D. (2020). Heat related illness among workers in Washington State: A descriptive study using workers' compensation claims, 2006-2017. *American Journal of Industrial Medicine*, *63*(4), 300–311. https://doi.org/10.1002/ajim.23092

Heung, M., Steffick, D. E., Zivin, K., Gillespie, B. W., Banerjee, T., Hsu, C., Powe, N. R., Pavkov, M. E., Williams, D. E., Saran, R., Shahinian, V. B., Saran, R., Li, Y., Bragg-Gresham, J., Shahinian, V., Morgenstern, H., Heung, M., Steffick, D., Tilea, A., … Waller, L. (2016). Acute Kidney Injury Recovery Pattern and Subsequent Risk of CKD: An Analysis of Veterans Health Administration Data. *American Journal of Kidney Diseases*, *67*(5), 742–752. https://doi.org/10.1053/j.ajkd.2015.10.019

Heutel, G., Miller, N.H., & Molitor, D. (2021). Adaptation and the mortality effects of temperature across US climate regions. *Review of Economics and Statistics*, 103(4), 740-753.

Hill, O. T., Wahi, M. M., Carter, R., Kay, A. B., Mckinnon, C. J., & Wallace, R. F. (2012). Rhabdomyolysis in the US Active Duty Army, 2004–2006. *Medicine & Science in Sports & Exercise*, *44*(3), 442–449. https://doi.org/10.1249/MSS.0b013e3182312745

Hirsch, B., Jahn, E. J., & Schnabel, C. (2018). Do employers have more monopsony power in slack labor markets?. *ILR Review*, 71(3), 676-704.

Hirsch, B. T., Macpherson, D. A., & Even, W. E. (n.d.). *Union Membership, Coverage, Density and Employment by State and Sector: 1983-2023*. https://unionstats.com/state/xls/state_1983_2023.xlsx

Hirsch, J. A., Nicola, G., McGinty, G., Liu, R. W., Barr, R. M., Chittle, M. D., & Manchikanti, L. (2016). ICD-10: History and Context. *American Journal of Neuroradiology*, *37*(4), 596–599. https://doi.org/10.3174/ajnr.A4696

Holmes, N. A., Miller, V. S., Schneider, J., Hasan, O., & Bates, G. P. (2011). Plasma Sodium Levels and Dietary Sodium Intake in Manual Workers in the Middle East. *The Annals of Occupational Hygiene*, *55*(4), 397–402. https://doi.org/10.1093/annhyg/mer004

Holtzhausen, L.-M., Noakes, T. D., Kroning, B., De Klerk, M., Roberts, M., & Emsley, R. (1994). *Clinical and biochemical characteristics of collapsed ultra-marathon runners*.

Holzle, E., & Kligman, A. M. (1978). The pathogenesis of miliaria rubra: Role of the Resident Microflora. *British Journal of Dermatology*, *99*(2), 117–137. https://doi.org/10.1111/j.1365-2133.1978.tb01973.x

Hooker, T., & Baker, J. (2023, June 23). “We’re trapped in these trucks all day”: US Postal Service carrier. 25 News. www.kxxv.com/were-trapped-in-these-trucks-all-day-us-postal-service-carrier

Hope, A., & Tyssebotn, I. (1983). The Effect of Water Deprivation on Local Renal Blood Flow and Filtration in the laboratory rat. *Circulatory Shock*, *11*(2), 175–186.

Horn, G. P., Blevins, S., Fernhall, B., & Smith, D. L. (2013). Core temperature and heart rate response to repeated bouts of firefighting activities. *Ergonomics*, *56*(9), 1465–1473. https://doi.org/10.1080/00140139.2013.818719

Horswill, C. A., Stofan, J. R., Lacambra, M., Toriscelli, T. A., Eichner, E. R., & Murray, R. (2009). Sodium Balance During U. S. Football Training in the Heat: Cramp-Prone vs. Reference Players. *International Journal of Sports Medicine*, *30*(11), 789–794. https://doi.org/10.1055/s-0029-1234056

Hostler, D., Reis, S. E., Bednez, J. C., Kerin, S., & Suyama, J. (2010). Comparison of Active Cooling Devices with Passive Cooling for Rehabilitation of Firefighters Performing Exercise in Thermal Protective Clothing: A Report from the Fireground Rehab Evaluation (FIRE) Trial. *Prehospital Emergency Care*, *14*(3), 300–309. https://doi.org/10.3109/10903121003770654

Hough, T., & Ballantyne, B. L. (1899). Preliminary note on the effects of changes in external temperature on the circulation of blood in the skin. *Journal. Boston Society of Medical Sciences*, *3*(12), 330–334.

Howe, A. S., & Boden, B. P. (2007). Heat-Related Illness in Athletes. *The American Journal of Sports Medicine*, *35*(8), 1384–1395. https://doi.org/10.1177/0363546507305013

Hsiang, S. M. (2010). Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America. *Proceedings of the National Academy of Sciences*, *107*(35), 15367–15372. https://doi.org/10.1073/pnas.1009510107

Hsu, R. K., & Hsu, C. (2016). The Role of Acute Kidney Injury in Chronic Kidney Disease. *Seminars in Nephrology*, *36*(4), 283–292. https://doi.org/10.1016/j.semnephrol.2016.05.005

Human Performance Resources by Consortium for Health and Military Performance (HPRC). (2023). *Warrior heat- and exertion-related events collaborative*. https://www.hprc-online.org/resources-partners/whec

Hunt, P. R., Hackman, H., Berenholz, G., McKeown, L., Davis, L., & Ozonoff, V. (2007). Completeness and accuracy of International Classification of Disease (ICD) external cause of injury codes in emergency department electronic data. *Injury Prevention*, *13*(6), 422–425. https://doi.org/10.1136/ip.2007.015859

Hur, P., Park, K., Rosengren, K. S., Horn, G. P., & Hsiao-Wecksler, E. T. (2015). Effects of air bottle design on postural control of firefighters. *Applied Ergonomics*, *48*, 49–55. https://doi.org/10.1016/j.apergo.2014.11.003

Hur, P., Rosengren, K. S., Horn, G. P., Smith, D. L., & Hsiao-Wecksler, E. T. (2013). Effect of Protective Clothing and Fatigue on Functional Balance of Firefighters. *Journal of Ergonomics*, *S2*(2). https://doi.org/10.4172/2165-7556.S2-004

Iba, T., Connors, J. M., Levi, M., & Levy, J. H. (2022). Heatstroke-induced coagulopathy: Biomarkers, mechanistic insights, and patient management. *EClinicalMedicine*, *44*, 101276. https://doi.org/10.1016/j.eclinm.2022.101276

Iglesias-Rios, L., Valentín-Cortés, M., Fleming, P. J., O'Neill, M. S., & Handal, A. J. (2023). The Michigan Farmworker Project: A Community-Based Participatory Approach to Research on Precarious Employment and Labor Exploitation of Farmworkers. *Labor Studies Journal*, *48*(4), 336–362. https://doi.org/10.1177/0160449X231196227

Igloo Products Corp. (2024). *Igloo Coolers- 10 Gallon Seat Top Water Jug with Cup Dispenser*. Igloocoolers.com

Inaba, R., & Mirbod, S. M. (2007). Comparison of Subjective Symptoms and Hot Prevention Measures in Summer between Traffic Control Workers and Construction Workers in Japan. *Industrial Health*, *45*(1), 91–99. https://doi.org/10.2486/indhealth.45.91

International Labour Organization (ILO). (2019). *Working on a Warmer Planet: The Impact of Heat Stress on Labour Productivity and Decent Work*. International Labour Office.

International Organization for Standardization (ISO). (2017). *Ergonomics of the thermal environment—Assessment of heat stress using the WBGT (wet bulb globe temperature) index. Third Edition. ISO 7243:2017(E). 2017*. https://www.iso.org/standard/67188.html

Ioannou, L. (2024, April 27). *Communication with Leonidas Ioannou on April 27, 2024* [Personal communication].

Ioannou, L. G., Foster, J., Morris, N. B., Piil, J. F., Havenith, G., Mekjavic, I. B., Kenny, G. P., Nybo, L., & Flouris, A. D. (2022). Occupational heat strain in outdoor workers: A comprehensive review and meta-analysis. *Temperature*, *9*(1), 67–102. https://doi.org/10.1080/23328940.2022.2030634

Ioannou, L. G., Mantzios, K., Tsoutsoubi, L., Nintou, E., Vliora, M., Gkiata, P., Dallas, C. N., Gkikas, G., Agaliotis, G., Sfakianakis, K., Kapnia, A. K., Testa, D. J., Amorim, T., Dinas, P. C., Mayor, T. S., Gao, C., Nybo, L., & Flouris, A. D. (2021a). Occupational Heat Stress: Multi-Country Observations and Interventions. *International Journal of Environmental Research and Public Health*, *18*(12), 6303. https://doi.org/10.3390/ijerph18126303

Ioannou, L. G., Tsoutsoubi, L., Mantzios, K., Gkikas, G., Piil, J. F., Dinas, P. C., Notley, S. R., Kenny, G. P., Nybo, L., & Flouris, A. D. (2021b). The Impacts of Sun Exposure on Worker Physiology and Cognition: Multi-Country Evidence and Interventions. *International Journal of Environmental Research and Public Health*, *18*(14), 7698. https://doi.org/10.3390/ijerph18147698

Ioannou, L. G., Tsoutsoubi, L., Samoutis, G., Bogataj, L. K., Kenny, G. P., Nybo, L., Kjellstrom, T., & Flouris, A. D. (2017). Time-motion analysis as a novel approach for evaluating the impact of environmental heat exposure on labor loss in agriculture workers. *Temperature*, *4*(3), Article 3. https://doi.org/10.1080/23328940.2017.1338210

Ireland, A., Johnston, D., & Knott, R. (2024). Impacts of Extreme Heat on Labor Force Dynamics. *Centre for Health Economics, Monash Business School*.

Isen, A., Rossin-Slater, M., & Walker, R. (2017). Relationship between season of birth, temperature exposure, and later life wellbeing. *Proceedings of the National Academy of Sciences*, *114*(51), 13447–13452. https://doi.org/10.1073/pnas.1702436114

Ishani, A., Xue, J. L., Himmelfarb, J., Eggers, P. W., Kimmel, P. L., Molitoris, B. A., & Collins, A. J. (2009). Acute Kidney Injury Increases Risk of ESRD among Elderly. *Journal of the American Society of Nephrology*, *20*(1), 223–228. https://doi.org/10.1681/ASN.2007080837

Jacklitsch, B. L., King, K. A., Vidourek, R. A., & Merianos, A. L. (2018). Heat-Related Training and Educational Material Needs among Oil Spill Cleanup Responders. *Environmental Health Insights*, *12*, 117863021880229. https://doi.org/10.1177/1178630218802295

Jackson, L. L., & Rosenberg, H. R. (2010). Preventing Heat-Related Illness Among Agricultural Workers. *Journal of Agromedicine*, *15*(3), 200–215. https://doi.org/10.1080/1059924X.2010.487021

Jansen, P. H. P., Gabreëls, F. J. M., & Van Engelen, B. G. M. (2002). Diagnosis and Differential Diagnosis of Muscle Cramps: A Clinical Approach: *Journal of Clinical Neuromuscular Disease*, *4*(2), 89–94. https://doi.org/10.1097/00131402-200212000-00008

Jay, O., Cramer, M. N., Ravanelli, N. M., & Hodder, S. G. (2015). Should electric fans be used during a heat wave? *Applied Ergonomics*, *46*, 137–143. https://doi.org/10.1016/j.apergo.2014.07.013

Jay, O., Hoelzl, R., Weets, J., Morris, N., English, T., Nybo, L., Niu, J., de Dear, R., & Capon, A. (2019). Fanning as an alternative to air conditioning – A sustainable solution for reducing indoor occupational heat stress. *Energy and Buildings*, *193*, 92–98. https://doi.org/10.1016/j.enbuild.2019.03.037

Jessoe, K., Manning, D. T., & Taylor, J. E. (2018). Climate Change and Labour Allocation in Rural Mexico: Evidence from Annual Fluctuations in Weather. *The Economic Journal*, *128*(608), 230–261. https://doi.org/10.1111/ecoj.12448

Jimenez, C., Melin, B., Koulmann, N., Allevard, A. M., Launay, J. C., & Savourey, G. (1999). Plasma volume changes during and after acute variations of body hydration level in humans. *European Journal of Applied Physiology*, *80*, 1–8.

J.J. Keller and Associates Inc. (2022). *J.J. Keller Center for Market Insight Pulse Poll (August 2022)*.

Joblist. (2022, July 5). Survey: Do you know how to take a break from work? *Joblist.Com*. https://www.joblist.com/trends/survey-taking-breaks-from-work

Joe, L., Roisman, R., Beckman, S., Jones, M., Beckman, J., Frederick, M., & Harrison, R. (2014). Using multiple data sets for public health tracking of work-related injuries and illnesses in California. *American Journal of Industrial Medicine*, *57*(10), 1110–1119. https://doi.org/10.1002/ajim.22361

Johansson, B., Rask, K., & Stenberg, M. (2010). Piece rates and their effects on health and safety – A literature review. *Applied Ergonomics*, *41*(4), 607–614. https://doi.org/10.1016/j.apergo.2009.12.020

Johnson, R. J., Wesseling, C., & Newman, L. S. (2019). Chronic Kidney Disease of Unknown Cause in Agricultural Communities. *New England Journal of Medicine*, *380*(19), 1843–1852. https://doi.org/10.1056/NEJMra1813869

Junglee, N. A., Di Felice, U., Dolci, A., Fortes, M. B., Jibani, M. M., Lemmey, A. B., Walsh, N. P., & Macdonald, J. H. (2013). Exercising in a hot environment with muscle damage: Effects on acute kidney injury biomarkers and kidney function. *American Journal of Physiology-Renal Physiology*, *305*(6), F813–F820. https://doi.org/10.1152/ajprenal.00091.2013

Jurewicz, J., Radwan, M., Sobala, W., Radwan, P., Bochenek, M., & Hanke, W. (2014). Effects of occupational exposure—Is there a link between exposure based on an occupational questionnaire and semen quality? *Systems Biology in Reproductive Medicine*, *60*(4), 227–233. https://doi.org/10.3109/19396368.2014.907837

Justia. (2022). *Meal and Rest Break Laws in Employment: 50-State Survey*. https://www.justia.com/employment/employment-laws-50-state-surveys/meal-and-rest-break-laws-in-the-workplace-50-state-survey/

Kahn, M. E. (2016). The Climate Change Adaptation Literature. *Review of Environmental Economics and Policy*, *10*(1), 166–178. https://doi.org/10.1093/reep/rev023

Kaltsatou, A., Flouris, A. D., Herry, C. L., Notley, S. R., Macartney, M. J., Seely, A. J. E., & Kenny, G. P. (2020). Heart rate variability in older workers during work under the Threshold Limit Values for heat exposure. *American Journal of Industrial Medicine*, *63*(9), 787–795. https://doi.org/10.1002/ajim.23156

Kaltsatou, A., Notley, S. R., Flouris, A. D., & Kenny, G. P. (2021). An exploratory survey of heat stress management programs in the electric power industry. *Journal of Occupational and Environmental Hygiene*, *18*(9), 436–445. https://doi.org/10.1080/15459624.2021.1954187

Kamijo, Y., & Nose, H. (2006). Heat Illness during Working and Preventive Considerations from Body Fluid Homeostasis. *Industrial Health*, *44*(3), 345–358. https://doi.org/10.2486/indhealth.44.345

Kamijo, Y.-I., Lee, K., & Mack, G. W. (2005). Active cutaneous vasodilation in resting humans during mild heat stress. *Journal of Applied Physiology*, *98*(3), 829–837. https://doi.org/10.1152/japplphysiol.00235.2004

Karasick, A. S., Thomas, R. J., Cannon, D. L., Fagan, K. M., Bray, P. A., Hodgson, M. J., & Tustin, A. W. (2020). *Notes from the Field:* Amphetamine Use Among Workers with Severe Hyperthermia—Eight States, 2010–2019. *MMWR. Morbidity and Mortality Weekly Report*, *69*(30), 1004–1005. https://doi.org/10.15585/mmwr.mm6930a5

Karthick, S., Kermanshachi, S., & Pamidimukkala, A. (2023). Analysis of the Health and Safety Challenges Faced by Construction Workers in Extreme Hot Weather Conditions. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *15*(1), 04522048. https://doi.org/10.1061/JLADAH.LADR-882

Karvatte, N., Klosowski, E. S., de Almeida, R. G., Mesquita, E. E., de Oliveira, C. C., & Alves, F. V. (2016). Shading effect on microclimate and thermal comfort indexes in integrated crop-livestock-forest systems in the Brazilian Midwest. *International Journal of Biometeorology*, *60*(12), 1933–1941. https://doi.org/10.1007/s00484-016-1180-5

Karvatte, N., Miyagi, E. S., Carvalho de Oliveira, C., Mastelaro, A. P., de Aguiar Coelho, F., Bayma, G., Bungenstab, D. J., & Alves, F. V. (2021). Spatiotemporal variations on infrared temperature as a thermal comfort indicator for cattle under agroforestry systems. *Journal of Thermal Biology*, *97*, 102871. https://doi.org/10.1016/j.jtherbio.2021.102871

Kazman, J. B., Attipoe, S., Kupchak, B. R., & Deuster, P. A. (2020). Caffeine and heat have additive but not interactive effects on physiologic strain: A factorial experiment. *Journal of Thermal Biology*, *89*, 102563. https://doi.org/10.1016/j.jtherbio.2020.102563

KDIGO. (2012). Kidney Disease: Improving Global Outcomes (KDIGO). *KDIGO Clinical Practice Guideline for Acute Kidney Injury*, *2*(1), 1. https://doi.org/10.1038/kisup.2012.1

Kearney, G. D., Hu, H., Xu, X., Hall, M. B., & Balanay, J. A. G. (2016). Estimating the Prevalence of Heat-Related Symptoms and Sun Safety–Related Behavior among Latino Farmworkers in Eastern North Carolina. *Journal of Agromedicine*, *21*(1), 15–23. https://doi.org/10.1080/1059924X.2015.1106377

Kellogg, D. L., Pérgola, P. E., Piest, K. L., Kosiba, W. A., Crandall, C. G., Grossmann, M., & Johnson, J. M. (1995). Cutaneous Active Vasodilation in Humans Is Mediated by Cholinergic Nerve Cotransmission. *Circulation Research*, *77*(6), 1222–1228. https://doi.org/10.1161/01.RES.77.6.1222

Kenny, G. P., Poirier, M. P., Metsios, G. S., Boulay, P., Dervis, S., Friesen, B. J., Malcolm, J., Sigal, R. J., Seely, A. J. E., & Flouris, A. D. (2017). Hyperthermia and cardiovascular strain during an extreme heat exposure in young versus older adults. *Temperature*, *4*(1), 79–88. https://doi.org/10.1080/23328940.2016.1230171

Kenny, G. P., Sigal, R. J., & McGinn, R. (2016). Body temperature regulation in diabetes. *Temperature*, *3*(1), 119–145. https://doi.org/10.1080/23328940.2015.1131506

Kenny, G. P., Wilson, T. E., Flouris, A. D., & Fujii, N. (2018). Heat exhaustion. In *Handbook of Clinical Neurology* (Vol. 157, pp. 505–529). Elsevier. https://doi.org/10.1016/B978-0-444-64074-1.00031-8

Kenny, G. P., Yardley, J., Brown, C., Sigal, R. J., & Jay, O. (2010). Heat stress in older individuals and patients with common chronic diseases. *Canadian Medical Association Journal*, *182*(10), 1053–1060. https://doi.org/10.1503/cmaj.081050

Kerstein, M. D., Wright, D., Connelly, J., & Hubbard, R. (1986). Heat Illness in Hot/Humid Environment. *Military Medicine*, *151*(6), 308–311. https://doi.org/10.1093/milmed/151.6.308

Kestrel Instruments. (2024). *Kestrel Drop D2 Wireless Temperature & Humidity Data Logger*. Kestrelinstruments.com

Khan, F. Y. (2009). Rhabdomyolysis: A review of the literature. *The Netherlands Journal of Medicine*, *67*(9), 272–283.

Khogali, M. (1997). Heat Illness Alert Program: Practical Implications for Management and Prevention. *Annals of the New York Academy of Sciences*, *813*(1), 526–533. https://doi.org/10.1111/j.1749-6632.1997.tb51742.x

Khogali, M., & Weiner, J. (1980). Heat Stroke: Report on 18 Cases. *The Lancet*, 276–278.

Kiatkitroj, K., Arphorn, S., Tangtong, C., Maruo, S. J., & Ishimaru, T. (2021). Risk factors associated with heat-related illness among sugarcane farmers in Thailand. *Industrial Health*, *60*(5), 447–458. https://doi.org/10.2486/indhealth.2021-0161

Kim, J., Lee, J., Kim, S., Ryu, H. Y., Cha, K. S., & Sung, D. J. (2016). Exercise-induced rhabdomyolysis mechanisms and prevention: A literature review. *Journal of Sport and Health Science*, *5*(3), 324–333. https://doi.org/10.1016/j.jshs.2015.01.012

King, M. A., Leon, L. R., Mustico, D. L., Haines, J. M., & Clanton, T. L. (2015). Biomarkers of multiorgan injury in a preclinical model of exertional heat stroke. *Journal of Applied Physiology*, *118*(10), 1207–1220. https://doi.org/10.1152/japplphysiol.01051.2014

Kiyatkin, E. A., & Sharma, H. S. (2009). Acute Methamphetamine Intoxication: Brain hyperthermia, blood-brain barrier and brain edema. In *International Review of Neurobiology* (Vol. 88, pp. 65–100). Elsevier. https://doi.org/10.1016/S0074-7742(09)88004-5

Kjellstrom, T., Freyberg, C., Lemke, B., Otto, M., & Briggs, D. (2018). Estimating population heat exposure and impacts on working people in conjunction with climate change. *International Journal of Biometeorology*, *62*(3), 291–306. https://doi.org/10.1007/s00484-017-1407-0

Kjellstrom, T., Holmer, I., & Lemke, B. (2009a). Workplace heat stress, health and productivity – an increasing challenge for low and middle-income countries during climate change. *Global Health Action*, *2*(1), 2047. https://doi.org/10.3402/gha.v2i0.2047

Kjellstrom, T., Kovats, R. S., Lloyd, S. J., Holt, T., & Tol, R. S. J. (2009b). The Direct Impact of Climate Change on Regional Labor Productivity. *Archives of Environmental & Occupational Health*, *64*(4), 217–227. https://doi.org/10.1080/19338240903352776

Kjellstrom, T., Lemke, B., Otto, M., Hyatt, O., & Dear, K. (2014). *Occupational Heat Stress* (2014:4). Health and Environment International Trust. https://climatechip.org/sites/default/files/publications/TP2014_4_Occupational_Heat_Stress_WHO.pdf

Klok, L., Rood, N., Kluck, J., & Kleerekoper, L. (2019). Assessment of thermally comfortable urban spaces in Amsterdam during hot summer days. *International Journal of Biometeorology*, *63*(2), 129–141. https://doi.org/10.1007/s00484-018-1644-x

Knapik, J. J., Canham-Chervak, M., Hauret, K., Laurin, M. J., Hoedebecke, E., Craig, S., & Montain, S. J. (2002). Seasonal Variations in Injury Rates During US Army Basic Combat Training. *The Annals of Occupational Hygiene*. https://doi.org/10.1093/annhyg/mef013

Kniesner, T. J., Viscusi, W. K., Woock, C., & Ziliak, J. P. (2012). The value of a statistical life: Evidence from panel data. Review of Economics and Statistics, 94(1), 74-87.

Knochel, J. P., & Schlein, E. M. (1972). On the mechanism of rhabdomyolysis in potassium depletion. *Journal of Clinical Investigation*, *51*(7), 1750–1758. https://doi.org/10.1172/JCI106976

Knowlton, K., Rotkin-Ellman, M., King, G., Margolis, H. G., Smith, D., Solomon, G., Trent, R., & English, P. (2009). The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits. *Environmental Health Perspectives*, *117*(1), 61–67. https://doi.org/10.1289/ehp.11594

Kodadek, L., Carmichael, S. P., Seshadri, A., Pathak, A., Hoth, J., Appelbaum, R., Michetti, C. P., & Gonzalez, R. P. (2022). Rhabdomyolysis: An American Association for the Surgery of Trauma Critical Care Committee Clinical Consensus Document. *Trauma Surgery & Acute Care Open*, *7*(1), e000836. https://doi.org/10.1136/tsaco-2021-000836

Koh, D. (1995). An outbreak of occupational dermatosis in an electronics store. *Contact Dermatitis*, *32*(6), 327–330. https://doi.org/10.1111/j.1600-0536.1995.tb00620.x

Korey Stringer Institute. (n.d.). *Hyponatremia*. Retrieved February 5, 2024, from https://ksi.uconn.edu/emergency-conditions/hyponatremia/

Krishnamurthy, M., Ramalingam, P., Perumal, K., Kamalakannan, L. P., Chinnadurai, J., Shanmugam, R., Srinivasan, K., & Venugopal, V. (2017). Occupational Heat Stress Impacts on Health and Productivity in a Steel Industry in Southern India. *Safety and Health at Work*, *8*(1), 99–104. https://doi.org/10.1016/j.shaw.2016.08.005

Kuehn, L., & McCormick, S. (2017). Heat Exposure and Maternal Health in the Face of Climate Change. *International Journal of Environmental Research and Public Health*, *14*(8), 853. https://doi.org/10.3390/ijerph14080853

Kupferman, J., Ramírez-Rubio, O., Amador, J. J., López-Pilarte, D., Wilker, E. H., Laws, R. L., Sennett, C., Robles, N. V., Lau, J. L., Salinas, A. J., Kaufman, J. S., Weiner, D. E., Scammell, M. K., McClean, M. D., Brooks, D. R., & Friedman, D. J. (2018). Acute Kidney Injury in Sugarcane Workers at Risk for Mesoamerican Nephropathy. *American Journal of Kidney Diseases*, *72*(4), 475–482. https://doi.org/10.1053/j.ajkd.2018.04.014

Kyung, M., Lee, S.-J., Dancu, C., & Hong, O. (2023). Underreporting of workers' injuries or illnesses and contributing factors: A systematic review. *BMC Public Health*, *23*(1), 558. https://doi.org/10.1186/s12889-023-15487-0

Lai, W., Qiu, Y., Tang, Q., Xi, C., & Zhang, P. (2023). The Effects of Temperature on Labor Productivity. *Annual Review of Resource Economics*, *15*, 213–232.

Laitano, O., Garcia, C. K., Mattingly, A. J., Robinson, G. P., Murray, K. O., King, M. A., Ingram, B., Ramamoorthy, S., Leon, L. R., & Clanton, T. L. (2020). Delayed metabolic dysfunction in myocardium following exertional heat stroke in mice. *The Journal of Physiology*, *598*(5), 967–985. https://doi.org/10.1113/JP279310

Laitano, O., King, M. A., & Leon, L. R. (2019). Common Misconceptions in Classic and Exertional Heat Stroke. In *Heat Stress in Sport and Exercise: Thermophysiology of Health and Performance* (pp. 91–112). Springer International Publishing. https://doi.org/10.1007/978-3-319-93515-7_5

Lam, M., Krenz, J., Palmández, P., Negrete, M., Perla, M., Murphy-Robinson, H., & Spector, J. T. (2013). Identification of barriers to the prevention and treatment of heat-related illness in Latino farmworkers using activity-oriented, participatory rural appraisal focus group methods. *BMC Public Health*, *13*(1), 1004. https://doi.org/10.1186/1471-2458-13-1004

Lamarche, D. T., Meade, R. D., D'Souza, A. W., Flouris, A. D., Hardcastle, S. G., Sigal, R. J., Boulay, P., & Kenny, G. P. (2017). The recommended Threshold Limit Values for

heat exposure fail to maintain body core temperature within safe limits in older working adults. *Journal of Occupational and Environmental Hygiene*, *14*(9), 703–711. https://doi.org/10.1080/15459624.2017.1321844

Langer, C. E., Mitchell, D. C., Armitage, T. L., Moyce, S. C., Tancredi, D. J., Castro, J., Vega-Arroyo, A. J., Bennett, D. H., & Schenker, M. B. (2021). Are Cal/OSHA Regulations Protecting Farmworkers in California From Heat-Related Illness? *Journal of Occupational & Environmental Medicine*, *63*(6), 532–539. https://doi.org/10.1097/JOM.0000000000002189

Langkulsen, U., Vichit-Vadakan, N., & Taptagaporn, S. (2010). Health impact of climate change on occupational health and productivity in Thailand. *Global Health Action*, *3*(1), 5607. https://doi.org/10.3402/gha.v3i0.5607

Lavetti, K. (2023). Compensating Wage Differentials in Labor Markets: Empirical Challenges and Applications. *Journal of Economic Perspectives*, *37*(3), 189–212. https://doi.org/10.1257/jep.37.3.189

Lee, L. S. H., Cheung, P. K., Fung, C. K. W., & Jim, C. Y. (2020). Improving street walkability: Biometeorological assessment of artificial-partial shade structures in summer sunny conditions. *International Journal of Biometeorology*, *64*(4), 547–560. https://doi.org/10.1007/s00484-019-01840-9

Leibler, J. H., Ramirez-Rubio, O., Velázquez, J. J. A., Pilarte, D. L., Obeid, W., Parikh, C. R., Gadupudi, S., Scammell, M. K., Friedman, D. J., & Brooks, D. R. (2021). Biomarkers of kidney injury among children in a high-risk region for chronic kidney disease of uncertain etiology. *Pediatric Nephrology*, *36*(2), 387–396. https://doi.org/10.1007/s00467-020-04595-3

Leigh, J. P. (2011). Economic Burden of Occupational Injury and Illness in the United States: U.S. Economic Burden of Occupational Injury and Illness. *Milbank Quarterly*, *89*(4), 728–772. https://doi.org/10.1111/j.1468-0009.2011.00648.x

Leon, L. R., & Helwig, B. G. (2010). Heat stroke: Role of the systemic inflammatory response. *Journal of Applied Physiology*, *109*(6), 1980–1988. https://doi.org/10.1152/japplphysiol.00301.2010

Leon, L. R., & Kenefick, R. (2012). Chapter 10: Pathophysiology of Heat-Related Illnesses. In *Wilderness Medicine Textbook* (pp. 113-e44).

Lewandowski, S. A., & Shaman, J. L. (2022). Heat stress morbidity among US military personnel: Daily exposure and lagged response (1998–2019). *International Journal of Biometeorology*, *66*(6), 1199–1208. https://doi.org/10.1007/s00484-022-02269-3

Li, J., Shen, X., Funk, T. L., & Wang, X. (2018). *Feasibility Study of Environmental Control of Dairy Barns using Air Conditioning or Evaporative Cooling*. 10th International Livestock Environment Symposium (ILES X). https://doi.org/10.13031/iles.18-144

Li, M., Ferreira, S., & Smith, T. A. (2020). Temperature and self-reported mental health in the United States. *PLOS ONE*, *15*(3), e0230316. https://doi.org/10.1371/journal.pone.0230316

Li, X., Chow, K. H., Zhu, Y., & Lin, Y. (2016). Evaluating the impacts of high-temperature outdoor working environments on construction labor productivity in China: A case study of rebar workers. *Building and Environment*, *95*, 42–52. https://doi.org/10.1016/j.buildenv.2015.09.005

Lieberman, H. R. (2007). Hydration and Cognition: A Critical Review and Recommendations for Future Research. *Journal of the American College of Nutrition*, *26*(sup5), 555S-561S. https://doi.org/10.1080/07315724.2007.10719658

Lim, C. L., Chung, K. K., & Hock, L. L. K. (1997). The Effects of Prolonged Passive Heat Exposure and Basic Military Training on Thermoregulatory and Cardiovascular Responses in Recruits from a Tropical Country. *Military Medicine*, *162*(9), 623–627. https://doi.org/10.1093/milmed/162.9.623

Lin, N. W., Ramirez-Cardenas, A., Wingate, K. C., King, B. S., Scott, K., & Hagan-hayes, K. (2023). Risk factors for heat-related illness resulting in death or hospitalization in the oil and gas extraction industry. *Journal of Occupational and Environmental Hygiene*, *1*(14).

Lind, A., Humphreys, P. W., Collins, K. J., Foster, K., & Sweetland, K. F. (1970). Influence of age and daily duration of exposure on responses of men to work in heat. *Journal of Applied Physiology*, *28*(1), 50–56.

Lind, A. R. (1963). Physiological effects of continuous or intermittent work in the heat. *Journal of Applied Physiology*, *18*(1), 57–60. https://doi.org/10.1152/jappl.1963.18.1.57

Ljungberg, A.-S., Enander, A., & Holmer, I. (1979). Evaluation of heat stress during sedentary work. *Scandinavian Journal of Work, Environment & Health*, *5*(1), 23–30. https://doi.org/10.5271/sjweh.2669

Lohaus, D., Habermann, W., & Nachreiner, M. (2022). Sickness presenteeism explained by balancing perceived positive and negative effects. *Frontiers in Psychology*, *13*, 963560. https://doi.org/10.3389/fpsyg.2022.963560

LoPalo, M. (2023). Temperature, Worker Productivity, and Adaptation: Evidence from Survey Data Production. *American Economic Journal: Applied Economics*, *15*(1), 192–229. https://doi.org/10.1257/app.20200547

Louisiana Department of Health (DOH). (2023). *Heat-Related Illness in Louisiana: Review of Emergency Department and Hospitalization Data from 2010-2020*. Louisiana Department of Health. https://ldh.la.gov/assets/docs/lah/HRI_in_Louisiana_from_2010-2020.pdf

Louisiana Department of Health (DOH). (2024). *Heat-Related Emergency Department Visits in Louisiana: Review of Syndromic Surveillance Data for April through October 2023*. Louisiana Department of Health. https://ldh.la.gov/assets/docs/lah/HRI_Syndromic_Surveillance_Report_2023.pdf

Lu, I.-C., Yang, C.-C., Huang, C.-H., Chen, S.-Y., Lin, C.-W., Lin, C.-H., & Chuang, H.-Y. (2022). The Risk Factors for Radiolucent Nephrolithiasis among Workers in High-Temperature Workplaces in the Steel Industry. *International Journal of Environmental Research and Public Health*, *19*(23), 15720. https://doi.org/10.3390/ijerph192315720

Luber, G., Sanchez, C., & Conklin, L. (2006). Heat-related deaths—United States, 1999-2003. *MMWR. Morbidity and Mortality Weekly Report*, *55*(29), 796–798.

Lucas, R. A. I., Epstein, Y., & Kjellstrom, T. (2014). Excessive occupational heat exposure: A significant ergonomic challenge and health risk for current and future workers. *Extreme Physiology & Medicine*, *3*(1), 14. https://doi.org/10.1186/2046-7648-3-14

Lucas, R. A. I., Sarma, S., Schlader, Z. J., Pearson, J., & Crandall, C. G. (2015). Age-related changes to cardiac systolic and diastolic function during whole-body passive hyperthermia. *Experimental Physiology*, *100*(4), 422–434. https://doi.org/10.1113/expphysiol.2014.083014

Lucas, R. A., Skinner, B. D., Arias-Monge, E., Jakobsson, K., Wesseling, C., Weiss, I., Poveda, S., Cerda-Granados, F. I., Glaser, J., Hansson, E., & Wegman, D. H. (2023). Targeting workload to ameliorate risk of heat stress in industrial sugarcane workers. *Scandinavian Journal of Work, Environment & Health*, *49*(1), 43–52. https://doi.org/10.5271/sjweh.4057

Luetmer, M. T., Boettcher, B. J., Franco, J. M., Reisner, J. H., Cheville, A. L., & Finnoff, J. T. (2020). Exertional Rhabdomyolysis: A Retrospective Population-based Study. *Medicine & Science in Sports & Exercise*, *52*(3), 608–615. https://doi.org/10.1249/MSS.0000000000002178

Luginbuhl, R., Jackson, L., Castillo, D., & Loringer, K. (2008). Heat-related deaths among crop workers—United States, 1992—2006. *MMWR. Morbidity and Mortality Weekly Report*, *57*(24), 649–653.

Lugo-Amador, N. M., Rothenhaus, T., & Moyer, P. (2004). Heat-related illness. *Emergency Medicine Clinics of North America*, *22*(2), 315–327. https://doi.org/10.1016/j.emc.2004.01.004

Luhring, K. E., Butts, C. L., Smith, C. R., Bonacci, J. A., Ylanan, R. C., Ganio, M. S., & McDermott, B. P. (2016). Cooling Effectiveness of a Modified Cold-Water Immersion Method After Exercise-Induced Hyperthermia. *Journal of Athletic Training*, *51*(11), 946–951. https://doi.org/10.4085/1062-6050-51.12.07

Lui, B., Cuddy, J. S., Hailes, W. S., & Ruby, B. C. (2014). Seasonal heat acclimatization in wildland firefighters. *Journal of Thermal Biology*, *45*, 134–140. https://doi.org/10.1016/j.jtherbio.2014.08.009

Luque, J. S., Becker, A., Bossak, B. H., Grzywacz, J. G., Tovar-Aguilar, J. A., & Guo, Y. (2020). Knowledge and Practices to Avoid Heat-Related Illness among Hispanic Farmworkers along the Florida-Georgia Line. *Journal of Agromedicine*, *25*(2), 190–200. https://doi.org/10.1080/1059924X.2019.1670312

Luque, J. S., Bossak, B. H., Davila, C. B., & Tovar-Aguilar, J. A. (2019). “I Think the Temperature was 110 Degrees!”: Work Safety Discussions Among Hispanic Farmworkers. *Journal of Agromedicine*, *24*(1), 15–25. https://doi.org/10.1080/1059924X.2018.1536572

Macleod, J., & Hotchkiss, R. S. (1941). The effect of hyperpyrexia upon spermatozoa counts in men. *Endocrinology*, *28*(5), 780–784.

Macleod, W.B., & Nakavachara, V. (2007). Can wrongful discharge law enhance employment? *The Economic Journal*, *117*(521), F218–F278.

Maline, G. E., & Goldfarb, D. S. (2024). Climate change and kidney stones. *Current Opinion in Nephrology & Hypertension*, *33*(1), 89–96. https://doi.org/10.1097/MNH.0000000000000931

Mani, A., Musolin, K., James, K., Kincer, G., Alexander, B., Succop, P., Lovett, W., Jetter, W. A., & Bhattacharya, A. (2013). Risk factors associated with live fire training: Buildup of heat stress and fatigue, recovery and role of micro-breaks. *Occupational Ergonomics*, *11*(2), 109–121. https://doi.org/10.3233/OER-130212

Mann, R., & Schuetz, J. (2022. As extreme heat grips the globe, access to air conditioning is an urgent public health issue. *Brookings*. https://www.brookings.edu/articles/as-extreme-heat-grips-the-globe-access-to-air-conditioning-is-an-urgent-public-health-issue/

Manspeaker, S., Henderson, K., & Riddle, D. (2016). Treatment of exertional rhabdomyolysis in athletes: A systematic review. *JBI Database of Systematic Reviews and Implementation Reports*, *14*(6), 117–147. https://doi.org/10.11124/JBISRIR-2016-001879

Maricopa County Public Health Department. (n.d.). *Maricopa County Heat Morbidity Report 2006-2017*. https://www.maricopa.gov/ArchiveCenter/ViewFile/Item/1373

Marklund, S., Gustafsson, K., Bergström, G., & Leineweber, C. (2021). Reasons for presenteeism in different occupational branches in Sweden: A population based cross-sectional study. *International Archives of Occupational and Environmental Health*, *94*(6), 1385–1395. https://doi.org/10.1007/s00420-021-01701-2

Martínez-Solanas, È., López-Ruiz, M., Wellenius, G. A., Gasparrini, A., Sunyer, J., Benavides, F. G., & Basagaña, X. (2018). Evaluation of the Impact of Ambient Temperatures on Occupational Injuries in Spain. *Environmental Health Perspectives*, *126*(6), 067002. https://doi.org/10.1289/EHP2590

Massetti, E., & Mendelsohn, R. (2018). Measuring Climate Adaptation: Methods and Evidence. *Review of Environmental Economics and Policy*, *12*(2), 324–341. https://doi.org/10.1093/reep/rey007

Masuda, Y. J., Garg, T., Anggraeni, I., Ebi, K., Krenz, J., Game, E. T., Wolff, N. H., & Spector, J. T. (2021). Warming from tropical deforestation reduces worker productivity in rural communities. *Nature Communications*, *12*(1), 1601. https://doi.org/10.1038/s41467-021-21779-z

Mattke, S., Balakrishnan, A., Bergamo, G., & Newberry, S. J. (2007). *A Review of Methods to Measure Health-related Productivity Loss*. *13*(4).

Maung, Z., & Tustin, A. W. (2020). The Heat Death Line: Proposed Heat Index Alert Threshold for Preventing Heat-Related Fatalities in the Civilian Workforce. *NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy*, *30*(2), 138–145. https://doi.org/10.1177/1048291120933819

Mazlomi, A., Golbabaei, F., Farhang Dehghan, S., Abbasinia, M., Mahmoud Khani, S., Ansari, M., & Hosseini, M. (2017). The influence of occupational heat exposure on cognitive performance and blood level of stress hormones: A field study report. *International Journal of Occupational Safety and Ergonomics*, *23*(3), 431–439. https://doi.org/10.1080/10803548.2016.1251137

Mazloumi, A., Golbabaei, F., Mahmood Khani, S. M. K., Kazemi, Z., Hosseini, M., Abbasinia, M., & Farhang Dehghan, S. (2014). Evaluating Effects of Heat Stress on Cognitive Function among Workers in a Hot Industry. *Health Promotion Perspectives; EISSN 2228-6497*. https://doi.org/10.5681/HPP.2014.031

McCarthy, R. B., Shofer, F. S., & Green-McKenzie, J. (2019). Outcomes of a Heat Stress Awareness Program on Heat-Related Illness in Municipal Outdoor Workers. *Journal of Occupational & Environmental Medicine*, *61*(9), 724–728. https://doi.org/10.1097/JOM.0000000000001639

McDermott, B. P., Casa, D. J., O'Connor, F. G., Adams, W. B., Armstrong, L. E., Brennan, A. H., Lopez, R. M., Stearns, R. L., Troyanos, C., & Yeargin, S. W. (2009a). Cold-Water Dousing with Ice Massage to Treat Exertional Heat Stroke: A Case Series. *Aviation, Space, and Environmental Medicine*, *80*(8), 720–722. https://doi.org/10.3357/ASEM.2498.2009

McDermott, B. P., Casa, D. J., Ganio, M. S., Lopez, R. M., Yeargin, S. W., Armstrong, L. E., & Maresh, C. M. (2009b). Acute Whole-Body Cooling for Exercise-Induced Hyperthermia: A Systematic Review. *Journal of Athletic Training*, *44*(1), 84–93. https://doi.org/10.4085/1062-6050-44.1.84

McDermott, B. P., Casa, D. J., Yeargin, S. W., Gaino, M. S., Armstrong, L. E., & Maresh, C. M. (2007). Recovery and Return to Activity Following Exertional Heat Stroke: Considerations for the Sports Medicine Staff. *Journal of Sport Rehabilitation*, *16*, 163–181.

McDermott, B. P., Smith, C. R., Butts, C. L., Caldwell, A. R., Lee, E. C., Vingren, J. L., Munoz, C. X., Kunces, L. J., Williamson, K., Ganio, M. S., & Armstrong, L. E. (2018). Renal stress and kidney injury biomarkers in response to endurance cycling in the heat with and without ibuprofen. *Journal of Science and Medicine in Sport*, *21*(12), 1180–1184. https://doi.org/10.1016/j.jsams.2018.05.003

McInnes, J. A., Akram, M., MacFarlane, E. M., Keegel, T., Sim, M. R., & Smith, P. (2017). Association between high ambient temperature and acute work-related injury: A case-crossover analysis using workers' compensation claims data. *Scandinavian Journal of Work, Environment & Health*, *43*(1), 86–94. https://doi.org/10.5271/sjweh.3602

McLellan, T. M., & Selkirk, G. A. (2006). The Management of Heat Stress for the Firefighter: A Review of Work Conducted on Behalf of the Toronto Fire Service. *Industrial Health*, *44*(3), 414–426. https://doi.org/10.2486/indhealth.44.414

Meade, R. D., D'Souza, A. W., Krishen, L., & Kenny, G. P. (2017). The physiological strain incurred during electrical utilities work over consecutive work shifts in hot environments: A case report. *Journal of Occupational and Environmental Hygiene*, *14*(12), 986–994. https://doi.org/10.1080/15459624.2017.1365151

Meade, R. D., Lauzon, M., Poirier, M. P., Flouris, A. D., & Kenny, G. P. (2016a). The physical demands of electrical utilities work in North America. *Journal of Occupational and Environmental Hygiene*, *13*(1), 60–70. https://doi.org/10.1080/15459624.2015.1077966

Meade, R. D., Notley, S. R., Kirby, N. V., & Kenny, G. P. (2024). A critical review of the effectiveness of electric fans as a personal cooling intervention in hot weather and heatwaves. *The Lancet Planetary Health*, *8*(4), e256–e269. https://doi.org/10.1016/S2542-5196(24)00030-5

Meade, R. D., Poirier, M. P., Flouris, A. D., Hardcastle, S. G., & Kenny, G. P. (2016b). Do the Threshold Limit Values for Work in Hot Conditions Adequately Protect Workers? *Medicine & Science in Sports & Exercise*, *48*(6), 1187–1196. https://doi.org/10.1249/MSS.0000000000000886

Meegahapola, P. A., & Prabodanie, R. A. R. (2018). Impact of environmental conditions on workers' productivity and health. *International Journal of Workplace Health Management*, *11*(2), 74–84. https://doi.org/10.1108/IJWHM-10-2017-0082

Mekjavic, I. B., Gliha, M., Tobita, K., Ciuha, U., Tehovnik, D., Casanueva, A., Kingma, B., Nybo, L., Piil, J. F., Morris, N., Flouris, A., & Ioannou, L. (n.d.). *D3.3: Report on solutions to mitigate heat stress for workers of the manufacturing sector*.

Methner, M., & Eisenberg, J. (2018). Evaluation of heat stress and heat strain among employees working outdoors in an extremely hot environment. *Journal of Occupational and Environmental Hygiene*, *15*(6), Article 6. https://doi.org/10.1080/15459624.2018.1456663

Middel, A., & Krayenhoff, E. S. (2019). Micrometeorological determinants of pedestrian thermal exposure during record-breaking heat in Tempe, Arizona: Introducing the MaRTy observational platform. *Science of The Total Environment*, *687*, 137–151. https://doi.org/10.1016/j.scitotenv.2019.06.085

Mieusset, R., & Bujan, L. (1995). Testicular heating and its possible contributions to male infertility: A review. *International Journal of Andrology*, *18*(4), 169–184. https://doi.org/10.1111/j.1365-2605.1995.tb00408.x

Mieusset, R., Bujan, L., Mondinat, C., Mansat, A., Pontonnier, F., & Grandjean, H. (1987). Association of scrotal hyperthermia with impaired spermatogenesis in infertile men. *Fertility and Sterility*, *48*(6), 1006–1011. https://doi.org/10.1016/S0015-0282(16)59600-9

Mihal, C. P. (1981). Effect of heat stress on physiological factors for industrial workers performing routine work and wearing impermeable vapor-barrier clothing. *American Industrial Hygiene Association Journal*, *42*(2), 97–103. https://doi.org/10.1080/15298668191419424

Miller, G. (2008). *Hidden Tragedy: Underreporting of Workplace Injuries and Illnesses*. U.S. House of Representatives, The Committee on Education and Labor. https://www.bls.gov/iif/data-quality-research/hidden-tragedy-underreporting-of-workplace-injuries-and-illnesses.pdf

Minard, D. (1961). Prevention of heat casualties in Marine Corps recruits. Period of 1955-60, with comparative incidence rates and climatic heat stresses in other training categories. *Military Medicine*, *126*, 261–272.

Mine Safety and Health Administration (MSHA). (2012). *Heat Stress In Mining* (SM 6; Safety Manual Series). U.S. Department of Labor, Mine Safety and Health Administration. https://www.msha.gov/sites/default/files/Alerts and Hazards/Heat Stress.pdf

Minson, C. T., Wladkowski, S. L., Cardell, A. F., Pawelczyk, J. A., & Kenney, W. L. (1998). Age alters the cardiovascular response to direct passive heating. *Journal of Applied Physiology*, *84*(4), 1323–1332. https://doi.org/10.1152/jappl.1998.84.4.1323

Mirabelli, M. C., Quandt, S. A., Crain, R., Grzywacz, J. G., Robinson, E. N., Vallejos, Q. M., & Arcury, T. A. (2010). Symptoms of Heat Illness Among Latino Farm Workers in North Carolina. *American Journal of Preventive Medicine*, *39*(5), 468–471. https://doi.org/10.1016/j.amepre.2010.07.008

Mirabelli, M. C., & Richardson, D. B. (2005). Heat-Related Fatalities in North Carolina. *American Journal of Public Health*, *95*(4).

Mitchell, D. C., Castro, J., Armitage, T. L., Tancredi, D. J., Bennett, D. H., & Schenker, M. B. (2018). Physical activity and common tasks of California farm workers: California Heat Illness Prevention Study (CHIPS). *Journal of Occupational and Environmental Hygiene*, *15*(12), 857–869. https://doi.org/10.1080/15459624.2018.1519319

Mix, J., Elon, L., Vi Thien Mac, V., Flocks, J., Economos, E., Tovar-Aguilar, A. J., Stover Hertzberg, V., & McCauley, L. A. (2018). Hydration Status, Kidney Function, and Kidney Injury in Florida Agricultural Workers. *Journal of Occupational & Environmental Medicine*, *60*(5), e253–e260. https://doi.org/10.1097/JOM.0000000000001261

Miyamoto, M. (1994). Renal Cortical and Medullary Tissue Blood Flow During Experimental Hyperthermia in Dogs. *Japan Journal of Hyperthermic Oncology*, *10*(1), 78–89.

Mizelle, E., Larson, K. L., Bolin, L. P., & Kearney, G. D. (2022). Fluid Intake and Hydration Status Among North Carolina Farmworkers: A Mixed Methods Study. *Workplace Health & Safety*, *70*(12), 532–541. https://doi.org/10.1177/21650799221117273

Mora, C., Counsell, C. W. W., Bielecki, C. R., & Louis, L. V. (2017). Twenty-Seven Ways a Heat Wave Can Kill You: Deadly Heat in the Era of Climate Change. *Circulation: Cardiovascular Quality and Outcomes*, *10*(11), e004233. https://doi.org/10.1161/CIRCOUTCOMES.117.004233

Morabito, M., Cecchi, L., Crisci, A., Modesti, P. A., & Orlandini, S. (2006). Relationship between Work-Related Accidents and Hot Weather Conditions in Tuscany (Central Italy). *Industrial Health*, *44*(3), 458–464. https://doi.org/10.2486/indhealth.44.458

Morabito, M., Messeri, A., Crisci, A., Bao, J., Ma, R., Orlandini, S., Huang, C., & Kjellstrom, T. (2020). Heat-related productivity loss: Benefits derived by working in the shade or work-time shifting. *International Journal of Productivity and Performance Management*, *70*(3), 507–525. https://doi.org/10.1108/IJPPM-10-2019-0500

Morris, C. E., Gonzales, R. G., Hodgson, M. J., & Tustin, A. W. (2019). Actual and simulated weather data to evaluate wet bulb globe temperature and heat index as alerts for occupational heat-related illness. *Journal of Occupational and Environmental Hygiene*, *16*(1), 54–65. https://doi.org/10.1080/15459624.2018.1532574

Morris, N. B., Chaseling, G. K., English, T., Gruss, F., Maideen, M. F. B., Capon, A., & Jay, O. (2021). Electric fan use for cooling during hot weather: A biophysical modelling study. *The Lancet Planetary Health*, *5*(6), e368–e377. https://doi.org/10.1016/S2542-5196(21)00136-4

Morris, N. B., English, T., Hospers, L., Capon, A., & Jay, O. (2019). The Effects of Electric Fan Use Under Differing Resting Heat Index Conditions: A Clinical Trial. *Annals of Internal Medicine*, *171*(9), 675. https://doi.org/10.7326/M19-0512

Morris, N. B., Jay, O., Flouris, A. D., Casanueva, A., Gao, C., Foster, J., Havenith, G., & Nybo, L. (2020). Sustainable solutions to mitigate occupational heat strain – an umbrella review of physiological effects and global health perspectives. *Environmental Health*, *19*(1), 95. https://doi.org/10.1186/s12940-020-00641-7

Morrissey, M. C., Brewer, G. J., Williams, W. J., Quinn, T., & Casa, D. J. (2021a). Impact of occupational heat stress on worker productivity and economic cost. *American Journal of Industrial Medicine*, *64*(12), 981–988. https://doi.org/10.1002/ajim.23297

Morrissey, M. C., Casa, D. J., Brewer, G. J., Adams, W. M., Hosokawa, Y., Benjamin, C. L., Grundstein, A. J., Hostler, D., McDermott, B. P., McQuerry, M. L., Stearns, R. L., Filep, E. M., DeGroot, D. W., Fulcher, J., Flouris, A. D., Huggins, R. A., Jacklitsch, B. L., Jardine, J. F., Lopez, R. M., … Yeargin, S. W. (2021b). Heat Safety in the Workplace: Modified Delphi Consensus to Establish Strategies and Resources to Protect the US Workers. *GeoHealth*, *5*(8), e2021GH000443. https://doi.org/10.1029/2021GH000443

Morrissey-Basler, M. C., Eason, C. M., Clines, S. H., Kaufman, C. E., & Casa, D. J. (2024). Perceived challenges and barriers for females working in the heat. *Journal of Occupational and Environmental Hygiene*, *21*(2), 97–107. https://doi.org/10.1080/15459624.2023.2268725

Moyce, S., Mitchell, D., Armitage, T., Tancredi, D., Joseph, J., & Schenker, M. (2017). Heat strain, volume depletion and kidney function in California agricultural workers.

Occupational and Environmental Medicine, *74*(6), 402–409. https://doi.org/10.1136/oemed-2016-103848

Murphy, G., & Wolf, J. (2022). *Workers' Compensation: Benefits, Costs, and Coverage*. National Academy of Social Insurance.

Murray, K. O., Brant, J. O., Iwaniec, J. D., Sheikh, L. H., De Carvalho, L., Garcia, C. K., Robinson, G. P., Alzahrani, J. M., Riva, A., Laitano, O., Kladde, M. P., & Clanton, T. L. (2020). Exertional heat stroke leads to concurrent long-term epigenetic memory, immunosuppression and altered heat shock response in female mice. *The Journal of Physiology*, *599*(1), 119–141. https://doi.org/10.1113/JP280518

Murray, K. O., Clanton, T. L., & Horowitz, M. (2022). Epigenetic responses to heat: From adaptation to maladaptation. *Experimental Physiology*, *107*(10), 1144–1158. https://doi.org/10.1113/EP090143

Musselman, M. E., & Saely, S. (2013). Diagnosis and treatment of drug-induced hyperthermia. *American Journal of Health-System Pharmacy*, *70*(1), 34–42. https://doi.org/10.2146/ajhp110543

Mutic, A. D., Mix, J. M., Elon, L., Mutic, N. J., Economos, J., Flocks, J., Tovar-Aguilar, A. J., & McCauley, L. A. (2018). Classification of Heat-Related Illness Symptoms Among Florida Farmworkers. *Journal of Nursing Scholarship*, *50*(1), 74–82. https://doi.org/10.1111/jnu.12355

NACOSH Working Group on Heat. (2023). *Report for NACOSH at May 31, 2023 Meeting*.

Nath, I. (2020). *The Food Problem and the Aggregate Productivity Consequences of Climate Change* (w27297; p. w27297). National Bureau of Economic Research. https://doi.org/10.3386/w27297

National Center for Farmworker Health, Inc. (NCFH). (2022). *Facts About Farmworkers*. https://www.ncfh.org/uploads/3/8/6/8/38685499/facts_about_farmworkers_fact_sheet_1.10.23.pdf

National Institute for Occupational Safety and Health (NIOSH). (1972). *Criteria for a recommended standard: Occupational exposure to hot environments*. Publication 72-10269. https://www.cdc.gov/niosh/docs/72-10269/default.html

National Institute for Occupational Safety and Health (NIOSH). (1986). *Criteria for a recommended standard: Occupational exposure to hot environments*. Publication 86-113. https://www.cdc.gov/niosh/docs/86-113/default.html

National Institute for Occupational Safety and Health (NIOSH). (1997). *Fire Fighter Dies of Heat Stroke While Making a Fire Line During a Wildland Fire in California*. NIOSH FACE Program. https://www.cdc.gov/niosh/face/stateface/ca/97ca010.html

National Institute for Occupational Safety and Health (NIOSH). (2004). *Construction Laborer Dies from Heat Stroke at End of Workday*. NIOSH FACE Program. https://www.cdc.gov/niosh/face/stateface/ky/03ky053.html

National Institute for Occupational Safety and Health (NIOSH). (2007). *Migrant Farm Worker Dies From Heat Stroke While Working on a Tobacco Farm – North Carolina*. NIOSH FACE Program. https://www.cdc.gov/niosh/face/in-house/full200604.html

National Institute for Occupational Safety and Health (NIOSH). (2015). *Landscape Mowing Assistant Dies from Heat Stroke*. NIOSH FACE Program. https://www.cdc.gov/niosh/face/stateface/mi/02mi075.html

National Institute for Occupational Safety and Health (NIOSH). (2016). *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments* (2016–106). National Institute for Occupational Safety and Health. https://www.cdc.gov/niosh/docs/2016-106/default.html

National Institute for Occupational Safety and Health (NIOSH). (2017a). *Heat Stress: Hydration*. https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/2017-126.pdf

National Institute for Occupational Safety and Health (NIOSH). (2017b). *Heat Stress: Work/Rest Schedules*. https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2017-127.pdf

National Institute for Occupational Safety and Health (NIOSH). (2022, May 13). *Heat Stress – Heat Related Illness*. https://www.cdc.gov/niosh/topics/heatstress/heatrelillness.html#rash

National Institute for Occupational Safety and Health (NIOSH). (2023a). *Heat stress: First aid for heat illness.* U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. https://doi.org/10.26616/NIOSHPUB2024100

National Institute for Occupational Safety and Health (NIOSH). (2023b, March 2). *Work and fatigue*. https://www.cdc.gov/niosh/topics/fatigue/default.html

National Institute for Occupational Safety and Health (NIOSH). (2024, February 14). *About Heat Exposure and Reproductive Health*. https://www.cdc.gov/niosh/reproductive-health/prevention/heat.html

National Institute for Occupational Safety and Health (NIOSH) DSR. (1998). Surveillance for Nonfatal Occupational Injuries Treated in Hospital Emergency Departments—United States, 1996. *MMWR. Morbidity and Mortality Weekly Report*, *47*(15), 302–306.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2016). *Chronic Kidney Disease Tests & Diagnosis*. https://www.niddk.nih.gov/health-information/kidney-disease/chronic-kidney-disease-ckd/tests-diagnosis

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2017a). *Definition & Facts for Kidney Stones*. https://www.niddk.nih.go/health-information/urolgc-diseases/kidney-stones/definition-facts

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2017b). *Symptoms & Causes of Kidney Stones*. https://www.niddk.nih.gov/health-informtion/urologic-diseases/kidney-stones/symptoms-causes

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2017c). *Treatment for Kidney Stones*. https://www.niddk.nih.gov/health-information/urologic-diseases/kidney-stones/treatment

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2017d). *What is Chronic Kidney Disease?* https://www.niddk.nih.gov/health-information/kidney-disease/chronic-kidney-disease-ckd/what-is-chronic-kidney-disease

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). (2018). *Your Kidneys & How They Work*. https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work#:~:text=Yor kidneys remove wastes and,and potassium--in your blood.

National Oceanic and Atmospheric Administration (NOAA). (2023a). *Aquaculture | NOAA Fisheries*. https://www.fisheries.noaa.gov/topic/aquaculture

National Oceanic and Atmospheric Administration (NOAA). (2023b). *Local Climatological Data (LCD)*. https://www.ncei.noaa.gov/products/land-based-station/local-climatological-data

National Research Council. (2009). Strengthening Forensic Science in the United States: A Path Forward. *CrimRxiv*. https://doi.org/10.21428/cb6ab371.b2d683d2

National Safety Council (NSC). (n.d.). *NSC Injury Facts: Work Overview*. Retrieved May 19, 2024, from https://injuryfacts.nsc.org/work/work-overview/work-safety-introduction/

National Weather Service (NWS). (2022). *Weather Related Fatality and Injury Statistics*. https://www.weather.gov/hazstat/

National Weather Service (NWS). (2023, August 25). *Heat Index Calculator*. https://www.wpc.ncep.noaa.gov/html/heatindex.shtml

National Weather Service (NWS). (2024a). *National Weather Service Instruction 10-515 WFO Non-Precipitation Weather Products Specification*. https://www.weather.gov/media/directives/010_pdfs/pd01005015curr.pdf

National Weather Service (NWS). (2024b). *Regional Headquarters*. https://www.weather.gov/organization/regional

National Weather Service (NWS). (2024c, April 29). *Heat Forecast Tools NWS* [National Oceanic and Atmospheric Administration]. Heat Forecast Tools. https://www.weather.gov/safety/heat-index

Ndugga, N., & Artiga, S. (2023. Continued Rises in Extreme Heat and Implications for Health Disparities. *KFF*. https://www.kff.org/racial-equity-and-health-policy/issue-brief/continued-rises-in-extreme-heat-and-implications-for-health-disparities/

Ndugga, N., Pillai, D., & Artiga, S. (2023). Climate-Related Health Risks Among Workers: Who is at Increased Risk? *KFF*. https://www.kff.org/racial-equity-and-health-policy/issue-brief/climate-related-health-risks-among-workers-who-is-at-increased-risk/

Negrusa, S., Fomenko, O., & Thumula, V. (2024). *Impact of Excessive Heat on the Frequency of Work-Related Injuries*.

Neidell, M., Graff Zivin, J., Sheahan, M., Willwerth, J., Fant, C., Sarofim, M., & Martinich, J. (2021). Temperature and work: Time allocated to work under varying climate and labor market conditions. *PLOS ONE*, *16*(8), e0254224. https://doi.org/10.1371/journal.pone.0254224

Nelson, D. A., Deuster, P. A., O'Connor, F. G., & Kurina, L. M. (2018a). Sickle Cell Trait and Heat Injury Among US Army Soldiers. *American Journal of Epidemiology*, *187*(3), 523–528. https://doi.org/10.1093/aje/kwx285

Nelson, D. A., Deuster, P. A., O'Connor, F. G., & Kurina, L. M. (2018b). Timing and Predictors of Mild and Severe Heat Illness among New Military Enlistees. *Medicine & Science in Sports & Exercise*, *50*(8), 1603–1612. https://doi.org/10.1249/MSS.0000000000001623

Nelson, G. C., Vanos, J., Havenith, G., Jay, O., Ebi, K. L., & Hijmans, R. J. (2024). Global reductions in manual agricultural work capacity due to climate change. *Global Change Biology*, *30*(1), e17142. https://doi.org/10.1111/gcb.17142

Nerbass, F. B., Moist, L., Clark, W. F., Vieira, M. A., & Pecoits-Filho, R. (2019). Hydration Status and Kidney Health of Factory Workers Exposed to Heat Stress: A Pilot Feasibility Study. *Annals of Nutrition and Metabolism*, *74*(Suppl. 3), 30–37. https://doi.org/10.1159/000500373

Nevada Revised Proposed Regulation, R053-20 (2022). https://dir.nv.gov/uploadedFiles/dirnvgov/content/OSHA/Legislative_Matters/R05320%20-%20Proposed%20Heat%20Illness%20Regulation%20(2-28-2022).pdf

Nichols, A., & Zeckhauser, R. (1977). Government Comes to the Workplace: An Assessment of OSHA. *The Public Interest*, *49*(39).

Nielsen, B., Kassow, K., & Aschengreen, F. E. (1988). Heat balance during exercise in the sun. *European Journal of Applied Physiology and Occupational Physiology*, *58*(1–2), 189–196. https://doi.org/10.1007/BF00636625

Niemelä, R., Hannula, M., Rautio, S., Reijula, K., & Railio, J. (2002). The effect of air temperature on labour productivity in call centres—A case study. *Energy and Buildings*.

Noakes, T. D. (2008). A modern classification of the exercise-related heat illnesses. *Journal of Science and Medicine in Sport*, *11*(1), 33–39. https://doi.org/10.1016/j.jsams.2007.02.009

Notley, S. R., Akerman, A. P., Friesen, B. J., Poirier, M. P., McCourt, E., Flouris, A. D., & Kenny, G. P. (2022a). Heat tolerance and the validity of occupational heat exposure limits in women during moderate-intensity work. *Applied Physiology, Nutrition, and Metabolism*, *47*(7), 711–724. https://doi.org/10.1139/apnm-2022-0003

Notley, S. R., Akerman, A. P., Friesen, B. J., Poirier, M. P., Sigal, R. J., Flouris, A. D., Boulay, P., Mccourt, E., Ruzicka, M., & Kenny, G. P. (2021). Heat Tolerance and Occupational Heat Exposure Limits in Older Men with and without Type 2 Diabetes or

Hypertension. *Medicine & Science in Sports & Exercise*, *53*(10), 2196–2206. https://doi.org/10.1249/MSS.0000000000002698

Notley, S. R., Akerman, A. P., & Kenny, G. P. (2022b). Initial stay times for uncompensable occupational heat stress in young and older men: A preliminary assessment. *Applied Physiology, Nutrition, and Metabolism*, *47*(1), 110–113. https://doi.org/10.1139/apnm-2021-0550

Notley, S. R., Meade, R. D., Akerman, A. P., Poirier, M. P., Boulay, P., Sigal, R. J., Flouris, A. D., & Kenny, G. P. (2020). Evidence for age-related differences in heat acclimatisation responsiveness. *Experimental Physiology*, *105*(9), 1491–1499. https://doi.org/10.1113/EP088728

Notley, S. R., Park, J., Tagami, K., Ohnishi, N., & Taylor, N. A. S. (2017). Variations in body morphology explain sex differences in thermoeffector function during compensable heat stress. *Experimental Physiology*, *102*(5), 545–562. https://doi.org/10.1113/EP086112

Numé, A.-K., Kragholm, K., Carlson, N., Kristensen, S. L., Bøggild, H., Hlatky, M. A., Torp-Pedersen, C., Gislason, G., & Ruwald, M. H. (2017). Syncope and Its Impact on Occupational Accidents and Employment: A Danish Nationwide Retrospective Cohort Study. *Circulation: Cardiovascular Quality and Outcomes*, *10*(4), e003202. https://doi.org/10.1161/CIRCOUTCOMES.116.003202

Nybo, L. (2007). Exercise and heat stress: Cerebral challenges and consequences. In *Progress in Brain Research* (Vol. 162, pp. 29–43). Elsevier. https://doi.org/10.1016/S0079-6123(06)62003-7

Nybo, L., Rasmussen, P., & Sawka, M. N. (2014). Performance in the Heat—Physiological Factors of Importance for Hyperthermia-Induced Fatigue. *Comprehensive Physiology*, *4*(2). https://doi.org/10.1002%2Fcphy.c130012

O'Brien, K. K., Leon, L. R., & Kenefick, R. W. (2012). Chapter 11: Clinical Management of Heat-Related Illnesses. In *Wilderness Medicine Textbook* (pp. 232–238). Thermal and Mountain Medicine Division.

Occupational Safety and Health Administration (OSHA). (2011). *Heat-Related Illness Inspections*.

Occupational Safety and Health Administration (OSHA). (2019). *Regional Emphasis Program for Heat Illnesses*. Region VI: Regional Instruction CPL 2 02-00-027A. https://www.osha.gov/sites/default/files/enforcement/directives/CPL_2_02-00-027A.pdf

Occupational Safety and Health Administration (OSHA). (2021). *Inspection Guidance for Heat-Related Hazards*. Directorate of Enforcement Programs. https://www.osha.gov/laws-regs/standardinterpretations/2021-09-01

Occupational Safety and Health Administration (OSHA). (2022). *Regional Policy for Heat Illnesses*. Region IX: San Francisco Regional Instruction CPL 04-00-16. https://www.osha.gov/sites/default/files/enforcement/directives/CPL_04-00-16.pdf

Occupational Safety and Health Administration (OSHA). (2023a). *Small Business Advocacy Review (SBAR) Panel for a Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings: Small Entity Representative (SER) Poll Results*.

Occupational Safety and Health Administration (OSHA) (2023b). Employer Heat Program Question Results.

Occupational Safety and Health Administration (OSHA). (2024a). *Heat Stress Guide*. https://www.osha.gov/emergency-preparedness/guides/heat-stress

Occupational Safety and Health Administration (OSHA). (2024b). *Heat-related 5(a)(1) Inspections Data*.

Occupational Safety and Health Administration (OSHA) (2024c). Analytical Support for Supporting OSHA's Preliminary Economic Analysis for the Heat Injury and Illness Prevention NPRM.

Occupational Safety and Health Administration (OSHA) (2024d). Exposure Estimates for OSHA's Preliminary Economic Analysis for the Heat Injury and Illness Prevention NPRM.

Occupational Safety and Health Administration (OSHA) (2024e). Noncompliance Rates for Rest Breaks.

Occupational Safety and Health Administration (OSHA), & National Institute for Occupational Safety and Health (NIOSH). (2011). *Protecting workers from heat illness*. https://www.osha.gov/sites/default/files/publications/osha-niosh-heat-illness-infosheet.pdf

O'Connor, F. G., Brennan, F. H., Campbell, W., Heled, Y., & Deuster, P. (2008). Return to Physical Activity After Exertional Rhabdomyolysis. *Current Sports Medicine Reports*, *7*(6), 328–331. https://doi.org/10.1249/JSR.0b013e31818f0317

O'Connor, F. G., Deuster, P., Leggit, J., Williams, M. E., Madsen, C. M., Beutler, A., Nye, N. S., Kane, S. F., Oh, R., Marks, E., Baron, J., & Cook, G. A. (2020). Clinical Practice Guideline for the Management of Exertional Rhabdomyolysis in Warfighters 2020. *Warrior Heat- and Exertion-Related Events Collaborative*.

O'Connor, F. G., Williams, A. D., Blivin, S., Heled, Y., Deuster, P., & Flinn, S. D. (2007). Guidelines for Return to Duty (Play) after Heat Illness: A Military Perspective. *Journal of Sport Rehabilitation*, *16*(3), 227–237. https://doi.org/10.1123/jsr.16.3.227

O'Donnell, T. F., & Clowes, G. H. A. (1972). The circulatory abnormalities of heat stroke. *The New England Journal of Medicine*, *287*(15), 734–737.

Office of Management and Budget (OMB). (2023). *Circular No. A-4*. Executive Office of the President. https://www.whitehouse.gov/wp-content/uploads/2023/11/CircularA-4.pdf

Oh, R. C., Bury, D. C., & McClure, C. J. (2022). Exertional rhabdomyolysis: An analysis of 321 hospitalised US military service members and its relationship with heat illness. *BMJ Military Health*, e002028. https://doi.org/10.1136/military-2021-002028

O*NET. (2023). *Work Context*. https://www.onetcenter.org/dictionary/28.1/excel/work_context.html

Orlov, A., Sillmann, J., Aaheim, A., Aunan, K., & de Bruin, K. (2019). Economic Losses of Heat-Induced Reductions in Outdoor Worker Productivity: A Case Study of Europe. *Economics of Disasters and Climate Change*, *3*(3), 191–211. https://doi.org/10.1007/s41885-019-00044-0

Ortiz, X. A., Smith, J. F., Bradford, B. J., Harner, J. P., & Oddy, A. (2010). A comparison of the effects of 2 cattle-cooling systems on dairy cows in a desert environment. *Journal of Dairy Science*, *93*(10), Article 10. https://doi.org/10.3168/jds.2010-3127

Osborne, T. F., Veigulis, Z. P., Vaidyanathan, A., Arreola, D. M., & Schramm, P. J. (2023). Trends in heat related illness: Nationwide observational cohort at the US department of veteran affairs. *The Journal of Climate Change and Health*, *12*, 100256. https://doi.org/10.1016/j.joclim.2023.100256

Otani, H., Kaya, M., Tamaki, A., Goto, H., & Maughan, R. J. (2019). Exposure to high solar radiation reduces self-regulated exercise intensity in the heat outdoors. *Physiology & Behavior*, *199*, 191–199. https://doi.org/10.1016/j.physbeh.2018.11.029

Otani, H., Kaya, M., Tamaki, A., Goto, H., Tokizawa, K., & Maughan, R. J. (2021). Combined effects of solar radiation and airflow on endurance exercise capacity in the heat. *Physiology & Behavior*, *229*, 113264. https://doi.org/10.1016/j.physbeh.2020.113264

Otani, H., Kaya, M., Tamaki, A., Watson, P., & Maughan, R. J. (2016). Effects of solar radiation on endurance exercise capacity in a hot environment. *European Journal of Applied Physiology*, *116*(4), 769–779. https://doi.org/10.1007/s00421-016-3335-9

Otani, H., Kaya, M., Tamaki, A., Watson, P., & Maughan, R. J. (2018). Air velocity influences thermoregulation and endurance exercise capacity in the heat. *Applied Physiology, Nutrition, and Metabolism*, *43*(2), 131–138. https://doi.org/10.1139/apnm-2017-0448

Pan, Q., Sumner, D. A., Mitchell, D. C., & Schenker, M. (2021). Compensation incentives and heat exposure affect farm worker effort. *PLOS ONE*, *16*(11), e0259459. https://doi.org/10.1371/journal.pone.0259459

Pandolf, K. B. (1997). Aging and human heat tolerance. *Experimental Aging Research*, *23*(1), 69–105. https://doi.org/10.1080/03610739708254027

Pandolf, K. B., Griffin, T. B., Munro, E. H., & Goldman, R. F. (1980). Heat intolerance as a function of percent of body surface involved with miliaria rubra. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *239*(3), R233–R240. https://doi.org/10.1152/ajpregu.1980.239.3.R233

Park, J., Pankratz, N. M. C., & Behrer, A. (2021). Temperature, Workplace Safety, and Labor Market Inequality. *IZA Institute of Labor Economics*. https://doi.org/10.2139/ssrn.3892588

Park, R. J. (2022). Hot Temperature and High-Stakes Performance. *Journal of Human Resources*, *57*(2), 400–434. https://doi.org/10.3368/jhr.57.2.0618-9535R3

Park, R. J., Goodman, J., Hurwitz, M., & Smith, J. (2020). Heat and Learning. *American Economic Journal: Economic Policy*, *12*(2), 306–339. https://doi.org/10.1257/pol.20180612

Parsons, I., Snape, D., Stacey, M. J., Barlow, M., O'Hara, J., Gall, N., Chowienczyk, P., Wainwright, B., & Woods, D. R. (2023). *Improvements in orthostatic tolerance with physical training are augmented with heat acclimation; a randomised controlled trial*. https://doi.org/10.21203/rs.3.rs-3059681/v1

Parsons, I. T., Cox, A. T., Mollan, I. A., & Boos, C. J. (2015). Managing the military patient with syncope. *Journal of the Royal Army Medical Corps*, *161*(3), 180–186. https://doi.org/10.1136/jramc-2015-000493

Patel, D. R., Gyamfi, R., & Torres, A. (2009). Exertional Rhabdomyolysis and Acute Kidney Injury. *The Physician and Sportsmedicine*, *37*(1), 71–79. https://doi.org/10.3810/PSM.2009.04.1685

Patel, H. C., Rao, N., & Saha, A. (2006). Heat exposure effects among firefighters. *Indian Journal of Occupational and Environmental Medicine*, *10*(3), 121. https://doi.org/10.4103/0019-5278.29572

Paull, J. M., & Rosenthal, F. S. (1987). Heat Strain and Heat Stress for Workers Wearing Protective Suits at a Hazardous Waste Site. *American Industrial Hygiene Association Journal*, *48*(5), 458–463. https://doi.org/10.1080/15298668791385048

Pearson, J., Lucas, R. A. I., Schlader, Z. J., Zhao, J., Gagnon, D., & Crandall, C. G. (2014). Active and passive heat stress similarly compromise tolerance to a simulated hemorrhagic challenge. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *307*(7), R822–R827. https://doi.org/10.1152/ajpregu.00199.2014

Périard, J. D., DeGroot, D., & Jay, O. (2022). Exertional heat stroke in sport and the military: Epidemiology and mitigation. *Experimental Physiology*, *107*(10), 1111–1121. https://doi.org/10.1113/EP090686

Perkison, W. B., Schaefer, C. M., Green-McKenzie, J., Roy, R. W., Shofer, F. S., & McCarthy, R. B. (2024). Outcomes for a Heat Illness Prevention Program in Outdoor Workers: A 9-Year Overview. *Journal of Occupational & Environmental Medicine*, *66*(4), 293–297. https://doi.org/10.1097/JOM.0000000000003051

Peterkin, N. D., Atkin, J. S., & Coris, E. E. (2016). What Is the Best Practice for the Treatment of Exertional Heat Illnesses (Heat Cramps, Heat Syncope, Heat Exhaustion, and Exertional Heat Stroke)? *Athletic Training & Sports Health Care*, *8*(3), 97–99. https://doi.org/10.3928/19425864-20160303-01

Petitti, D. B., Harlan, S. L., Chowell-Puente, G., & Ruddell, D. (2013). Occupation and Environmental Heat-Associated Deaths in Maricopa County, Arizona: A Case-Control Study. *PLoS ONE*, *8*(5), e62596. https://doi.org/10.1371/journal.pone.0062596

Petropoulos, Z. E., Keogh, S. A., Jarquín, E., López-Pilarte, D., Amador Velázquez, J. J., García-Trabanino, R., Amador Sánchez, M. R., Guevara, R., Gruener, A., Allen, D. R., Leibler, J. H., Delgado, I. S., McClean, M. D., Friedman, D. J., Brooks, D. R., & Scammell, M. K. (2023). Heat stress and heat strain among outdoor workers in El Salvador and Nicaragua. *Journal of Exposure Science & Environmental Epidemiology*, *33*(4), 622–630. https://doi.org/10.1038/s41370-023-00537-x

Phan, V., & Beck, J. W. (2023). Why Do People (Not) Take Breaks? An Investigation of Individuals' Reasons for Taking and for Not Taking Breaks at Work. *Journal of Business and Psychology*, *38*(2), 259–282. https://doi.org/10.1007/s10869-022-09866-4

Phinney, L. T., Gardner, J. W., Kark, J. A., & Bruce Wenger, C. (2001). Long-term follow-up after exertional heat illness during recruit training. *Medicine & Science in Sports & Exercise*, *33*(9), 1443–1448. https://doi.org/10.1097/00005768-200109000-00004

Piil, J. F., Lundbye-Jensen, J., Trangmar, S. J., & Nybo, L. (2017). Performance in complex motor tasks deteriorates in hyperthermic humans. *Temperature*, *4*(4), 420–428. https://doi.org/10.1080/23328940.2017.1368877

Pilcher, J. J., Nadler, E., & Busch, C. (2002). Effects of hot and cold temperature exposure on performance: A meta-analytic review. *Ergonomics*, *45*(10), 682–698. https://doi.org/10.1080/00140130210158419

Pin, N. T., Ling, N. Y., & Siang, L. H. (1992). Dehydration from outdoor work and urinary stones in a tropical environment. *Occupational Medicine*, *42*(1), 30–32. https://doi.org/10.1093/occmed/42.1.30

Pinkerton, L. E., Bertke, S., Dahm, M. M., Kubale, T. L., Siegel, M. R., Hales, T. R., Yiin, J. H., Purdue, M. P., Beaumont, J. J., & Daniels, R. D. (2022). End-stage renal disease incidence in a cohort of US firefighters from San Francisco, Chicago, and Philadelphia. *American Journal of Industrial Medicine*, *65*(12), 975–984. https://doi.org/10.1002/ajim.23435

Pogačar, T., Žnidaršič, Z., Kajfež Bogataj, L., Flouris, A., Poulianiti, K., & Črepinšek, Z. (2019). Heat Waves Occurrence and Outdoor Workers' Self-assessment of Heat Stress in Slovenia and Greece. *International Journal of Environmental Research and Public Health*, *16*(4), 597. https://doi.org/10.3390/ijerph16040597

Pradhan, B., Kjellstrom, T., Atar, D., Sharma, P., Kayastha, B., Bhandari, G., & Pradhan, P. K. (2019). Heat Stress Impacts on Cardiac Mortality in Nepali Migrant Workers in Qatar. *Cardiology*, *143*(1–2), 37–48. https://doi.org/10.1159/000500853

Prudhomme, J., & Neidhardt, A. (2006). *Cal/OSHA Investigations of Heat Related Illnesses* [Personal communication].

Prudhomme, J., & Neidhardt, A. (2007). *Cal/OHSA investigations of Heat-Related Illness 2006* [Personal communication].

Pryor, R. R., Larson, J. R., Vandermark, L. W., Johnson, B. D., & Schlader, Z. J. (2023). Water consumption patterns impact hydration markers in males working in accordance with the National Institute for Occupational Safety and Health recommendations. *Journal*

of Occupational and Environmental Hygiene, *20*(9), 414–425. https://doi.org/10.1080/15459624.2023.2221713

Public Citizen, Farmworker Justice, United Farm Workers Foundation, 350 Spokane, 350.org, Academic Health Resources, Alliance of Nurses for Healthy Environments, American Federation of State, County and Municipal Employees - AFL-CIO, American Federation of Teachers, Association of Farmworker Opportunity Programs, Association of Western Pulp and Paper Workers, Boston University School of Public Health, California Rural Legal Assistance Foundation, California State University East Bay, CATA – The Farmworkers Support Committee, Catskill Mountainkeeper, Center for Biological Diversity, Center for Progressive Reform, … Whyte, Y. (2018). *Petition to OSHA for a Heat Standard*. https://www.citizen.org/article/petition-to-osha-for-a-heat-standard/

Qiu, Y., & Zhao, J. (2022). Adaptation and the distributional effects of heat: Evidence from professional archery competitions. *Southern Economic Journal*, *88*(3), 1149–1177. https://doi.org/10.1002/soej.12553

Quiller, G., Krenz, J., Ebi, K., Hess, J. J., Fenske, R. A., Sampson, P. D., Pan, M., & Spector, J. T. (2017). Heat exposure and productivity in orchards: Implications for climate change research. *Archives of Environmental & Occupational Health*, *72*(6), 313–316. https://doi.org/10.1080/19338244.2017.1288077

Rachootin, P., & Olsen, J. (1983). The Risk of Infertility and Delayed Conception Associated With Exposures in the Danish Workplace. *Journal of Occupational Medicine*, *25*(5), 394–402.

Racinais, S., Alonso, J. M., Coutts, A. J., Flouris, A. D., Girard, O., González-Alonso, J., Hausswirth, C., Jay, O., Lee, J. K. W., Mitchell, N., Nassis, G. P., Nybo, L., Pluim, B. M., Roelands, B., Sawka, M. N., Wingo, J. E., & Périard, J. D. (2015). Consensus recommendations on training and competing in the heat. *Scandinavian Journal of Medicine & Science in Sports*, *25*(S1), 6–19. https://doi.org/10.1111/sms.12467

Racinais, S., Buchheit, M., Bilsborough, J., Bourdon, P. C., Cordy, J., & Coutts, A. J. (2014). Physiological and Performance Responses to a Training Camp in the Heat in Professional Australian Football Players. *International Journal of Sports Physiology and Performance*, *9*(4), 598–603. https://doi.org/10.1123/ijspp.2013-0284

Racinais, S., Mohr, M., Buchheit, M., Voss, S. C., Gaoua, N., Grantham, J., & Nybo, L. (2012). Individual responses to short-term heat acclimatisation as predictors of football performance in a hot, dry environment. *British Journal of Sports Medicine*, *46*(11), 810–815. https://doi.org/10.1136/bjsports-2012-091227

Ramsey, J. D. (1975). Heat Stress Standard: OSHA's Advisory Committee Recommendations. *National Safety News*, *111*(6), 89–95.

Ramsey, J. D. (1995). Task performance in heat: A review. *Ergonomics*, *38*(1), 154–165.

Ramsey, J. D., Burford, C. L., Beshir, M. Y., & Jensen, R. C. (1983). Effects of workplace thermal conditions on safe work behavior. *Journal of Safety Research*, *14*(3), 105–114. https://doi.org/10.1016/0022-4375(83)90021-X

Ramsey, J. D., & Kwon, Y. G. (1992). Recommended alert limits for perceptual motor loss in hot environments. *International Journal of Industrial Ergonomics*, *9*(3), 245–257. https://doi.org/10.1016/0169-8141(92)90018-U

Rao, P. (2007). Heat Related Illnesses: An Occupational Health Concern for Farmworkers. *Farmworker Justice and Migrant Clinicians Network*.

Ratkalkar, V. N., & Kleinman, J. G. (2011). Mechanisms of Stone Formation. *Clinical Reviews in Bone and Mineral Metabolism*, *9*(3), 187–197. https://doi.org/10.1007/s12018-011-9104-8

Ravanelli, N. M., Gagnon, D., Hodder, S. G., Havenith, G., & Jay, O. (2017). The biophysical and physiological basis for mitigated elevations in heart rate with electric fan use in extreme heat and humidity. *International Journal of Biometeorology*, *61*(2), 313–323. https://doi.org/10.1007/s00484-016-1213-0

Ravanelli, N. M., Hodder, S. G., Havenith, G., & Jay, O. (2015). Heart Rate and Body Temperature Responses to Extreme Heat and Humidity With and Without Electric Fans. *JAMA*, *313*(7), 724. https://doi.org/10.1001/jama.2015.153

Rekha, S., Nalini, S. J., Bhuvana, S., Kanmani, S., Hirst, J. E., & Venugopal, V. (2023). Heat stress and adverse pregnancy outcome: Prospective cohort study. *BJOG: An International Journal of Obstetrics & Gynaecology*, *131*(5), 612–622. https://doi.org/10.1111/1471-0528.17680

Renbourn, E. T. (1958). The History of Sweat and Prickly Heat, 19th–20th Century. *Journal of Investigative Dermatology*, *30*(5), 249–259. https://doi.org/10.1038/jid.1958.50

Riccò, M., Vezzosi, L., Bragazzi, N. L., & Balzarini, F. (2020). Heat-Related Illnesses among Pesticide Applicators in North-Eastern Italy (2017). *Journal of Agromedicine*, *25*(1), 52–64. https://doi.org/10.1080/1059924X.2019.1606745

Rice, C. (2002). *Wage Rates for Economic Analyses of the Toxics Release Inventory Program*. Environmental Protection Agency (EPA).

Rivero, N., & Uzcategui, E. M. (2024, February 17). These farmworkers created America's strongest workplace heat rules. *Washington Post*. https://www.washingtonpost.com/climate-solutions/interactive/2024/farmworker-heat-safety-fair-food-program/

Roback, J. (1982). Wages, Rents, and the Quality of Life. *Journal of Political Economy*, *90*(6), 1257–1278. https://doi.org/10.1086/261120

Roberts, G. T., Ghebeh, H., Chishti, M. A., Al-Mohanna, F., El-Sayed, R., Al-Mohanna, F., & Bouchama, A. (2008). Microvascular Injury, Thrombosis, Inflammation, and Apoptosis in the Pathogenesis of Heatstroke: A Study in Baboon Model. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *28*(6), 1130–1136. https://doi.org/10.1161/ATVBAHA.107.158709

Roberts, W. O., Armstrong, L. E., Sawka, M. N., Yeargin, S. W., Heled, Y., Yeargin, S., & O'Connor, F. G. (2023). ACSM Expert Consensus Statement on Exertional Heat

Illness: Recognition, Management, and Return to Activity. *Current Sports Medicine Reports*, *22*(4), 134–149.

Rocha, L. A., Fromknecht, C. Q., Redman, S. D., Brady, J. E., Hodge, S. E., & Noe, R. S. (2017). Medicolegal Death Scene Investigations after Natural Disaster- and Weather-Related Events: A Review of the Literature. *Academic Forensic Pathology*, *7*(2), 221–239. https://doi.org/10.23907/2017.023

Roddie, I. C., Shepherd, J. T., & Whelan, R. F. (1957). The contribution of constrictor and dilator nerves to the skin vasodilatation during body heating. *The Journal of Physiology*, *136*(3), 489–497. https://doi.org/10.1113/jphysiol.1957.sp005775

Rode, A., Baker, R. E., Carleton, T., D'Agostino, A., Delgado, M., Foreman, T., Gergel, D. R., Greenstone, M., Houser, T., Hsiang, S., Hultgren, A., Jina, A., Kopp, R. E., Malevich, S. B., McCusker, K., Nath, I., Pecenco, M., Rising, J., & Yuan, J. (2022). Labor Disutility in a Warmer World: The Impact of Climate Change on the Global Workforce. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4221478

Rogers, J. D. (2012). *Hoover Dam: Construction Milestones in Concrete Delivery and Placement, Steel Fabrication, and Job Site Safety*. 163–188.

Romanello, M., Napoli, C. di, Green, C., Kennard, H., Lampard, P., Scamman, D., Walawender, M., Ali, Z., Ameli, N., Ayeb-Karlsson, S., Beggs, P. J., Belesova, K., Berrang Ford, L., Bowen, K., Cai, W., Callaghan, M., Campbell-Lendrum, D., Chambers, J., Cross, T. J., … Costello, A. (2023). The 2023 report of the Lancet Countdown on health and climate change: The imperative for a health-centred response in a world facing irreversible harms. *The Lancet*, *402*(10419), 2346–2394. https://doi.org/10.1016/S0140-6736(23)01859-7

Roman-Ponce, H., Thatcher, W. W., Buffington, D. E., Wilcox, C. J., & Van Horn, H. H. (1977). Physiological and Production Responses of Dairy Cattle to a Shade Structure in a Subtropical Environment. *Journal of Dairy Science*, *60*(3), 424–430. https://doi.org/10.3168/jds.S0022-0302(77)83882-4

Roncal Jimenez, C. A., Ishimoto, T., Lanaspa, M. A., Rivard, C. J., Nakagawa, T., Ejaz, A. A., Cicerchi, C., Inaba, S., Le, M., Miyazaki, M., Glaser, J., Correa-Rotter, R., González, M. A., Aragón, A., Wesseling, C., Sánchez-Lozada, L. G., & Johnson, R. J. (2014). Fructokinase activity mediates dehydration-induced renal injury. *Kidney International*, *86*(2), 294–302. https://doi.org/10.1038/ki.2013.492

Roncal-Jimenez, C., Lanaspa, M. A., Jensen, T., Sanchez-Lozada, L. G., & Johnson, R. J. (2015). Mechanisms by Which Dehydration May Lead to Chronic Kidney Disease. *Annals of Nutrition and Metabolism*, *66*(Suppl. 3), 10–13. https://doi.org/10.1159/000381239

Rosenman, K. D., Kalush, A., Reilly, M. J., Gardiner, J. C., Reeves, M., & Luo, Z. (2006). How Much Work-Related Injury and Illness is Missed By the Current National Surveillance System? *Journal of Occupational and Environmental Medicine*, *48*(4), 357–365. https://doi.org/10.1097/01.jom.0000205864.81970.63

Rosner, M. H., & Kirven, J. (2007). Exercise-Associated Hyponatremia. *Clinical Journal of the American Society of Nephrology*, *2*(1), 151–161. https://doi.org/10.2215/CJN.02730806

Ross, J. A., Shipp, E. M., Trueblood, A. B., & Bhattacharya, A. (2016). Ergonomics and Beyond: Understanding How Chemical and Heat Exposures and Physical Exertions at Work Affect Functional Ability, Injury, and Long-Term Health. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *58*(5), 777–795. https://doi.org/10.1177/0018720816645457

Roti Roti, J. L. (2008). Cellular responses to hyperthermia (40–46°C): Cell killing and molecular events. *International Journal of Hyperthermia*, *24*(1), 3–15. https://doi.org/10.1080/02656730701769841

Rowlinson, S., YunyanJia, A., Li, B., & ChuanjingJu, C. (2014). Management of climatic heat stress risk in construction: A review of practices, methodologies, and future research. *Accident Analysis & Prevention*, *66*, 187–198. https://doi.org/10.1016/j.aap.2013.08.011

Ruggles, S., Flood, S., Sobek, M., Backman, D., Chen, A., Cooper, G., Richards, S., Rodgers, R., & Schouweiler, M. (2024). *IPUMS USA: Version 15.0 American Community Survey 2018-2022* (15.0) [dataset]. Minneapolis, MN: IPUMS. https://doi.org/10.18128/D010.V15.0

Ruser, J. W. (2008, August). Examining evidence on whether BLS undercounts workplace injuries and illnesses. *Monthly Labor Review*. https://www.bls.gov/opub/mlr/2008/08/art2full.pdf

Russell, J., & Conroy, C. (1991). Representativeness of deaths identified through the injury-at-work item on the death certificate: Implications for surveillance. *American Journal of Public Health*, *81*(12), 1613–1618. https://doi.org/10.2105/AJPH.81.12.1613

Sadiq, L. S., Hashim, Z., & Osman, M. (2019). The Impact of Heat on Health and Productivity among Maize Farmers in a Tropical Climate Area. *Journal of Environmental and Public Health*, *2019*, 1–7. https://doi.org/10.1155/2019/9896410

SafetySign.com. (2024). *Caution Hot Work Area Sign*. Safetysign.com

Sahu, S., Sett, M., & Kjellstrom, T. (2013). Heat Exposure, Cardiovascular Stress and Work Productivity in Rice Harvesters in India: Implications for a Climate Change Future. *Industrial Health*, *51*(4), 424–431. https://doi.org/10.2486/indhealth.2013-0006

Saigal, C. S., Joyce, G., Timilsina, A. R., & The Urologic Diseases In America Project. (2005). Direct and indirect costs of nephrolithiasis in an employed population: Opportunity for disease management? *Kidney International*, *68*(4), 1808–1814. https://doi.org/10.1111/j.1523-1755.2005.00599.x

Sanchez, C. A., Thomas, K. E., Malilay, J., & Annest, J. L. (2010). Nonfatal Natural and Environmental Injuries Treated in Emergency Departments, United States, 2001–2004. *Family & Community Health*, *33*(1), 3–10. https://doi.org/10.1097/FCH.0b013e3181c4e2fa

Sandor, R. P. (1997). Heat Illness: On-Site Diagnosis and Cooling. *The Physician and Sportsmedicine*, *25*(6), 35–40. https://doi.org/10.1080/00913847.1997.11440257

Santelli, J., Sullivan, J. M., Czarnik, A., & Bedolla, J. (2014). Heat Illness In The Emergency Department: Keeping Your Cool. *Emergency Medicine Practice*, *16*(8).

Sanusi, R., Johnstone, D., May, P., & Livesley, S. J. (2016). Street Orientation and Side of the Street Greatly Influence the Microclimatic Benefits Street Trees Can Provide in Summer. *Journal of Environmental Quality*, *45*(1), 167–174. https://doi.org/10.2134/jeq2015.01.0039

Sato, Y., Roncal-Jimenez, C. A., Andres-Hernando, A., Jensen, T., Tolan, D. R., Sanchez-Lozada, L. G., Newman, L. S., Butler-Dawson, J., Sorensen, C., Glaser, J., Miyazaki, M., Diaz, H. F., Ishimoto, T., Kosugi, T., Maruyama, S., Garcia, G. E., Lanaspa, M. A., & Johnson, R. J. (2019). Increase of core temperature affected the progression of kidney injury by repeated heat stress exposure. *American Journal of Physiology-Renal Physiology*, *317*(5), F1111–F1121. https://doi.org/10.1152/ajprenal.00259.2019

Saunders, A. G., Dugas, J. P., Tucker, R., Lambert, M. I., & Noakes, T. D. (2005). The effects of different air velocities on heat storage and body temperature in humans cycling in a hot, humid environment. *Acta Physiologica Scandinavica*, *183*(3), 241–255. https://doi.org/10.1111/j.1365-201X.2004.01400.x

Sauret, J. M., Marinides, G., & Wang, G. K. (2002). Rhabdomyolysis. *American Family Physician*, *65*(5), 907–912.

Savioli, G., Zanza, C., Longhitano, Y., Nardone, A., Varesi, A., Ceresa, I. F., Manetti, A. C., Volonnino, G., Maiese, A., & La Russa, R. (2022). Heat-Related Illness in Emergency and Critical Care: Recommendations for Recognition and Management with Medico-Legal Considerations. *Biomedicines*, *10*(10), 2542. https://doi.org/10.3390/biomedicines10102542

Sawka, M. N., Leon, L. R., Montain, S. J., & Sonna, L. A. (2011). Integrated Physiological Mechanisms of Exercise Performance, Adaptation, and Maladaptation to Heat Stress. In *Comprehensive Physiology* (1st ed., pp. 1883–1928). Wiley. https://doi.org/10.1002/cphy.c100082

Sawka, M. N., Wenger, C. B., Young, A. J., & Pandolf, K. B. (1993). Physiological Responses to Exercise in the Heat. *Nutritional Needs in Hot Environments: Applications for Military Personnel in Field Operations*, 55–74.

Schallig, W., Levels, K., & Daanen, H. A. (2017). The influence of heat on the occurrence of exercise associated muscle cramps: A review. *Sport En Geneeskunde*, *1*, 30–39.

Scherzer, T., Rugulies, R., & Krause, N. (2005). Work-Related Pain and Injury and Barriers to Workers' Compensation Among Las Vegas Hotel Room Cleaners. *American Journal of Public Health*, *95*(3), 483–488. https://doi.org/10.2105/AJPH.2003.033266

Schickele, E. (1947). Environment and fatal heat stroke: An analysis of 157 cases occurring in the Army in the U.S. during World War II. *The Military Surgeon*, *100*(3), 235–256. https://doi.org/10.1093/milmed/100.3.235

Schlader, Z. J., Chapman, C. L., Sarker, S., Russo, L., Rideout, T. C., Parker, M. D., Johnson, B. D., & Hostler, D. (2017). Firefighter Work Duration Influences the Extent of Acute Kidney Injury. *Medicine & Science in Sports & Exercise*, *49*(8), 1745–1753. https://doi.org/10.1249/MSS.0000000000001254

Schlader, Z. J., Davis, M. S., & Bouchama, A. (2022). Biomarkers of heatstroke-induced organ injury and repair. *Experimental Physiology*, *107*(10), 1159–1171. https://doi.org/10.1113/EP090142

Schlader, Z. J., Hostler, D., Parker, M. D., Pryor, R. R., Lohr, J. W., Johnson, B. D., & Chapman, C. L. (2019). The Potential for Renal Injury Elicited by Physical Work in the Heat. *Nutrients*, *11*(9), 2087. https://doi.org/10.3390/nu11092087

Schlader, Z. J., Wilson, T. E., & Crandall, C. G. (2016). Mechanisms of orthostatic intolerance during heat stress. *Autonomic Neuroscience*, *196*, 37–46. https://doi.org/10.1016/j.autneu.2015.12.005

Schrier, R. W., Hano, J., Keller, H. I., Finkel, R. M., Gilliland, P. F., Cirksena, W. J., & Teschan, P. E. (1970). Renal Metabolic and Circulatory Responses to Heat and Exercise. *Annals of Internal Medicine*, *73*(2), 213–223.

Schrier, R. W., Henderson, H. S., Tisher, C. C., & Tannen, R. L. (1967). Nephropathy Associated with Heat Stress and Exercise. *Annals of Internal Medicine*, *67*(2), 356–376.

Schroeder, C., Bush, V. E., Norcliffe, L. J., Luft, F. C., Tank, J., Jordan, J., & Hainsworth, R. (2002). Water Drinking Acutely Improves Orthostatic Tolerance in Healthy Subjects. *Circulation*, *106*(22), 2806–2811. https://doi.org/10.1161/01.CIR.0000038921.64575.D0

Sefton, J. M., McAdam, J. S., Pascoe, D. D., Lohse, K. R., Banda, R. L., Henault, C. B., Cherrington, A. R., & Adams, N. E. (2016). Evaluation of 2 Heat-Mitigation Methods in Army Trainees. *Journal of Athletic Training*, *51*(11), 936–945. https://doi.org/10.4085/1062-6050-51.10.13

Selkirk, G. A., McLellan, T. M., & Wong, J. (2004). Active Versus Passive Cooling During Work in Warm Environments While Wearing Firefighting Protective Clothing. *Journal of Occupational and Environmental Hygiene*, *1*(8), 521–531. https://doi.org/10.1080/15459620490475216

Semenza, J. C., McCullough, J. E., Flanders, D., McGeehin, M. A., & Lumpkin, J. R. (1999). Excess hospital admissions during the July 1995 heat wave in Chicago. *American Journal of Preventive Medicine*, *16*(4), 269–277. https://doi.org/10.1016/S0749-3797(99)00025-2

Seo, Y., Powell, J., Strauch, A., Roberge, R., Kenny, G. P., & Kim, J.-H. (2019). Heat stress assessment during intermittent work under different environmental conditions and clothing combinations of effective wet bulb globe temperature (WBGT). *Journal of*

Occupational and Environmental Hygiene, *16*(7), 467–476. https://doi.org/10.1080/15459624.2019.1612523

Seppänen, O., Fisk, W. J., & Lei, Q. (2006). Effect of Temperature on Task Performance in Office Environment. *Lawrence Berkeley National Laboratory*.

Seto, C. K., Way, D., & O'Connor, N. (2005). Environmental Illness in Athletes. *Clinics in Sports Medicine*, *24*(3), 695–718. https://doi.org/10.1016/j.csm.2005.03.002

Sett, M., & Sahu, S. (2014). Effects of occupational heat exposure on female brick workers in West Bengal, India. *Global Health Action*, *7*(1), 21923. https://doi.org/10.3402/gha.v7.21923

Sexton, S., Wang, Z., & Mullins, J. T. (2022). Heat Adaptation and Human Performance in a Warming Climate. *Journal of the Association of Environmental and Resource Economists*, *9*(1), 141–163. https://doi.org/10.1086/715509

Shaikh, Z. (2023). Autopsy reveals cause of death for mail carrier who collapsed in Dallas heat. *Dallas News*. https://www.dallasnews.com/new/2023/09/30/autopsy-reveals-cause-of-death-for-mail-carrier-who-collapsed-in-dallas-heat/

Sharma, V. M., Pichan, G., & Panwar, M. R. (1983). Differential effects of hot-humid and hot-dry environments on mental functions. *International Archives of Occupational and Environmental Health*, *52*(4), 315–327. https://doi.org/10.1007/BF02226897

SHARP. (2022). *Heat-related Illness in New Workers* (SHARP Publication 76-31-2022; SHARP Stats). Washington Department of Labor and Industries. https://lni.wa.gov/safety-health/safety-research/files/2022/76_31_2022_HRI_Tenure.pdf

Shen, T., Howe, H. L., Alo, C., & Moolenaar, R. L. (1998). Toward A Broader Definition of Heat-Related Death: Comparison of Mortality Estimates From Medical Examiners' Classification With Those From Total Death Differentials During the July 1995 Heat Wave in Chicago, Illinois: *The American Journal of Forensic Medicine and Pathology*, *19*(2), 113–118. https://doi.org/10.1097/00000433-199806000-00003

Shi, D. S., Weaver, V. M., Hodgson, M. J., & Tustin, A. W. (2022). Hospitalised heat-related acute kidney injury in indoor and outdoor workers in the USA. *Occupational and Environmental Medicine*, *79*(3), 184–191. https://doi.org/10.1136/oemed-2021-107933

Shiao, T. F., Chen, J. C., Yang, D. W., Lee, S. N., Lee, C. F., & Cheng, W. T. K. (2011). Feasibility assessment of a tunnel-ventilated, water-padded barn on alleviation of heat stress for lactating Holstein cows in a humid area. *Journal of Dairy Science*, *94*(11), Article 11. https://doi.org/10.3168/jds.2010-3730

Shire, J., Vaidyanathan, A., Lackovic, M., & Bunn, T. (2020). Association Between Work-Related Hyperthermia Emergency Department Visits and Ambient Heat in Five Southeastern States, 2010–2012—A Case-Crossover Study. *GeoHealth*, *4*(8), e2019GH000241. https://doi.org/10.1029/2019GH000241

Shirreffs, S. M., & Maughan, R. J. (1997). Whole body sweat collection in humans: An improved method with preliminary data on electrolyte content. *Journal of Applied Physiology*, *82*(1), 336–341. https://doi.org/10.1152/jappl.1997.82.1.336

Shvartz, E., Meroz, A., Magazanik, A., Shoenfeld, Y., & Shapiro, Y. (1977). Exercise and heat orthostatism and the effect of heat acclimation and physical fitness. *Aviation, Space, and Environmental Medicine*, *48*(9), 836–842.

Simmons, S. E., Saxby, B. K., McGlone, F. P., & Jones, D. A. (2008). The effect of passive heating and head cooling on perception, cardiovascular function and cognitive performance in the heat. *European Journal of Applied Physiology*, *104*(2), 271–280. https://doi.org/10.1007/s00421-008-0677-y

Singh, S., Hanna, E. G., & Kjellstrom, T. (2015). Working in Australia's heat: Health promotion concerns for health and productivity. *Health Promotion International*, *30*(2), 239–250. https://doi.org/10.1093/heapro/dat027

Sinha, P., Caulkins, M. L., & Cropper, M. L. (2018). Household location decisions and the value of climate amenities. *Journal of Environmental Economics and Management*, *92*, 608–637. https://doi.org/10.1016/j.jeem.2017.08.005

Small Business Administration (SBA). (2023). *Table of Small Business Size Standards*. https://www.sba.gov/document/support-table-size-standards

Smallcombe, J. W., Foster, J., Hodder, S. G., Jay, O., Flouris, A. D., & Havenith, G. (2022). Quantifying the impact of heat on human physical work capacity; part IV: Interactions between work duration and heat stress severity. *International Journal of Biometeorology*, *66*(12), 2463–2476. https://doi.org/10.1007/s00484-022-02370-7

Smit, A. A. J., Halliwill, J. R., Low, P. A., & Wieling, W. (1999). Pathophysiological basis of orthostatic hypotension in autonomic failure. *The Journal of Physiology*, *519*(1), 1–10. https://doi.org/10.1111/j.1469-7793.1999.0001o.x

Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*.

Smith, D. J., Ferranti, E. P., Hertzberg, V. S., & Mac, V. (2021). Knowledge of Heat-Related Illness First Aid and Self-Reported Hydration and Heat-Related Illness Symptoms in Migrant Farmworkers. *Workplace Health & Safety*, *69*(1), 15–21. https://doi.org/10.1177/2165079920934478

Somanathan, E., Somanathan, R., Sudarshan, A., & Tewari, M. (2021). The Impact of Temperature on Productivity and Labor Supply: Evidence from Indian Manufacturing. *Journal of Political Economy*, *129*(6), 1797–1827. https://doi.org/10.1086/713733

Sonna, L. A., Wenger, C. B., Flinn, S., Sheldon, H. K., Sawka, M. N., & Lilly, C. M. (2004). Exertional heat injury and gene expression changes: A DNA microarray analysis study. *Journal of Applied Physiology*, *96*(5), 1943–1953. https://doi.org/10.1152/japplphysiol.00886.2003

Sorensen, C. J., Butler-Dawson, J., Dally, M., Krisher, L., Griffin, B. R., Johnson, R. J., Lemery, J., Asensio, C., Tenney, L., & Newman, L. S. (2019). Risk Factors and Mechanisms Underlying Cross-Shift Decline in Kidney Function in Guatemalan Sugarcane Workers. *Journal of Occupational & Environmental Medicine*, *61*(3), 239–250. https://doi.org/10.1097/JOM.0000000000001529

Sorkin, I. (2018). Ranking Firms Using Revealed Preference. *The Quarterly Journal of Economics*, *133*(3), 1331–1393. https://doi.org/10.1093/qje/qjy001

Spector, J. T., Bonauto, D. K., Sheppard, L., Busch-Isaksen, T., Calkins, M., Adams, D. A., Lieblich, M., & Fenske, R. A. (2016). A Case-Crossover Study of Heat Exposure and Injury Risk in Outdoor Agricultural Workers. *PLOS One*, *11*(10), e0164498. https://doi.org/10.1371/journal.pone.0164498

Spector, J. T., Krenz, J., & Blank, K. N. (2015). Risk Factors for Heat-Related Illness in Washington Crop Workers. *Journal of Agromedicine*, *20*(3), 349–359. https://doi.org/10.1080/1059924X.2015.1047107

Spector, J. T., Krenz, J., Calkins, M., Ryan, D., Carmona, J., Pan, M., Zemke, A., & Sampson, P. D. (2018). Associations between heat exposure, vigilance, and balance performance in summer tree fruit harvesters. *Applied Ergonomics*, *67*, 1–8. https://doi.org/10.1016/j.apergo.2017.09.002

Spector, J. T., Krenz, J., Rauser, E., & Bonauto, D. K. (2014). Heat-related illness in Washington State agriculture and forestry sectors. *American Journal of Industrial Medicine*, *57*(8), 881–895. https://doi.org/10.1002/ajim.22357

Spector, J. T., Sampson, L., Flunker, J. C., Adams, D., & Bonauto, D. K. (2023). Occupational heat-related illness in Washington State: A descriptive study of day of illness and prior day ambient temperatures among cases and clusters, 2006–2021. *American Journal of Industrial Medicine*, *66*(8), 623–636. https://doi.org/10.1002/ajim.23506

Steadman, R. G. (1979). The Assessment of Sultriness. Part I: A Temperature-Humidity Index Based on Human Physiology and Clothing Science. Journal of Applied Meteorology, 18(7), 861–873. https://doi.org/10.1175/1520-0450(1979)018<0861:TAOSPI>2.0.CO;2

Stevens, A. (2017). *Temperature, Wages, and Agricultural Labor Productivity* [Working paper].

Stoecklin-Marois, M., Hennessy-Burt, T., Mitchell, D., & Schenker, M. (2013). Heat-related Illness Knowledge and Practices among California Hired Farm Workers in The MICASA Study. *Industrial Health*, *51*(1), 47–55. https://doi.org/10.2486/indhealth.2012-0128

Stöllberger, C., Lutz, W., & Finsterer, J. (2009). Heat-related side-effects of neurological and non-neurological medication may increase heatwave fatalities. *European Journal of Neurology*, *16*(7), 879–882. https://doi.org/10.1111/j.1468-1331.2009.02581.x

Stonehill, R. B., & Keil, P. G. (1961). Successful Preventive Medical Measures Against Heat Illness at Lackland Air Force Base. *American Journal of Public Health and the Nations Health*, *51*(4), 586–590. https://doi.org/10.2105/AJPH.51.4.586

Sulzberger, M. B., & Griffin, T. B. (1969). Induced Miliaria, Postmiliarial Hypohidrosis, and Some Potential Sequelae. *Archives of Dermatology*, *99*(2), 145. https://doi.org/10.1001/archderm.1969.01610200017003

Sunstein, C. R. (2014). The Limits of Quantification. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2424878

Taggart, S. M., Girard, O., Landers, G. J., & Wallman, K. E. (2024). Symptoms of heat illness and water consumption habits in mine industry workers over the summer months in Australia. *Industrial Health*, 2023–0139. https://doi.org/10.2486/indhealth.2023-0139

Takakura, J., Fujimori, S., Takahashi, K., Hijioka, Y., Hasegawa, T., Honda, Y., & Masui, T. (2017). Cost of preventing workplace heat-related illness through worker breaks and the benefit of climate-change mitigation. *Environmental Research Letters*, *12*(6), 064010. https://doi.org/10.1088/1748-9326/aa72cc

Talbott, J. H., & Michelsen, J. (1933). Heat Cramps. A Clinical and Chemical Study. *The Journal of Clinical Investigation*, *12*(3), 533–549. https://doi.org/10.1172/JCI100516

Tawatsupa, B., Yiengprugsawan, V., Kjellstrom, T., Berecki-Gisolf, J., Seubsman, S.-A., & Sleigh, A. (2013). Association between Heat Stress and Occupational Injury among Thai Workers: Findings of the Thai Cohort Study. *Industrial Health*, *51*(1), 34–46. https://doi.org/10.2486/indhealth.2012-0138

Taylor, L., Watkins, S. L., Marshall, H., Dascombe, B. J., & Foster, J. (2016). The Impact of Different Environmental Conditions on Cognitive Function: A Focused Review. *Frontiers in Physiology*, *6*. https://doi.org/10.3389/fphys.2015.00372

Tetzlaff, E. J., O'Connor, F. K., Meade, R. D., & Kenny, G. P. (2024). An exploratory survey of on-site heat stress management practices in the Canadian mining industry. *Journal of Occupational and Environmental Hygiene*, 1–14. https://doi.org/10.1080/15459624.2024.2332722

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving decisions about health, wealth and happiness* (Revised edition, new international edition). Penguin Books.

Thompson, T. L., Nguyen, T. X., & Karodeh, C. R. (2018). Twelve cases of exertional rhabdomyolysis in college football players from the same institution over a 23-year span: A descriptive study. *The Physician and Sportsmedicine*, *46*(3), 331–334. https://doi.org/10.1080/00913847.2018.1481717

Thongprayoon, C., Petnak, T., Kanduri, S. R., Kovvuru, K., Cheungpasitporn, W., Boonpheng, B., Chewcharat, A., Bathini, T., Medaura, J., Vallabhajosyula, S., & Kaewput, W. (2020). Impact of rhabdomyolysis on outcomes of hospitalizations for heat stroke in the United States. *Hospital Practice*, *48*(5), 276–281. https://doi.org/10.1080/21548331.2020.1792214

Thonneau, P., Ducot, B., Bujan, L., Mieusset, R., & Spira, A. (1997). Effect of male occupational heat exposure on time to pregnancy. *International Journal of Andrology*, *20*(5), 274–278. https://doi.org/10.1046/j.1365-2605.1997.d01-303.x

Tokizawa, K., Sawada, S., Oka, T., Yasuda, A., Tai, T., Ida, H., & Nakayama, K. (2014). Fan-precooling effect on heat strain while wearing protective clothing. *International Journal of Biometeorology*, *58*(9), 1919–1925. https://doi.org/10.1007/s00484-014-0794-8

Tork. (2021, June 14). Employees are still skipping lunch despite working from home, new Tork survey finds. *Torkusa.Com*. https://www.torkusa.com/press-releases/tork-takes-back-lunch-break

Torres, P. A., Helmstetter, J. A., Kaye, A. M., & Kaye, A. D. (2015). Rhabdomyolysis: Pathogenesis, Diagnosis, and Treatment. *The Oschner Journal*, *15*(1), 58–69.

Trangmar, S. J., & González-Alonso, J. (2017). New Insights Into the Impact of Dehydration on Blood Flow and Metabolism During Exercise. *Exercise and Sport Sciences Reviews*, *45*(3), 146–153. https://doi.org/10.1249/JES.0000000000000109

Tseng, M.-F., Chou, C.-L., Chung, C.-H., Chen, Y.-K., Chien, W.-C., Feng, C.-H., & Chu, P. (2020). Risk of chronic kidney disease in patients with heat injury: A nationwide longitudinal cohort study in Taiwan. *PLOS ONE*, *15*(7), e0235607. https://doi.org/10.1371/journal.pone.0235607

Turk, M. F. (2018). *A History of Occupational Health and Safety: From 1905 to the Present* (1st ed.). University of Nevada Press.

Tustin, A. W., Cannon, D. L., Arbury, S. B., Thomas, R. J., & Hodgson, M. J. (2018a). Risk Factors for Heat-Related Illness in U.S. Workers: An OSHA Case Series. *Journal of Occupational & Environmental Medicine*, *60*(8), e383–e389. https://doi.org/10.1097/JOM.0000000000001365

Tustin, A. W., Lamson, G. E., Jacklitsch, B. L., Thomas, R. J., Arbury, S. B., Cannon, D. L., Gonzales, R. G., & Hodgson, M. J. (2018b). Evaluation of Occupational Exposure Limits for Heat Stress in Outdoor Workers—United States, 2011–2016. *MMWR. Morbidity and Mortality Weekly Report*, *67*(26), 733–737. https://doi.org/10.15585/mmwr.mm6726a1

Tversky, A., & Kahneman, D. (1974). Judgment Under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124–1131.

Uchiyama, K., King, J., Wallman, K., Taggart, S., Dugan, C., & Girard, O. (2022). The influence of rest break frequency and duration on physical performance and psychophysiological responses: A mining simulation study. *European Journal of Applied Physiology*, *122*(9), 2087–2097. https://doi.org/10.1007/s00421-022-04979-3

United States Geological Survey (USGS). (2019). Evaporation and the Water Cycle. www.usgs.gov/special-topics/water-science-school/science/evaporation-and-water-cycle#overview

University of Groningen, & University of California, Davis. (2024). *Share of Labour Compensation in GDP at Current National Prices for United States [LABSHPUSA156NRUG], retrieved from FRED, Federal Reserve Bank of St. Louis*. https://fred.stlouisfed.org/series/LABSHPUSA156NRUG

Urdaz, J. H., Overton, M. W., Moore, D. A., & Santos, J. E. P. (2006). Technical Note: Effects of Adding Shade and Fans to a Feedbunk Sprinkler System for Preparturient Cows on Health and Performance. *Journal of Dairy Science*, *89*(6), Article 6. https://doi.org/10.3168/jds.S0022-0302(06)72267-6

Uribarri, J. (2020). Chronic kidney disease and kidney stones. *Current Opinion in Nephrology and Hypertension*, *29*(2), 237–242. https://doi.org/10.1097/MNH.0000000000000582

USVI Governor's Office. (2024). *USVI Proposed Executive Budget FY23 & FY24*. https://www.vi.gov/wp-content/uploads/2022/06/2023-2024-final-budget-book.pdf

Vaidyanathan, A., Malilay, J., Schramm, P., & Saha, S. (2020). Heat-Related Deaths—United States, 2004–2018. *Morbidity and Mortality Weekly Report (MMWR)*, *69*(24).

Vaidyanathan, A., Saha, S., Vicedo-Cabrera, A. M., Gasparrini, A., Abdurehman, N., Jordan, R., Hawkins, M., Hess, J., & Elixhauser, A. (2019). Assessment of extreme heat and hospitalizations to inform early warning systems. *Proceedings of the National Academy of Sciences*, *116*(12), 5420–5427. https://doi.org/10.1073/pnas.1806393116

Van der Walt, W., & Strydom, N. (1975). *Mortality rate due to heat stroke for the period 1930-1974 and the influence of heat acclimatization* (29/75). Chamber of Mines of South Africa Research Organization.

Van Lieshout, J. J., Wieling, W., Karemaker, J. M., & Secher, N. H. (2003). Syncope, cerebral perfusion, and oxygenation. *Journal of Applied Physiology*, *94*(3), 833–848. https://doi.org/10.1152/japplphysiol.00260.2002

Vanos, J., Vecellio, D. J., & Kjellstrom, T. (2019). Workplace heat exposure, health protection, and economic impacts: A case study in Canada. *American Journal of Industrial Medicine*, *62*(12), 1024–1037. https://doi.org/10.1002/ajim.22966

Varghese, B. M., Hansen, A., Bi, P., & Pisaniello, D. (2018). Are workers at risk of occupational injuries due to heat exposure? A comprehensive literature review. *Safety Science*, *110*, 380–392. https://doi.org/10.1016/j.ssci.2018.04.027

Varghese, B. M., Hansen, A. L., Williams, S., Bi, P., Hanson-Easey, S., Barnett, A. G., Heyworth, J. S., Sim, M. R., Rowett, S., Nitschke, M., Di Corleto, R., & Pisaniello, D. L. (2020). Determinants of heat-related injuries in Australian workplaces: Perceptions of health and safety professionals. *Science of The Total Environment*, *718*, 137138. https://doi.org/10.1016/j.scitotenv.2020.137138

Venugopal, V., Latha, P. K., Shanmugam, R., Krishnamoorthy, M., Srinivasan, K., Perumal, K., & Chinnadurai, J. S. (2020). Risk of kidney stone among workers exposed to high occupational heat stress—A case study from southern Indian steel industry. *Science of The Total Environment*, *722*, 137619. https://doi.org/10.1016/j.scitotenv.2020.137619

Vicario, S. J., Okabajue, R., & Haltom, T. (1986). Rapid cooling in classic heatstroke: Effect on mortality rates. *The American Journal of Emergency Medicine*, *4*(5), 394–398. https://doi.org/10.1016/0735-6757(86)90185-3

Viscusi, W. K., & Gentry, E. P. (2015). The value of a statistical life for transportation regulations: A test of the benefits transfer methodology. *Journal of Risk and Uncertainty*, *51*(1), 53–77. https://doi.org/10.1007/s11166-015-9219-2

Wadsworth, G., Courville, M., & Schenker, M. (2019). Pay, Power, and Health: HRI and the Agricultural Conundrum. *Labor Studies Journal*, *44*(3), 214–235. https://doi.org/10.1177/0160449X18767749

Waikar, S. S., & Bonventre, J. V. (2009). Creatinine Kinetics and the Definition of Acute Kidney Injury. *Journal of the American Society of Nephrology*, *20*(3), 672–679. https://doi.org/10.1681/ASN.2008070669

Waites, G. M. H. (1991). Thermoregulation of the scrotum and testis: Studies in animals and significance for man. *Temperature and Environmental Effects on the Testis*, 9–17.

Wallace, R. F. (2003). *Risk Factors and Mortality in Relation to Heat Illness Severity* (USARIEM TECHNICAL REPORT T-03/14). U.S. Army Research Institute of Environmental Medicine. https://apps.dtic.mil/sti/tr/pdf/ADA416199.pdf

Wallace, R. F., Kriebel, D., Punnett, L., Wegman, D. H., & Amoroso, P. J. (2007). Prior heat illness hospitalization and risk of early death. *Environmental Research*, *104*(2), 290–295. https://doi.org/10.1016/j.envres.2007.01.003

Wallace, R. F., Kriebel, D., Punnett, L., Wegman, D. H., Wenger, C. B., Gardner, J. W., & Gonzalez, R. R. (2005). The Effects of Continuous Hot Weather Training on Risk of Exertional Heat Illness: *Medicine & Science in Sports & Exercise*, *37*(1), 84–90. https://doi.org/10.1249/01.MSS.0000150018.90213.AA

Walmart, Inc. (2024). *Reddy Ice Premium Packaged Ice- 7lbs Bag*. Walmart.com

Walter, E. J., & Carraretto, M. (2016). The neurological and cognitive consequences of hyperthermia. *Critical Care*, *20*(1), 199. https://doi.org/10.1186/s13054-016-1376-4

Wang, F., Zhang, Y., Li, J., Xia, H., Zhang, D., & Yao, S. (2022). The pathogenesis and therapeutic strategies of heat stroke-induced liver injury. *Critical Care*, *26*(1), 391. https://doi.org/10.1186/s13054-022-04273-w

Wang, J.-C., Chien, W.-C., Chu, P., Chung, C.-H., Lin, C.-Y., & Tsai, S.-H. (2019). The association between heat stroke and subsequent cardiovascular diseases. *PLOS ONE*, *14*(2), e0211386. https://doi.org/10.1371/journal.pone.0211386

Ward, M. D., King, M. A., Gabrial, C., Kenefick, R. W., & Leon, L. R. (2020). Biochemical recovery from exertional heat stroke follows a 16-day time course. *PLOS ONE*, *15*(3), e0229616. https://doi.org/10.1371/journal.pone.0229616

Washington Department of Labor and Industries. (2023). *Final Cost-Benefit Analysis & Significant Legislative Rule Analysis*. Washington Department of Labor and Industries. https://www.lni.wa.gov/rulemaking-activity/AO21-33/2133FCBA.pdf

Watanabe, S., Shimomura, T., & Miyazaki, H. (2009). Thermal evaluation of a chair with fans as an individually controlled system. *Building and Environment*, *44*(7), Article 7. https://doi.org/10.1016/j.buildenv.2008.05.016

Watkins, E. R., Hayes, M., Watt, P., & Richardson, A. J. (2019). Heat tolerance of Fire Service Instructors. *Journal of Thermal Biology*, *82*, 1–9. https://doi.org/10.1016/j.jtherbio.2019.03.005

Watson, K. B., Carlson, S. A., Loustalot, F., Town, M., Eke, P. I., Thomas, C. W., & Greenlund, K. J. (2022). Chronic Conditions Among Adults Aged 18─34 Years—United States, 2019. *MMWR. Morbidity and Mortality Weekly Report*, *71*(30), 964–970. https://doi.org/10.15585/mmwr.mm7130a3

WebstaurantStore. (2024). *Tornado 20" Industrial 3-Speed High-Velocity Oscillating Metal Pedestal Fan*. WebstaurantStore.com

Wee, J., Tan, X. R., Gunther, S. H., Ihsan, M., Leow, M. K. S., Tan, D. S.-Y., Eriksson, J. G., & Lee, J. K. W. (2023). Effects of Medications on Heat Loss Capacity in Chronic Disease Patients: Health Implications Amidst Global Warming. *Pharmacological Reviews*, *75*(6), 1140–1166. https://doi.org/10.1124/pharmrev.122.000782

Wegman, D. (2023). *Communication with David Wegman on November 15, 2023*.

Wegman, D. H., Apelqvist, J., Bottai, M., Ekström, U., García-Trabanino, R., Glaser, J., Hogstedt, C., Jakobsson, K., Jarquín, E., Lucas, R. A. I., Weiss, I., Wesseling, C., Bodin, T., & The Work Health and Efficiency (WE) Program Working Group. (2018). Intervention to diminish dehydration and kidney damage among sugarcane workers. *Scandinavian Journal of Work, Environment & Health*, *44*(1), 16–24. https://doi.org/10.5271/sjweh.3659

Weil, D. (2014). *The Fissured Workplace*. Harvard University Press.

Weinberger, K. R., Harris, D., Spangler, K. R., Zanobetti, A., & Wellenius, G. A. (2020). Estimating the number of excess deaths attributable to heat in 297 United States counties. *Environmental Epidemiology*, *4*(3), e096. https://doi.org/10.1097/EE9.0000000000000096

Weiner, J. S. (1950). Observations on the Working Ability of Bantu Mineworkers with Reference to Acclimatization to Hot Humid Conditions. *Occupational and Environmental Medicine*, *7*(1), 17–26. https://doi.org/10.1136/oem.7.1.17

Wells, J. C. K. (2002). Thermal Environment and Human Birth Weight. *Journal of Theoretical Biology*, *214*(3), 413–425. https://doi.org/10.1006/jtbi.2001.2465

Wenzel, F. G., & Horn, T. D. (1998). Nonneoplastic disorders of the eccrine glands. *Journal of the American Academy of Dermatology*, *38*(1), 1–20. https://doi.org/10.1016/S0190-9622(98)70532-8

Wesdock, J. C., & Donoghue, A. M. (2019). Life-threatening heat-related illness with severe hyponatremia in an aluminum smelter worker. *American Journal of Industrial Medicine*, *62*(12), 1068–1075. https://doi.org/10.1002/ajim.23061

Wesseling, C., Aragón, A., González, M., Weiss, I., Glaser, J., Bobadilla, N. A., Roncal-Jiménez, C., Correa-Rotter, R., Johnson, R. J., & Barregard, L. (2016). Kidney function in sugarcane cutters in Nicaragua – A longitudinal study of workers at risk of Mesoamerican nephropathy. *Environmental Research*, *147*, 125–132. https://doi.org/10.1016/j.envres.2016.02.002

Wexelman, B. A., Eden, E., & Rose, K. M. (2013). Survey of New York City Resident Physicians on Cause-of-Death Reporting, 2010. *Preventing Chronic Disease*, *10*, 120288. https://doi.org/10.5888/pcd10.120288

Whitman, S., Good, G., Donoghue, E. R., Benbow, N., Shou, W., & Mou, S. (1997). Mortality in Chicago attributed to the July 1995 heat wave. *American Journal of Public Health*, *87*(9), 1515–1518. https://doi.org/10.2105/AJPH.87.9.1515

Wiatrowski, W. (2014, June). Examining the completeness of occupational injury and illness data: An update on current research. *Monthly Labor Review*. https://www.bls.gov/opub/mlr/2014/article/pdf/examining-the-completeness-of-occupational-injury-and-illness-data-an-update-on-current-research.pdf

Wilson, A. J., Bressler, R. D., Ivanovich, C., Tuholske, C., Raymond, C., Horton, R. M., Sobel, A., Kinney, P., & Shrader, J. G. (2024). Age-dependent vulnerability to humid heat: Evidence from wet-bulb temperature exposure. https://static1.squarespace.com/static/5e47fa157fcd934d19bbfa65/t/6595ebe8e1f3877c9b0dc45c/1704324077819/wilson_bressler_etal_humid_heat.pdf

Wilson, T. E., Cui, J., Zhang, R., & Crandall, C. G. (2006). Heat stress reduces cerebral blood velocity and markedly impairs orthostatic tolerance in humans. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *291*(5), R1443–R1448. https://doi.org/10.1152/ajpregu.00712.2005

Wing, J. F. (1965). A Review of the effects of high ambient temp on mental performance. *Aerospace Medical Research Laboratories. Aerospace Medical Division. Air Force Systems Command. Wright-Patterson Air Force Base, Ohio*.

Wong, B. J., & Hollowed, C. G. (2017). Current concepts of active vasodilation in human skin. *Temperature*, *4*(1), 41–59. https://doi.org/10.1080/23328940.2016.1200203

Woolf, S., Morina, J., French, E., Funk, A., Sabo, R., Fong, S., Hoffman, J., Chapman, D., & Krist, A. (2023). *The Health Care Costs of Extreme Heat*. The Center for American Progress. https://www.americanprogress.org/article/the-health-care-costs-of-extreme-heat/

Workers Defense Project. (2013). *Build a Better Texas: Construction Working Conditions in the Lone Star State*.

World Health Organization (WHO). (2004). *International statistical classification of diseases and related health problems* (10th revision, 2nd edition).

World Health Organization (WHO). (2016). *International statistical classification of diseases and related health problems* (10th revision, 5th edition).

World Health Organization (WHO). (2019). *ICD-11 Implementation or Transition Guide*.

Wright Beatty, H. E., Keillor, J. M., Hardcastle, S. G., Boulay, P., & Kenny, G. P. (2015). Preservation of Cognitive Performance with Age during Exertional Heat Stress under Low and High Air Velocity. *BioMed Research International*, *2015*, 1–10. https://doi.org/10.1155/2015/619103

Wu, M., Wang, C., Liu, Z., Zhong, L., Yu, B., Cheng, B., & Liu, Z. (2021). Clinical Characteristics and Risk Factors Associated With Acute Kidney Injury Inpatient With Exertional Heatstroke: An Over 10-Year Intensive Care Survey. *Frontiers in Medicine*, *8*, 678434. https://doi.org/10.3389/fmed.2021.678434

Wu, X., Brady, J. E., Rosenberg, H., & Li, G. (2014). Emergency Department Visits for Heat Stroke in the United States, 2009 and 2010. *Injury Epidemiology*, *1*(1), 8. https://doi.org/10.1186/2197-1714-1-8

Wuellner, S. E., Adams, D. A., & Bonauto, D. K. (2016). Unreported workers' compensation claims to the BLS Survey of Occupational Injuries and Illnesses: Establishment factors. *American Journal of Industrial Medicine*, *59*(4), 274–289. https://doi.org/10.1002/ajim.22563

Wuellner, S. E., & Bonauto, D. K. (2014). Exploring the relationship between employer recordkeeping and underreporting in the BLS Survey of Occupational Injuries and Illnesses. *American Journal of Industrial Medicine*, *57*(10), 1133–1143. https://doi.org/10.1002/ajim.22350

Wuellner, S., & Phipps, P. (2018). Employer knowledge of federal requirements for recording work-related injuries and illnesses: Implications for occupational injury surveillance data. *American Journal of Industrial Medicine*, *61*(5), 422–435. https://doi.org/10.1002/ajim.22824

W.W. Grainger, Inc. (2024). *32 qt Cooler Capacity*. Grainger.com

Wyndham, C. H. (1969). Adaptation to heat and cold. *Environmental Research*, *2*(5–6), 442–469. https://doi.org/10.1016/0013-9351(69)90015-2

Wyndham, C., Strydom, N. B., Morrison, J. F., Dutoit, F. D., & Kraan, J. G. (1954). A new method of acclimatization to heat. *Arbeitsphysiologie*, *15*(5), 373–382. https://doi.org/10.1007/BF00935938

Wyndham, C., Strydom, N., Williams, C., Morrison, J., & Bredell, G. (1966). The heat reactions of bantu males in various states of acclimatization. *Int. Z. Angew. Physiol. Einschl. Arbeitsphysiol.*, *23*, 79–92.

Wyss, C. R., Brengelmann, G. L., Johnson, J. M., Rowell, L. B., & Niederberger, M. (1974). Control of skin blood flow sweating and heart rate role of skin vs. core temperature. *Journal of Applied Physiology*, *36*(6), 726–733.

Xiang, J., Bi, P., Pisaniello, D., & Hansen, A. (2014a). Health Impacts of Workplace Heat Exposure: An Epidemiological Review. *Industrial Health*, *52*(2), 91–101. https://doi.org/10.2486/indhealth.2012-0145

Xiang, J., Bi, P., Pisaniello, D., Hansen, A., & Sullivan, T. (2014b). Association between high temperature and work-related injuries in Adelaide, South Australia, 2001–2010. *Occupational & Environmental Medicine*, *71*(4), 246–252. https://doi.org/10.1136/oemed-2013-101584

Xu, J. (2012). QuickStats: Number of Heat-Related Deaths, by Sex—National Vital Statistics System, United States, 1999–2010. *MMWR. Morbidity and Mortality Weekly Report*, *61*(36), 729.

Yaglou, C. P., & Minard, D. (1957). Control of heat casualties at military training centers. *Archives of Industrial Health*, *16*(4), 302–316.

Yeoman, K., Weakley, A., DuBose, W., Honn, K., McMurry, T., Eiter, B., ... & Poplin, G. (2022). Effects of heat strain on cognitive function among a sample of miners. Applied ergonomics, 102, 103743.

Yi, W., & Chan, A. (2017). Effects of Heat Stress on Construction Labor Productivity in Hong Kong: A Case Study of Rebar Workers. *International Journal of Environmental Research and Public Health*, *14*(9), 1055. https://doi.org/10.3390/ijerph14091055

Yi, W., & Chan, A. P. C. (2013). Optimizing work–rest schedule for construction rebar workers in hot and humid environment. *Building and Environment*, *61*, 104–113. https://doi.org/10.1016/j.buildenv.2012.12.012

Yüzen, D., Graf, I., Tallarek, A.-C., Hollwitz, B., Wiessner, C., Schleussner, E., Stammer, D., Padula, A., Hecher, K., Arck, P. C., & Diemert, A. (2023). Increased late preterm birth risk and altered uterine blood flow upon exposure to heat stress. *EBioMedicine*, *93*, 104651. https://doi.org/10.1016/j.ebiom.2023.104651

Zander, K. K., Botzen, W. J. W., Oppermann, E., Kjellstrom, T., & Garnett, S. T. (2015). Heat stress causes substantial labour productivity loss in Australia. *Nature Climate Change*, *5*(7), 647–651. https://doi.org/10.1038/nclimate2623

Zeller, L., Novack, V., Barski, L., Jotkowitz, A., & Almog, Y. (2011). Exertional heatstroke: Clinical characteristics, diagnostic and therapeutic considerations. *European Journal of Internal Medicine*, *22*(3), 296–299. https://doi.org/10.1016/j.ejim.2010.12.013

Zhang, H., Guo, F., Liu, K., Wang, J., Dong, J., & Zhu, P. (2022). Spatial differences in thermal comfort in summer in coastal areas: A study on Dalian, China. *Frontiers in Public Health*, *10*, 1024757. https://doi.org/10.3389/fpubh.2022.1024757

Zhang, P., Deschenes, O., Meng, K., & Zhang, J. (2018). Temperature effects on productivity and factor reallocation: Evidence from a half million chinese manufacturing plants. *Journal of Environmental Economics and Management*, *88*, 1–17. https://doi.org/10.1016/j.jeem.2017.11.001

Zhang, S., & Zhu, N. (2021). Exercise heat acclimation causes human responses and safety performance improvements. *Journal of Thermal Biology*, *100*, 103042. https://doi.org/10.1016/j.jtherbio.2021.103042

Zhang, W., Ding, N., Han, Y., He, J., & Zhang, N. (2023). The impact of temperature on labor productivity——Evidence from temperature-sensitive enterprises. *Frontiers in Environmental Science*, *10*, 1039668. https://doi.org/10.3389/fenvs.2022.1039668

Zhang, X., Chen, X., & Zhang, X. (2024). Temperature and Low-Stakes Cognitive Performance. *Journal of the Association of Environmental and Resource Economists*, *11*(1), 75–96.

List of Subjects in 29 CFR Parts 1910, 1915, 1917, 1918, 1926, and 1928

Heat-related injuries and illnesses, Heat stress, Incorporation by reference, Occupational safety and health, Safety.

Signed at Washington, DC.

Douglas L. Parker,
Assistant Secretary of Labor for Occupational Safety and Health.

Amendments to Standards

For the reasons set forth in the preamble, OSHA proposes to amend 29 CFR parts 1910, 1915, 1917, 1918, 1926, and 1928 as follows:

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Subpart A—General

1. The authority citation for part 1910, subpart A, is revised to read as follows:

Authority: 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), 3–2000 (65 FR 50017), 5–2002 (67 FR 65008), 5–2007 (72 FR 31159), 4–2010 (75 FR 55355), 1–2012 (77 FR 3912), or 8-2020 (85 FR 58393), as applicable. Sections 1910.6, 1910.7, 1910.8 and 1910.9 also issued under 29 CFR 1911. Section 1910.7(f) also issued under 31 U.S.C. 9701; 29 U.S.C. 9a; 5 U.S.C. 553; Public Law 106–113 (113 Stat. 1501A–222); Public Law 11–8 and 111–317; and OMB Circular A–25 (dated July 8, 1993) (58 FR 38142, July 15, 1993).

2. Amend § 1910.6 to subpart A by revising the introductory text of paragraph (z) and adding paragraph (z)(4) to read as follows:

§ 1910.6 Incorporation by reference.

* * * * *

(z) National Institute for Occupational Safety and Health (NIOSH), 1600 Clifton Road, Atlanta, GA 30329; website: www.cdc.gov/niosh.

* * * * *

(4) NIOSH Publication No. 2016-106. Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments, February 2016; IBR approved for § 1910.148(b).

* * * * *

Subpart J—General Environmental Controls

3. The authority citation for part 1910, subpart J, is revised to read as follows:

Authority: 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31159), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912) or 8-2020 (85 FR 58393), as applicable.

Sections 1910.141, 1910.142, 1910.145, 1910.146, 1910.147, and 1910.148 also issued under 29 CFR part 1911.

4. Add § 1910.148 to subpart J to read as follows:

§ 1910.148 Heat Injury and Illness Prevention.

(a) *Scope and application*. (1) Except as otherwise provided in this paragraph (a), this standard applies to all employers.

(2) This standard does not apply to the following:

(i) Work activities for which there is no reasonable expectation of exposure at or above the initial heat trigger;

(ii) Short duration employee exposures at or above the initial heat trigger of 15 minutes or less in any 60-minute period;

(iii) Organizations whose primary function is the performance of firefighting; emergency response activities of workplace emergency response teams, emergency medical services, or technical search and rescue; and any emergency response activities already covered under 29 CFR 1910.120, 1910.146, 1910.156, part 1915, subpart P, 1926.65, and 1926.1211;

(iv) Work activities performed in indoor work areas or vehicles where air-conditioning consistently keeps the ambient temperature below 80°F;

(v) Telework (i.e., work done from home or another remote location of the employee's choosing); and

(vi) Sedentary work activities at indoor work areas that only involve some combination of the following: sitting, occasional standing and walking for brief periods of time, and occasional lifting of objects weighing less than 10 pounds.

(3) Employers whose employees all exclusively perform activities described in paragraphs (a)(2)(i) through (vi) of this section are exempt from this standard.

(b) *Definitions*. The following definitions apply to this standard:

Acclimatization means the body's adaptation to work in the heat as a person is exposed to heat gradually over time, which reduces the strain caused by heat stress and enables a person to work with less chance of heat illness or injury.

Ambient temperature means the temperature of the air surrounding a body. It is also called "air temperature" or "dry bulb temperature."

Cooling personal protective equipment (PPE) means equipment worn to protect the user against heat injury or illness.

Heat index means the National Weather Service heat index, which combines ambient temperature and humidity.

High heat trigger means a heat index of 90°F or a wet bulb globe temperature equal to the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)~~, see [NIOSH publication] (incorporated by reference, see § 1910.6)~~.

Indoor/indoors means an area under a ceiling or overhead covering that restricts airflow and has along its entire perimeter walls, doors, windows, dividers, or other physical barriers that restrict airflow, whether open or closed.

Initial heat trigger means a heat index of 80°F or a wet bulb globe temperature equal to the NIOSH Recommended Alert Limit (RAL).~~, see [NIOSH publication](incorporated by reference, see § 1910.6).~~

Outdoor/outdoors means an area that is not indoors. For purposes of this standard, vehicles operated outdoors are considered outdoor work areas unless exempted by paragraph (a)(2) of this section.

Radiant heat means heat transferred by electromagnetic waves between surfaces. Sources of radiant heat include the sun, hot objects, hot liquids, hot surfaces, and fire.

Recommended Alert Limit (RAL) means the NIOSH-recommended heat stress alert limits for unacclimatized workers, see NIOSH Publication No. 2016-106 (incorporated by reference, see § 1910.6).

Recommended Exposure Limit (REL) means the NIOSH-recommended heat stress exposure limits for acclimatized workers, see NIOSH Publication No. 2016-106 (incorporated by reference, see § 1910.6).

Shade means the blockage of direct sunlight, such that objects do not cast a shadow in the area of blocked sunlight.

Signs and symptoms of a heat emergency means the physiological manifestations of a heat-related illness that requires emergency response and includes loss of consciousness (i.e., fainting, collapse) with excessive body temperature, which may or may not be accompanied by vertigo, nausea, headache, cerebral dysfunction, or bizarre behavior. This could also include staggering, vomiting, acting irrationally or disoriented, having convulsions, and (even after resting) having an elevated heart rate.

Signs and symptoms of heat-related illness means the physiological manifestations of a heat-related illness and includes headache, nausea, weakness, dizziness, elevated body temperature, muscle cramps, and muscle pain or spasms.

Vapor-impermeable clothing means full-body clothing that significantly inhibits or completely prevents sweat produced by the body from evaporating into the outside air. Examples include encapsulating suits, various forms of chemical resistant suits, and other forms of nonbreathable PPE.

Vehicle means a car, truck, van, or other motorized means of transporting people or goods.

Wet bulb globe temperature (WBGT) means a heat metric that takes into account ambient temperature, humidity, radiant heat from sunlight or artificial heat sources, and air movement.

Work area means an area where one or more employees are working within a work site.

Work site means a physical location (e.g., fixed, mobile) where the employer's work or operations are performed.

(c) *Heat injury and illness prevention plan*. (1) The employer must develop and implement a work site heat injury and illness prevention plan (HIIPP) with site-specific information.

(2) The HIIPP must include:

(i) A comprehensive list of the types of work activities covered by the plan;

(ii) All policies and procedures necessary to comply with the requirements of this standard; and

(iii) An identification of the heat metric (i.e., heat index or wet bulb globe temperature) the employer will monitor to comply with paragraph (d) of this section.

(3) If the employer has employees who wear vapor-impermeable clothing, the employer must evaluate heat stress hazards resulting from these clothing and implement policies and procedures based on reputable sources to protect employees while wearing

these clothing. The employer must include these policies and procedures and document the evaluation in the HIIPP.

(4) If the employer has more than 10 employees, the HIIPP must be written.

(5) The employer must designate one or more heat safety coordinators to implement and monitor the HIIPP. The identity of the heat safety coordinator(s) must be documented in any written HIIPP. The heat safety coordinator(s) must have the authority to ensure compliance with all aspects of the HIIPP.

(6) The employer must seek the input and involvement of non-managerial employees and their representatives, if any, in the development and implementation of the HIIPP.

(7) The employer must review and evaluate the effectiveness of the HIIPP whenever a heat-related illness or injury occurs that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness, but at least annually. Following each review, the employer must update the HIIPP as necessary. The employer must seek input and involvement of non-managerial employees and their representatives, if any, during any reviews and updates.

(8) The employer must make the HIIPP readily available at the work site to all employees performing work at the work site.

(9) The HIIPP must be available in a language each employee, supervisor, and heat safety coordinator understands.

(d) *Identifying heat hazards*—(1) *Outdoor work*. The employer must monitor heat conditions at outdoor work areas by:

(i) Tracking local heat index forecasts provided by the National Weather Service or other reputable sources; or

(ii) At or as close as possible to the work area(s), measuring the following:

(A) Heat index, or ambient temperature and humidity measured separately to calculate heat index; or

(B) Wet bulb globe temperature.

(2) *Frequency of outdoor monitoring*. The employer must monitor with sufficient frequency to determine with reasonable accuracy employees' exposure to heat.

(3) *Indoor work*. (i) At indoor work sites, the employer must identify each work area(s) where there is a reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger.

(ii) The employer must develop and implement a monitoring plan covering each work area identified in paragraph (d)(3)(i) of this section to determine when employees are exposed to heat at or above the initial and high heat triggers. The employer must include the monitoring plan in the HIIPP and the monitoring plan must include measuring one of the following at or as close as possible to the work area(s) identified in paragraph (d)(3)(i) of this section:

(A) Heat index, or ambient temperature and humidity measured separately to calculate heat index; or

(B) Wet bulb globe temperature.

(iii) Whenever there is a change in production, processes, equipment, controls, or a substantial increase in outdoor temperature which has the potential to increase heat exposure indoors, the employer must evaluate any affected work area(s) to identify where there is reasonable expectation that employees are or may be exposed to heat at or above the initial heat trigger. The employer must update their monitoring plan or develop and implement a monitoring plan, in accordance with paragraph (d)(3)(ii) of this section, to account for any increases in heat exposure.

(iv) The employer must seek the input and involvement of non-managerial employees and their representatives, if any, when evaluating the work site to identify

work areas with a reasonable expectation of exposures at or above the initial heat trigger and in developing and updating monitoring plans in accordance with paragraphs (d)(3)(i) through (iii) of this section.

(4) *Heat metric*. The heat metric the employer chooses to monitor will determine the applicable initial and high heat triggers for purposes of this standard. If the employer does not identify their choice of heat metric in the HIIPP or monitor as required by paragraph (d) of this section, the initial and high heat triggers will be the heat index values identified in the definitions.

(5) *Exemption from monitoring*. The employer can assume that the temperature at a work area is at or above both the initial heat and high heat triggers instead of conducting on-site measurements or tracking local forecasts. In such cases, the employer must provide all control measures outlined in paragraphs (e) and (f) of this section.

(e) *Requirements at or above the initial heat trigger*—(1) *Timing*. The employer must implement the controls described in this paragraph (e) when employees are exposed to heat at or above the initial heat trigger.

(2) *Drinking water*. The employer must provide access to potable water for drinking that is:

(i) Placed in locations readily accessible to the employee;

(ii) Suitably cool; and

(iii) Of sufficient quantity to provide access to 1 quart of drinking water per employee per hour.

Note 1 to paragraph (e)(2). The requirements of this paragraph (e)(2) are in addition to the requirements in the sanitation standard applicable to the employer (29 CFR 1910.141, 1915.88, 1917.127, 1918.95, 1926.51, 1928.110) and the temporary labor camps standard (29 CFR 1910.142).

(3) *Break area(s) at outdoor work sites*. The employer must provide one or more area(s) for employees to take breaks that can accommodate the number of employees on break, is readily accessible to the work area(s), and has at least one of the following:

(i) Artificial shade (e.g., tent, pavilion) or natural shade (e.g., trees), but not shade from equipment, that provides blockage of direct sunlight and is open to the outside air; or

(ii) Air-conditioning, if in an enclosed space like a trailer, vehicle, or structure.

(4) *Break area(s) at indoor work sites*. The employer must provide one or more area(s) for employees to take breaks (e.g., break room) that is air-conditioned or has increased air movement and, if appropriate, de-humidification, can accommodate the number of employees on break, and is readily accessible to the work area(s).

(5) *Indoor work area controls.* The employer must provide one of the following at each work area identified in paragraph (d)(3)(i) of this section:

(i) Increased air movement, such as fans or comparable natural ventilation, and, if appropriate, de-humidification;

(ii) Air-conditioned work area; or

(iii) In cases of radiant heat sources, other measures that effectively reduce employee exposure to radiant heat in the work area (e.g., shielding/barriers, isolating heat sources).

(6) *Evaluation of fan use*. At ambient temperatures above 102°F, if the employer is providing fans to comply with paragraph (e)(4) or (5) of this section, the employer must evaluate the humidity to determine if fan use is harmful, and if the employer determines that it is, the employer must discontinue fan use.

(7) *Acclimatization*—(i) *New employees*. The employer must implement one of the following acclimatization protocols for each employee during their first week on the job:

(A) A plan that, at minimum, incorporates the measures in paragraph (f) of this section whenever the heat index is at or above the initial heat trigger during the employee's first week of work; or

(B) Gradual acclimatization to heat in which the employee's exposure to heat is restricted to no more than: 20% of a normal work shift exposure duration on the first day of work, 40% on the second day of work, 60% of the third day of work, and 80% on the fourth day of work.

(ii) *Returning employees*. The employer must implement one of the following acclimatization protocols for each employee who has been away (e.g., on vacation or sick leave) for more than 14 days during their first week back on the job:

(A) A plan that, at minimum, incorporates the measures in paragraph (f) of this section whenever the heat index is at or above the initial heat trigger during the employee's first week upon returning to work; or

(B) Gradual acclimatization to heat in which employee exposure to heat is restricted to no more than: 50% of a normal work shift exposure duration on the first day of work, 60% on the second day of work, and 80% of the third day of work.

(iii) *Exception to acclimatization requirements*. The requirements of paragraphs (e)(7)(i) and (ii) of this section do not apply if the employer can demonstrate the employee consistently worked under the same or similar conditions as the employer's working conditions within the prior 14 days.

(8) *Rest breaks if needed*. The employer must allow and encourage employees to take paid rest breaks in the break area required by paragraph (e)(3) or (4) of this section if needed to prevent overheating.

(9) *Effective communication*. The employer must maintain a means of effective, two-way communication with employees (e.g., by voice or electronic means (such as a handheld transceiver, phone, or radio)) and regularly communicate with employees.

(10) *Personal protective equipment (PPE)*. If the employer provides employees with cooling PPE, the employer must ensure the cooling properties of the PPE are maintained at all times during use.

(f) *Requirements at or above the high heat trigger*—(1) *Timing*. In addition to the controls required by paragraph (e) of this section, the employer must implement the controls described in this paragraph (f) when employees are exposed to heat at or above the high heat trigger.

(2) *Rest breaks*. The employer must provide employees a minimum 15-minute paid rest break at least every two hours in the break area required by paragraph (e)(3) or (4) of this section, subject to the following:

(i) A meal break may count as a rest break, even if it is not otherwise required by law to be paid;

(ii) Periods during which employees are donning and doffing personal protective equipment (e.g., coveralls) must not count towards the total time provided for rest breaks; and

(iii) The time for employees to walk to and from the break area is not included in the time provided for rest breaks.

(3) *Observation for signs and symptoms*. The employer must implement at least one of the following methods of observing employees for signs and symptoms of heat-related illness:

(i) A mandatory buddy system in which co-workers observe each other; or

(ii) Observation by a supervisor or heat safety coordinator, with no more than 20 employees observed per supervisor or heat safety coordinator.

(iii) For employees who are alone at a work site, the employer must maintain a means of effective, two-way communication with those employees (e.g., by electronic

means (such as a handheld transceiver, phone, or radio)) and make contact with the employees at least every two hours.

(4) *Hazard Alert*. Prior to the work shift or upon determining the high heat trigger is met or exceeded, the employer must notify employees of the following:

(i) The importance of drinking plenty of water;

(ii) Employees' right to, at employees' election, take rest breaks if needed and the rest breaks required by paragraph (f)(2) of this section;

(iii) How to seek help and the procedures to take in a heat emergency; and

(iv) For mobile work sites, the location of break area(s) required by paragraph (e)(3) or (4) of this section and drinking water required by paragraph (e)(2) of this section.

(5) *Excessively high heat areas*. The employer must place warning signs at indoor work areas with ambient temperatures that regularly exceed 120°F. The warning signs must be legible, visible, and understandable to employees entering the work areas.

(g) *Heat illness and emergency response and planning*. (1) As part of their HIIPP, the employer must develop and implement a heat emergency response plan that includes:

(i) A list of emergency phone numbers (e.g., 911, emergency services);

(ii) A description of how employees can contact a supervisor and emergency medical services;

(iii) Individual(s) designated to ensure that heat emergency procedures are invoked when appropriate;

(iv) A description of how to transport employees to a place where they can be reached by an emergency medical provider;

(v) Clear and precise directions to the work site, including the address of the work site, which can be provided to emergency dispatchers; and

(vi) Procedures for responding to an employee experiencing signs and symptoms of heat-related illness, including heat emergency procedures for responding to an employee with suspected heat stroke.

(2) If an employee is experiencing signs and symptoms of heat-related illness, the employer must:

(i) Relieve them from duty;

(ii) Monitor them;

(iii) Ensure they are not left alone;

(iv) Offer them on-site first aid or medical services before ending monitoring; and

(v) Provide them with the means to reduce their body temperature.

(3) If an employee is experiencing signs and symptoms of a heat emergency, the employer must:

(i) Take immediate actions to reduce the employee's body temperature before emergency medical services arrive;

(ii) Contact emergency medical services immediately; and

(iii) Perform activities described in paragraphs (g)(2)(i) through (iv) of this section.

(h) *Training*—(1) *Initial training*. Prior to any work at or above the initial heat trigger, the employer must ensure that each employee receives training on, and understands, the following:

(i) Heat stress hazards;

(ii) Heat-related injuries and illnesses;

(iii) Risk factors for heat-related injury or illness, including the contributions of physical exertion, clothing, personal protective equipment, a lack of acclimatization, and personal risk factors (e.g., age, health, alcohol consumption, and use of certain medications);

(iv) Signs and symptoms of heat-related illness and which ones require immediate emergency action;

(v) The importance of removing personal protective equipment that may impair cooling during rest breaks;

(vi) Importance of taking rest breaks to prevent heat-related illness or injury, and that rest breaks are paid;

(vii) Importance of drinking water to prevent heat-related illness or injury;

(viii) The location of break areas;

(ix) The location of employer-provided water;

(x) The importance of employees reporting any signs and symptoms of heat-related illness they may experience, and those they observe in co-workers;

(xi) All policies and procedures that are applicable to the employee's duties, as indicated in the work site's HIIPP;

(xii) The identity of the heat safety coordinator(s);

(xiii) The requirements of this standard;

(xiv) How the employee can access the work site's HIIPP; and

(xv) Employees have a right to the protections required by this standard (e.g., rest breaks, water) and employers are prohibited from discharging or in any manner discriminating against any employee for exercising those rights.

(xvi) If the employer is required by paragraph (f)(5) of this section to place warning signs for excessively high heat areas, they must train employees in the procedures to follow when working in these areas.

(2) *Supervisor training*. The employer must ensure that each supervisor responsible for supervising employees performing any work at or above the initial heat trigger and each heat safety coordinator receives training on, and understands, both the topics outlined in paragraph (h)(1) of this section and the following:

(i) The policies and procedures developed to comply with the applicable requirements of this standard, including the policies and procedures for monitoring heat conditions developed to comply with paragraphs (d)(1) and (d)(3)(ii) of this section; and

(ii) The procedures the supervisor or heat safety coordinator must follow if an employee exhibits signs and symptoms of heat-related illness.

(3) *Annual refresher training*. The employer must ensure that each employee receives annual training on, and understands, the subjects addressed in paragraph (h)(1) of this section. The employer must also ensure that each supervisor and heat safety coordinator additionally receives annual training on, and understands, the topics addressed in paragraph (h)(2) of this section. For employees who perform work outdoors, the employer must conduct the annual refresher training before or at the start of heat season.

(4) *Supplemental training*. The employer must ensure that each employee promptly receives, and understands, additional training whenever:

(i) Changes occur that affect the employee's exposure to heat at work (e.g., new job tasks);

(ii) The employer changes the policies or procedures addressed in paragraph (h)(1)(xi) of this section;

(iii) There is an indication that the employee has not retained the necessary understanding; or

(iv) A heat-related injury or illness occurs at the work site that results in death, days away from work, medical treatment beyond first aid, or loss of consciousness.

(5) *Presentation*. Training must be provided in a language and at a literacy level each employee, supervisor, and heat safety coordinator understands. The employer must provide employees with an opportunity for questions and answers about the training materials.

(i) *Recordkeeping.* If the employer conducts on-site measurements at indoor work areas pursuant to paragraph (d)(3)(ii) of this section, they must have written or electronic records of those indoor work area measurements and retain those records for 6 months.

(j) *Requirements implemented at no cost to employees*. The implementation of all requirements of this standard must be at no cost to employees, including paying employees their normal rate of pay when compliance requires employee time.

(k) *Dates*—(1) *Effective date*. This standard is effective [60 days after date of publication of the final rule in the *Federal Register*].

(2) *Compliance date*. Employers must comply with all requirements of this standard by [150 days after date of publication of the final rule in the *Federal Register*].

(l) *Severability*. Each provision within this standard is separate and severable from the other provisions. If any provision of this standard is held to be invalid or unenforceable on its face, or as applied to any person, entity, or circumstance, or is stayed or enjoined, that provision shall be construed so as to continue to give the maximum effect to the provision permitted by law, unless such holding shall be one of utter invalidity or unenforceability, in which event the provision shall be severable from this standard and shall not affect the remainder of the standard.

PART 1915—OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR SHIPYARD EMPLOYMENT

5. The authority citation for part 1915 continues to read as follows:

Authority: 33 U.S.C. 941; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12-71 (36 FR 8754); 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31160), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912), or 8-2020 (85 FR 58393); 29 CFR part 1911; and 5 U.S.C. 553, as applicable.

Subpart F - General Working Conditions

6. Add § 1915.95 to subpart F to read as follows:

§ 1915.95 Heat Injury and Illness Prevention.

The requirements applicable to shipyard employment under this section are identical to the requirements set forth at 29 CFR 1910.148.

PART 1917—MARINE TERMINALS

7. The authority citation for part 1917 continues to read as follows:

Authority: 33 U.S.C. 941; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31160), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912), or 8-2020 (85 FR 58393), as applicable; and 29 CFR part 1911.

Sections 1917.28 and 1917.31 also issued under 5 U.S.C. 553.

Section 1917.29 also issued under 49 U.S.C. 1801-1819 and 5 U.S.C. 553.

Subpart B - Marine Terminal Operations

8. Add § 1917.32 to subpart B to read as follows:

§ 1917.32 Heat injury and illness prevention.

The requirements applicable to marine terminals under this section are identical to the requirements set forth at 29 CFR 1910.148.

PART 1918—SAFETY AND HEALTH REGULATIONS FOR LONGSHORING

9. The authority citation for part 1918 continues to read as follows:

Authority: 33 U.S.C. 941; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31160), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912), or 8-2020 (85 FR 58393), as applicable; and 29 CFR 1911.

Sections 1918.90 and 1918.110 also issued under 5 U.S.C. 553.

Section 1918.100 also issued under 49 U.S.C. 5101 et seq. and 5 U.S.C. 553.

10. Add subpart L to read as follows:

Subpart L - Occupational Health and Environmental Controls

Sec.

1918.111 through 1918.147 [Reserved]

1918.148 Heat injury and illness prevention.

§ 1918.148 Heat injury and illness prevention.

The requirements applicable to longshoring operations and related employments under this section are identical to the requirements set forth at 29 CFR 1910.148.

PART 1926—SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

11. The authority citation for part 1926 continues to read as follows:

Authority: 40 U.S.C. 3704; 29 U.S.C. 653, 655, and 657; and Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 5-2007 (72 FR 31159), 4-2010 (75 FR 55355), 1-2012 (77 FR 3912), or 8-2020 (85 FR 58393), as applicable; and 29 CFR part 1911, unless otherwise noted

Sections 1926.58, 1926.59, 1926.60, and 1926.65 also issued under 5 U.S.C. 553 and 29 CFR part 1911.

Section 1926.61 also issued under 49 U.S.C. 1801-1819 and 5 U.S.C. 553.

Section 1926.62 also issued under sec. 1031, Public Law 102-550, 106 Stat. 3672 (42 U.S.C. 4853).

Section 1926.65 also issued under sec. 126, Public Law 99-499, 100 Stat. 1614 (reprinted at 29 U.S.C.A. 655 Note) and 5 U.S.C. 553.

Subpart D—Occupational Health and Environmental Controls

12. Add § 1926.67 to subpart D to read as follows:

§ 1926.67 Heat injury and illness prevention.

The requirements applicable to construction work under this section are identical to the requirements set forth at 29 CFR 1910.148.

PART 1928—OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR AGRICULTURE

11. The authority citation for part 1928 continues to read as follows:

Authority: Sections 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736), 1-90 (55 FR 9033), 6-96 (62 FR 111), 3-2000 (65 FR 50017), 5-2002 (67 FR 65008), 4-2010 (75 FR 55355), or 8-2020 (85 FR 58393), as applicable; and 29 CFR 1911.

Section 1928.21 also issued under 49 U.S.C. 1801-1819 and 5 U.S.C. 553.

12. Amend § 1928.21 by:

a. In paragraph (a)(8)(i), removing the word “and” at the end of the paragraph;

b. Revising paragraph (a)(8)(ii); and

c. Adding paragraph (a)(9).

The revision and addition read as follows:

§ 1928.21 Applicable standards in 29 CFR part 1910.

(a) * * *

(8) * * *

(ii) Agricultural establishments that maintain a temporary labor camp, regardless of how many employees are engaged on any given day in hand-labor operations in the field; and

(9) Heat injury and illness prevention – § 1910.148 of this chapter with respect to requirements applicable to agricultural operations.

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