6560-50-P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 268

[EPA-HQ-OLEM-2025-2038; FRL-8504-02-OLEM]

RIN 2050-AH21

US Ecology Nevada, Inc. High Mercury Subcategory Wastes Land Disposal Restrictions Variance

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: The Environmental Protection Agency (EPA) is proposing to grant, with conditions, US Ecology Nevada Inc.'s (USE) petition for a site-specific treatability variance from the Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions (LDR) treatment standards. USE's petition is for treatment and disposal of elemental mercury waste generated from retorting high mercury waste in accordance with the LDR technology-based standard of RMERC. The EPA believes that the petition demonstrates that the LDR standard for placing elemental mercury generated from RMERC back into commerce for reuse is inappropriate and the treatment variance is sufficient to minimize threats to human health and the environment posed by land disposal of the waste. If the variance is granted, the existing LDR treatment standard of RMERC will continue to apply to high mercury hazardous wastes, but the elemental mercury generated from this process will be treated and land disposed subject to specified conditions at both Bethlehem Apparatus in Hellertown, Pennsylvania and USE's Beatty, Nevada, Subtitle C treatment, storage, and disposal (TSD) facility where treated mercury wastes will be disposed in a designated monofill.

DATES: Comments must be received on or before **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: You may send comments, identified by Docket ID No. EPA-HQ-OLEM-2025-

2038, by any of the following methods:

- Federal eRulemaking portal: *https://www.regulations.gov/* (our preferred method). Follow the online instructions for submitting comments.
- Mail: U.S. Environmental Protection Agency, EPA Docket Center, Office of Land and Emergency Management Docket, Mail Code 28221T, 1200 Pennsylvania Avenue NW, Washington, DC 20460.
- Hand delivery or courier: EPA Docket Center, WJC West Building, Room 3334, 1301 Constitution Avenue, NW, Washington, DC 20004. The Docket Center's hours of operations are 8:30 a.m. – 4:30 p.m. Eastern time, Monday – Friday (except Federal Holidays).

Instructions: All submissions received must include the Docket ID No. for this rulemaking. Comments received may be posted without change to *https://www.regulations.gov/*, including any personal information provided. For detailed instructions on sending comments and additional information on the rulemaking process, see the "Public Participation" heading of the **SUPPLEMENTARY INFORMATION** section of this document.

FOR FURTHER INFORMATION CONTACT: Bethany Russell, Waste Characterization Branch, Waste Identification, Notice, and Generators Division, Office of Resource Conservation and Recovery (5304P), Environmental Protection Agency, 1200 Pennsylvania Ave, N.W., Washington, D.C. 20460; telephone number: (202) 566-2233; email address: russell.bethany@epa.gov.

SUPPLEMENTARY INFORMATION:

I. Public Participation

A. Docket

EPA has established a docket for this action under Docket ID No. EPA-HQ-OLEM-2025-2038. All documents in the docket are listed in the *https://www.regulations.gov* index. Publicly available docket materials are available either electronically at

https://www.regulations.gov or in hard copy at the EPA Docket Center. The Public Reading Room for the docket is open from 8:30 a.m. to 4:30 p.m. Eastern, Monday through Friday, excluding holidays. The telephone number for the Public Reading Room and Docket Center is (202) 566-1744.

B. Written Comments

Submit your comments, identified by Docket ID No. EPA-HQ-OLEM-2025-2038, at *https://www.regulations.gov* (our preferred method), or the other methods identified in the **ADDRESSES** section. Once submitted, comments cannot be edited or removed from the docket. The EPA may publish any comment received to its public docket. Do not submit electronically any information you consider to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Multimedia submissions (audio, video, etc.) must be accompanied by a written comment. The written comment is considered the official comment and should include discussion of all points you wish to make. The EPA will generally not consider comments or comment contents located outside of the primary submission (i.e., on the web, cloud, or other file sharing system). For additional submission methods, the full EPA public comment policy, information about CBI or multimedia submissions, and general guidance on making effective comments, please visit *https://www.epa.gov/dockets/commenting-epa-dockets*.

C. Submitting CBI

Do not submit information that you consider to be CBI electronically through *https://www.regulations.gov* or email. Send or deliver information identified as CBI to only the following address: ORCR Document Control Officer, Mail Code 5305-P, Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Washington, DC 20460; Attn: Docket ID No. EPA-HQ-OLEM-2025-2038.

Clearly mark the part or all the information that you claim to be CBI. For CBI information in a disk or CD-ROM that you mail to the EPA, mark the outside of the disk or CD-

ROM as CBI and then identify electronically within the disk or CD-ROM the specific information that is claimed as CBI. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. If you submit a CD-ROM or disk that does not contain CBI, mark the outside of the disk or CD-ROM clearly that it does not contain CBI. Information marked as CBI will not be disclosed except in accordance with procedures set forth in 40 Code of Federal Regulations (CFR) part 2.

II. General Information

A. Does this document apply to me?

This action applies only to elemental mercury treated at Bethlehem Apparatus Hellertown, Pennsylvania and land disposed at USE's facility located at Highway 95, 11 Miles South of Beatty, Beatty, Nevada 98003.

B. What action is the Agency taking?

On September 22, 2025, the EPA received a complete petition from USE requesting a variance from the existing prohibition on land disposal of elemental mercury (metallic mercury, Hg(0)) generated from the treatment of waste codes D009 and U151 high mercury subcategory (high mercury wastes) within the United States. High mercury wastes are those containing a concentration of greater than 260 mg/kg mercury. The LDR of 40 CFR 268.40 requires RMERC for treatment of waste codes D009 and U151 high mercury wastes. RMERC is the technology code for retorting or roasting in a thermal processing unit capable of volatilizing mercury for recovery/reclamation (see 40 CFR 268.42). The regulations do not authorize the land disposal of the elemental mercury reclaimed from the RMERC process. Instead, the LDR treatment standard requires elemental mercury reclaimed from these wastes be legitimately recycled (see 40 CFR 260.43) by placing the elemental mercury into commerce for use or reuse as an effective substitute for a commercial chemical product (see 261.1(c)(5)). When the recyling requirement for elemental mercury was established, there was a balanced market for elemental mercury.

However, the supply of reclaimed elemental mercury presently exceeds the market demand and will continue to exceed market demand for the foreseeable future, and, for that reason, excess elemental mercury generated from RMERC is being stored at authorized sites across the country. In this action, the EPA is proposing to provide USE for their Beatty, Nevada facility, a variance from the requirement that elemental mercury reclaimed from RMERC of D009, U151, or Bevill-exempt high mercury wastes generated in the U.S. gold mining industry[1] be placed into commerce. Specifically, the EPA is proposing to grant, with conditions, USE's petition for a variance pursuant to 40 CFR 268.44 to allow land disposal of elemental mercury converted to mercury sulfide powder that is then blended with linear low-density polyethylene (LLDPE) and extruded as a monolith into an impermeable/non-reactive container that is placed into a future permitted monofill located at USE's facility in Beatty, Nevada. At the time of this proposed approval, USE has an agreement with Bethlehem Apparatus to perform the treatment portion of this process. See section VII., Future Amendments to this Variance, for procedures that may allow USE to retain this variance if USE moves any portion of the treatment process from Bethlehem Apparatus's Hellertown, Pennsylvania location.

C. What is the Agency's authority for taking this action?

Sections 3004(d) through (g) of RCRA, 42 U.S.C. 6294(d)-(g), prohibit the land disposal of hazardous wastes unless such wastes meet the LDR treatment standards (treatment standards) established by the EPA (the Agency). Section 3004(m) of RCRA, 42 U.S.C. 6924(m) requires the EPA to set levels or methods of treatment, if any, that substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste, so that short-term and long-term threats to human health and the environment are minimized.

[1] The issue has arisen that U.S. gold mining Bevill-exempt high mercury waste does not carry a waste code because of the Bevill exemption. Although exempt, Bevill waste is like D009/U151 wastes in that it must be retorted to extract the elemental mercury to meet DOE's acceptance criteria. After retorting, the prohibition on land disposal of elemental mercury remains and is unaffected by the Bevill exemption.

When facilities generate hazardous wastes that cannot be treated to the specified levels or when it is technically inappropriate for such wastes to undergo the prescribed treatment, generators or treaters of hazardous waste can apply for a variance from an LDR treatment standard. See 51 FR at 40605-40606, November 7, 1986, and 62 FR 64504, December 5, 1997. The requirements for an LDR treatment variance are found at 40 CFR 268.44 and LDR variance petitioners must follow the procedures in 40 CFR 260.20. Of note, 40 CFR 268.44(k) cross-references compliance with 40 CFR 268.7 for testing, tracking and recordkeeping requirements for generators, reverse distributors, treaters and disposal facilities.

In this case, EPA is proposing to act pursuant to 40 CFR 268.44(h) because it finds that the existing requirement is inappropriate, even though the treatment is technically possible, and the variance would be applicable to a specific treatment process conducted at Bethlehem Apparatus and disposal location at USE's TSD in Beatty, Nevada.[2] Specifically, as the USE petition demonstrates, the required treatment standard of placing elemental mercury into commerce for reuse after RMERC is inappropriate because the small market demand for elemental mercury is greatly exceeded by the supply of elemental mercury recovered from D009 and U151 hazardous wastes and from Bevill wastes generated by the U.S. gold mining industry (*https://www.epa.gov/system/files/documents/2023-12/2023-mercury-inventory-report_final.pdf*) and the resulting stockpiled elemental mercury poses an ongoing potential hazard to human health and the environment. Approval of the petition, with conditions, will allow for the site-specific treatment and land disposal of elemental mercury in a manner that minimizes threats to human health and the environment posed by the waste.

III. Background

[2] According to 42 CFR 268.44(h)(2), a petitioner may obtain a variance from an applicable treatment standard if it is inappropriate to require the waste to be treated to the level specified in the treatment standard or by the method specified as the treatment standard, even though such treatment is technically possible. To show that this is the case, as applicable here, the petitioner must demonstrate that treatment to the specified level or by the specified method is technically inappropriate (for example, resulting in combustion of large amounts of mildly contaminated environmental media). Section 268.44(m) further requires the petitioner to demonstrate that compliance with the variance is sufficient to minimize threats to human health and the environment posed by land disposal of the waste.

A. Mercury in the Environment

Mercury is a naturally occurring element. It enters the environment from natural sources (such as volcanoes) and human activities (such as industrial combustion and gold mining). Elemental mercury is an element that has not reacted with another substance. When mercury reacts with another substance, it forms a compound. Elemental mercury and mercury compounds have their own unique chemical properties, physical properties, and chemical structures. Once released into the environment, inorganic forms of mercury may be converted to the mercury compound methylmercury, which is the main form of organic mercury found in the environment. Methylmercury has been shown to be a developmental toxicant, with exposure causing subtle to severe neurological effects at very low levels of exposure, especially to fetuses and young children. For more information, visit the EPA website at *https://www.epa.gov/mercury/health-effects-exposures-mercury#methyl*.

The EPA's Mercury Study Report to Congress underscores the extensive research the Agency has conducted on mercury leading up to the 2008 Mercury Export Ban Act (MEBA) discussed later in this proposed approval. See Mercury Study Report to Congress, Volumes I–VIII, EPA–452/R–97–003, December 1997. In a separate action, the EPA identified mercury as one of the "53 persistent, bioaccumulative, and toxic chemicals and chemical categories which may be found in hazardous wastes regulated under RCRA." See 63 FR 60332, November 9, 1998. A May 28, 1999, Advanced Notice of Proposed Rulemaking (ANPRM) (64 FR 28949) addressed a small but critical aspect of the broader mercury contamination issue, specifically focusing on the treatment and disposal of mercury-bearing hazardous wastes. Disposal of mercury is challenging because, if not properly treated before disposal, it can be released into the environment where it can react and be converted to methylmercury.

B. U.S. Laws and Treaties Affecting International Supply and Trade of Elemental Mercury and Mercury Compounds

Beginning in 2013, MEBA prohibited exports of elemental mercury (with very limited exceptions), provided for long-term management and storage of elemental mercury in the U.S. by the Department of Energy (DOE), and prevented the sale, distribution, or transfer of elemental mercury held by U.S. federal agencies. See Mercury Export Ban Act of 2008, Pub. L. 110-414, as amended by the Frank R. Lautenberg Chemical Safety for the 21st Century Act, Pub. L. 114-182. In 2016, the Frank R. Lautenberg Chemical Safety for the 21st Century Act (Lautenberg Act) expanded the export ban to include five mercury compounds: mercury (I) chloride or calomel; mercury (II) oxide; mercury (II) sulfate; mercury (II) nitrate; and cinnabar or mercury sulfide. That ban took effect on January 1, 2020. MEBA does not affect RCRA or RCRA regulations, with the exception that elemental mercury stored at the DOE facility, or elemental mercury that is destined for the DOE facility and meets other requirements outlined in MEBA as amended in 2016, is not subject to the RCRA storage prohibition of 3004(j) of the Solid Waste Disposal Act. See 42 U.S.C. 6939f(g).

The United States is a Party to the Minamata Convention on Mercury (Convention), which entered into force on August 16, 2017. The Convention includes several provisions to reduce exposure to mercury, including a prohibition on new mercury mines and the phase-out of existing ones and the phase-out and phase-down of mercury use in specified products and processes. Some articles of the Convention pertain only to elemental mercury, while others apply to mercury compounds, as well. Legal demand for elemental mercury continues to fall globally.

C. Industries Generating Mercury Wastes

The Inventory of Mercury Supply, Use, and Trade in the United States 2023 Report (visit EPA website at *https://www.epa.gov/system/files/documents/2023-12/2023-mercury-inventory-report_final.pdf*) shows how industrial use and reuse of mercury in the United States has been declining for decades, with significant changes in production and consumption patterns. Mercury has not been domestically produced from ore since 1990, when the last U.S. mine closed. However, mercury wastes continue to be generated as a byproduct from gold ore mining and

secondary production processes. Nearly all mercury used in the U.S. now comes from secondary sources, which include soil cleanup and remediation wastes, spent batteries, chlor-alkali plants during decommissioning of electrolytic cells, mercury vapor and fluorescent lamps, dental amalgams, electrical apparatus, and measuring instruments. Secondary producers typically employ high-temperature roasting and retorting to reclaim mercury from these waste materials, followed by distillation to purify contaminated liquid mercury metal. Pursuant to MEBA, the DOE was directed to designate and operate a facility or facilities for the long-term management and storage of elemental mercury generated within the United States. See 42 U.S.C. 6939f(a). DOE issued a record of decision on December 2, 2024, selecting Waste Control Specialists, LLC (WCS) near Andrews, Texas (89 FR 95189) as the designated facility, but as of the date of this proposed action, WCS has not yet started accepting elemental mercury under MEBA.

D. Existing Mercury Treatment Standards

The EPA delineated two treatment subcategories for D009 and U151 mercury-containing hazardous waste in 40 CFR 268.40. The high mercury subcategory, which is relevant to this action, includes wastes with a total mercury concentration greater than or equal to 260 mg/kg, and the low mercury subcategory includes wastes with a total mercury concentration less than 260 mg/kg. Low mercury wastes are not mandated to follow a specific treatment technology but must achieve a numerical treatment standard of either 0.20 mg/L TCLP for nonwastewater residues from retorting or roasting or 0.025 mg/L TCLP for other nonwastewater low mercury wastes. For treatment of high mercury wastes, EPA selected the Best Demonstrated Available Technology (BDAT) as incineration (IMERC) if organics are present within the high mercury wastestream and roasting or retorting (RMERC) when organics are not present, and both these treatment options involve separating elemental mercury from the rest of the waste. See 40 CFR 268.42(a), table 1. This elemental mercury reclaimed from high mercury waste cannot be land disposed as it was intended to be placed into commerce. RMERC residues must meet a numerical treatment standard of 0.20 mg/L prior to land disposal, as measured by the toxicity

characteristic leaching procedure (TCLP), while all other nonwastewaters that exhibit or are expected to exhibit the characteristic of toxicity for mercury that are in the low mercury subcategory and are not residues from RMERC, must meet a more stringent standard of 0.025 mg/L TCLP. Elemental mercury contaminated with radioactive materials was never considered appropriate for placement into commerce and so has an existing land disposal treatment standard of amalgamation. See 40 CFR 268.42.

On January 29, 2003, EPA published a Notice of Data Availability (68 FR 4482) (the Notice) after reviewing studies conducted on the treatment of high mercury wastes. The EPA wanted to evaluate options to propose treatment and disposal alternatives to the existing LDR treatment standards of IMERC or RMERC. The Notice concluded that no technology demonstrated adequate stability across the plausible range of pH conditions found in landfills to ensure that mercury would not leach from the treated high mercury hazardous waste if land disposed. Additionally, other factors, such as leachate salinity, can significantly affect the solubility of mercury from treated wastes. As a result, the Agency concluded that reclamation of elemental mercury from D009 and U151 hazardous wastes for placement into commerce remained the most reliable approach for managing high mercury waste in a manner that is protective of human health and the environment. The EPA also stated that site-specific environmental conditions may be addressed in a petition for a site-specific variance from the applicable treatment standard that prohibits land disposal of elemental mercury.

Currently there are international treatment and disposal options for the land disposal of elemental mercury that appear to address the concerns with land disposal that the Agency identified. Because of the international disposal options, some domestic companies, such as Bethlehem Apparatus, do treat elemental mercury for export and disposal.

On January 16, 2025, DOE published a request for information regarding treatment and disposal of elemental mercury (90 FR 4728) indicating ongoing need and interest for treatment and disposal alternatives.

E. Why is a Treatability Variance Necessary for Elemental Mercury Extracted from High Mercury Wastes?

The EPA continues to find that recovering elemental mercury from high concentration mercury waste is appropriate because there are no identified treatment and disposal options for such wastes in the U.S. prior to incineration or retort/recovery that ensure adequate protection of human health and the environment. However, the EPA also finds that it is inappropriate to leave placement into commerce of elemental mercury the only final disposal option because there is no commercial market for elemental mercury. The Agency therefore concludes that a treatment and land disposal option is appropriate if a petition can demonstrate that the alternative treatment standard will substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized. Specific to mercury, as noted in the 2003 Notice, the petition for a variance must demonstrate that the treatment is effective under planned disposal conditions for the expected pH range for the disposal site and it must describe the specifics and likely effectiveness of the stabilization treatment to be used, among other things.

IV. Description of the Treatment and Disposal Approach in the Petition

On June 30, 2021, USE submitted a petition for a Determination of Equivalent Treatment under 40 CFR 268.42(b) to treat and dispose of elemental mercury reclaimed from the retort of D009 and U151 high mercury wastes. In response to EPA requests following the original June 2021, submission, on September 22, 2025, USE provided supplemental information and a revised petition, including a separate request for the Agency to evaluate the treatment process as a site-specific treatability variance pursuant to 40 CFR 268.44. Additional communication with USE led to the Agency proposing to include Bevill-exempt wastes from U.S. gold mining operations to the petition. The original and revised petitions and associated responses to Agency information requests (together referred to as "the petition") can be found in the docket (EPA-HQ-OLEM-2025-2038).

A. Treatment Process

The petition includes the conclusions of a study of a process for treating and stabilizing elemental mercury reclaimed from high mercury wastes that will minimize the risk of mercury release from the treated waste and allow for land disposal. USE has an existing agreement with Bethlehem Apparatus to perform the treatment portion of this process. Bethlehem Apparatus is permitted to treat/recycle mercury-bearing wastes through distillation to generate elemental mercury in the manner provided in their permits by the Commonwealth of Pennsylvania pursuant to its approved RCRA Subtitle C program. Visit Pennsylvania's DEP website to locate Bethlehem Apparatus's permits at *https://www.ahs.dep.pa.gov/eFACTSWeb/searchResults_singleAuth.aspx?AuthID=16767*. Bethlehem Apparatus also exports such treated elemental mercury for disposal. The Bethlehem Apparatus process post-RMERC includes: 1) conversion of distilled and retorted high-purity elemental mercury into a stable form of mercury sulfide (HgS) powder by reaction without significant excess sulfur through a patented proprietary process (U.S. Patent Nos. 7,691,361 and 8,501,107); 2) blending the HgS powder with melted linear low-density polyethylene (LLDPE) under a proprietary process with defined parameters under vacuum; and 3) extruding the LLDPE-HgS blend as a monolith (hereafter referred to as "HgS waste") directly into Department of Transportation (DOT)-rated nonreactive container (such as high density polyethylene (HDPE)) closed-head drums). Bethlehem Apparatus is required to conduct all portions of the treatment in compliance with its air and RCRA permits issued by Pennsylvania. All containers used to transport the HgS waste offsite from Bethlehem Apparatus to USE's Beatty, Nevada facility must meet all applicable DOT requirements under 49 CFR Subchapter C.

B. Disposal Environment

For final disposal, USE must construct a designated HgS hazardous waste (Subtitle C) monofill at its Beatty, Nevada facility, in compliance with its RCRA permit, where leachate generation is expected to be minimal due to its location in an arid environment.

Controlling variable environmental conditions that may influence mercury leaching from HgS waste is a critical part of the petition for a variance. USE's proposed monofill must only accept HgS waste treated by the process described in this proposal and USE's September 22, 2025, petition, subject to the conditions summarized in section VI., Conditions for Treatment and Disposal of HgS Wastes, of this proposal. The proposed monofill disposal site is located within an existing RCRA Subtitle C permitted facility in an arid environment in Beatty, Nevada, with an average annual rainfall of less than seven (7) inches per year. This location limits the potential impacts of rainwater to the disposal site by lowering the potential for leachate generation. Disposal in a segregated monofill reduces potential infiltration from other portions of the facility and the introduction of other contaminants or minerals from rainwater that may negatively influence mercury leachability. For these reasons, the EPA has determined that the proposed monofill location will minimize the potential for mercury migration or leaching from the treated waste. Additionally, the nearest residence is located approximately eleven (11) miles from the site, a safeguard against potential human interference or interaction with the disposal site.

The Nevada Department of Environmental Protection (NDEP) regulates hazardous waste pursuant to Nevada Administrative Code (NAC) and the Nevada Revised Statutes (NRS), as a State authorized to implement a hazardous waste program under the RCRA. As such, prior to construction of the monofill and acceptance/disposal of any HgS waste at the Beatty, Nevada facility, USE must obtain all necessary permits and permit modifications from NDEP.

The proposed monofill must meet, at a minimum, all Subtitle C standards and requirements imposed by NDEP. The approval of this variance application does not limit the delegated RCRA authority of NDEP to establish design and permitting conditions. Nothing in this document authorizes the disposal of HgS waste from the process described in this proposed approval at any portion of the facility other than the designated monofill that must be approved and permitted by NDEP. In addition to all applicable RCRA requirements of 40 CFR parts 260-

271 and corresponding state regulations, EPA herein requires USE to meet those specific conditions described in section VI. below, to retain this variance.

V. Basis for EPA's Proposed Determination to Approve

EPA evaluated both the proposed treatment and the disposal methods for reclaimed elemental mercury in USE's petition to determine whether they will minimize threats to human health and the environment consistent with RCRA and the EPA's statutory mandates and existing regulations. As explained further below, the Agency's evaluation of the proposed treatment approach agrees that the petition demonstrated that the concentration of mercury that leached from LLDPE encapsulated HgS monoliths is significantly lower than the Agency's most stringent established LDR standard of 0.025 mg/L TCLP for land disposal of mercury waste. Further, the potential for mercury leaching from LLDPE-encapsulated HgS monoliths was evaluated before those monoliths were encased in non-reactive containers, and therefore the potential for mercury leaching once disposed in USE's monofill within the containers is further reduced.

In addition, the evaluation of the proposed disposal site supports the Agency's preliminary determination to approve the variance. The proposed site is a monofill dedicated to disposal of HgS waste with a separate leachate collection system that should both prevent migration of mercury and allow for long-term evaluation of the effectiveness of the treatment because if any mercury is detected in the monofill leachate system, it will have a known source.

For these and other reasons discussed below, EPA is proposing to approve a site-specific treatment variance for the land disposal of treated elemental mercury in Beatty, Nevada, as described in the USE petition, subject to the additional conditions set forth below in section VI.

A. Evaluation of the Proposed Encapsulation Process

EPA undertook a study to validate LEAF analytical data results generated by USE's contract laboratory, Eurofins, for one of the waste forms and to ensure the results were reproducible. Additionally, EPA performed leaching experiments on one of the LLDPE-

encapsulated HgS waste forms using backfill soil collected from USE's proposed HgS waste monofill area to determine what effect, if any, leaching solution composition might have on mercury mobility.

USE engaged the EPA early in the process while compiling the original petition and remained engaged with the Agency throughout the process of data validation and leaching confirmation. The result of this engagement saw the final form of the treated waste replace USE's originally proposed process that extruded LLDPE-HgS into pellets and then placed the pellets into a closed-head HDPE drum. A summary of the results of both the EPA's validation study and USE's confirmatory sampling are presented below. Detailed methods and results of the EPA verification study, which includes data sets from USE's contract laboratory are in the docket for this action (EPA-HQ-OLEM-2025-2038) within the document titled Evaluation of the Leaching Potential of Mercury from Polyethylene-Encapsulated Mercury Sulfide Material for Disposal.

The EPA determined that it is necessary for the HgS waste to be disposed of in a Subtitle C monofill and be subject to the most stringent existing concentration-based LDR standard of 0.025 mg/L TCLP for mercury-containing nonwastewater. Further, USE is required to verify, at least quarterly as specified in section VI. below, that mercury leaching will not exceed 0.025 mg/L using the SW-846 LEAF method 1315 with modifications appropriate for mercury to estimate flux from the HgS waste and, assuming a 20-to-1 liquid-to-solid ratio and 18 hour leaching timeframe, to compare directly to the 0.025 mg/L LDR standard based on the traditional Toxicity Characteristic Leaching Procedure (TCLP) (U.S. EPA SW-846, EPA Method 1311). Refer to EPA document "Summary Document" in the docket for details.

1. Leaching Testing Method Selection and Data Verification Process

Leaching tests are the primary and most widely used indicator for evaluating the contaminant retention capacity of a solid matrix. Because this proposed alternative treatment process would result in much higher concentrations of mercury potentially being land disposed

than currently exists, and because of the toxic nature of mercury, EPA required USE to perform a range of aqueous leaching tests on HgS waste using LEAF methods 1313, 1314 and 1315 in addition to TCLP (method 1311) as part of the petition review process. These additional leaching tests included evaluation of pH-dependence of mercury leaching and evaluating dynamics of leaching behavior from HgS powder and LLDPE-encapsulated HgS waste forms.

The LEAF methods provide a more robust and accurate assessment of contaminant leaching behavior than TCLP because LEAF considers a range of environmental conditions and waste form properties and thereby facilitates management scenario-specific evaluation of potential constituent leaching. In contrast, TCLP was developed only to evaluate co-disposal with municipal solid waste as a plausible mis-management scenario, which is a disposal scenario not being considered for the HgS waste. See 55 FR 11798, March 29, 1990, for more information on the TCLP, noting that TCLP was originally developed to assess the plausible, worst case mismanagement scenario for evaluating industrial waste co-disposed in a municipal solid waste landfill. Although more extreme pH conditions have been observed in landfills, a historic compilation of landfill data indicates that approximately 95 percent of all hazardous waste landfills fall within the 2 to 12 pH range, with more than 90 percent being less than pH 10. See 65 FR 37945, June 19, 2000. In addition to meeting the 0.025 mg/L LDR standard by TCLP, EPA determined that quarterly verifications would also be required for the first two years and annually thereafter that diffusion of mercury from the LLDPE-encapsulated HgS waste form would continue to meet the LDR standard of 0.025 mg/L using LEAF method 1315 with modifications described in the document titled Evaluation of the Leaching Potential of Mercury from Polyethylene-Encapsulated Mercury Sulfide Material for Disposal in the docket. This additional testing is appropriate to ensure consistency of the integrated process for transforming elemental mercury into water-insoluble HgS and encapsulation in LLDPE and to ensure mercury leaching behavior continues to meet the performance standards during evaluation of their petition for disposal in case site conditions at USE's monofill fluctuate in future decades.

Leaching experiments were conducted on three waste forms of HgS for a total of eight (8) experiments to compare the "worst case scenario" leaching potential of unencapsulated HgS powder with the leaching potential of two forms of LLDPE-encapsulated HgS.

2. Summary of Key Findings from Leaching Experiments on HgS Waste Forms

Below is a summary of the methods and results of all experiments performed in the document titled Summary of HgS-Leaching Experiments Conducted by USE and EPA ("Summary Document") located in the docket for this proposal. The following key findings are excerpts from that document for tests on three different states of HgS – unencapsulated powder, LLDPE encapsulated pellets, and LLDPE encapsulated monoliths.

a. Waste Form 1 - Unencapsulated HgS powder

HgS powder is elemental mercury that has been retorted and redistilled and then converted to HgS in a batch process by introducing it into a computer-controlled mixing oven and heating with a slight stoichiometric excess of elemental sulfur, depositing solid, crystallized HgS on the surface of the drum inside the oven that was scraped and collected as a fine powder.

USE conducted aqueous leaching experiments on Waste Form 1 that included TCLP testing by method 1311 and column leaching tests by LEAF Method 1314, both of which were run on four (4) samples of this waste form derived from three (3) separate batches. Half of the TCLP results exceeded the 0.025 mg/L LDR standard, with a maximum concentration of 0.045 mg/L. The maximum cumulative release of mercury per unit mass of the waste across all method 1314 column tests and integrated over all leaching intervals up to a liquid-to-solid ratio of 10 L/kg was 0.24 mg/kg. This release corresponded to a hypothetical mercury concentration of 0.024 mg/L at the 20 L/kg liquid-to-solid (L/S) ratio used for TCLP (see supporting document for details), which was just below the LDR standard. Mercury concentrations also exceeded 0.025 mg/L at one or more leaching intervals in two of the four column tests. Based on the limited aqueous leaching data provided for this waste form, it would be unlikely to consistently meet the LDR standard of 0.025 mg/L for mercury by TCLP.

b. Waste Form 2 - LLDPE-encapsulated HgS pellets (pellets)

HgS pellets are HgS powder that is mixed with melted LLDPE encapsulating reagent in approximately a 1:6 ratio, after which it is extruded through a dye and cut into roughly spherical pellets approximately 3-4 mm in diameter.

USE conducted TCLP testing using method 1311 on 20 samples from four (4) separately produced batches of this waste form. None of the tested samples exceeded the 0.025 mg/L LDR standard for this waste form, and only one of the 20 results exceeded half of the LDR standard. USE and EPA also conducted 17 column tests using method 1314 on four (4) separately produced batches of this waste form. The maximum mercury release across all column tests and integrated across all leaching intervals up to a L/S ratio of 10 L/kg was 0.041 mg/kg. This release corresponded to a hypothetical mercury concentration of 0.0041 mg/L at the 20 L/kg L/S ratio used for TCLP, which was less than 20% of the LDR standard. The mercury concentration only exceeded the 0.025 mg/L LDR standard in one leaching interval in one (1) column test (one (1) result of a total of 152 aqueous column eluate samples tested across these column experiments). Collectively, these leaching experiments demonstrated that this waste form would be likely to consistently meet the 0.025 mg/L LDR standard for mercury by TCLP.

USE and EPA conducted additional pH-dependent batch leaching tests by Method 1313 on this waste form and observed that aqueous leaching of mercury increased at alkaline pH (pH 7 < pH 9 < pH 10.5 < pH 12). Average mercury concentrations were 0.003-0.008 mg/L at pH 3-5 (n=4), 0.0014 mg/L at pH 7 (n=10), 0.012 mg/L at pH 9 (n=10), 0.027 mg/L at pH 10.5 (n=10), and 0.051 mg/L at pH 12 (n=10). These results indicated that the mildly acidic pH used for TCLP testing would likely not represent the worst-case disposal scenario for this waste form. For reference, USE reported aqueous pH in the range of 8.3-9.4 for water in contact with backfill soil excavated from the proposed disposal site.

EPA conducted additional column tests by Method 1314 on this waste form in the presence of backfill soil from the proposed disposal site. The columns were configured so that

the aqueous leaching solution flowed through the backfill soil and then through the pellets. Column experiments were conducted on three (3) separate batches of pellets, and parallel column tests were performed contemporaneously on the same batches of pellets with no backfill soil. None of aqueous column eluate samples contained mercury concentrations above the laboratory's Lower Limit of Quantitation (LLOQ) in any of the leaching intervals. The maximum mercury release calculated assuming all values were at the LLOQ was <0.0250 mg/kg for column tests with backfill soil vs <0.0248 mg/kg for pellets without backfill soil. No quantifiable increase in mercury release was observed in the column tests with backfill soil and pellets compared to columns tests with only pellets. The hypothetical mercury concentrations in these experiments corresponding to an L/S ratio of 20 L/kg was <0.0025 mg/L after accounting for differences in solution-to-solid ratios in method 1314 relative to method 1311, which was an order of magnitude below the 0.025 mg/L LDR standard for mercury by TCLP.

c. Waste form 3 - LLDPE-encapsulated HgS monolith (monolith)

A HgS monolith is HgS powder that is mixed with melted LLDPE encapsulating reagent in approximately a 1:6 ratio, extruded into a mold and cooled to make cylindrical monoliths that were approximately 5.1 cm diameter x 10.2 cm height. USE conducted semidynamic tank leaching tests by LEAF method 1315 on six (6) replicate monolith samples at nine (9) leaching intervals up to 14 days each, for a total of 63 days. The maximum cumulative release of mercury estimated across all Method 1315 monolith tests and across all leaching intervals was only 3% higher than when all results were below the LLOQ and the mercury concentration in each interval was assumed to be at the laboratory's LLOQ of 0.0002 mg/L. The upper boundary mercury flux estimated from the 1315 tests and assuming that results below the LLOQ of 0.0002 mg/L were at the LLOQ was $2.4*10^{-6}$ $(mg)(m^2)^{-1}(sec)^{-1}$, or 0.21 $(mg)(m^2)^{-1}(day)^{-1}$. For the LLDPE-encapsulated HgS monoliths that were tested (cylinders ~10.2 cm height x 5.1 cm diameter, with a nominal mass of 0.26 kg, volume of 0.00021 m^3, and surface area of 0.020 m^2), the hypothetical mercury concentration in an aqueous solution in contact with the monolith at an

assumed 20 L/kg L/S ratio and 18-hour leaching interval used for TCLP extraction was 0.00016 mg/L, which is more than two orders of magnitude below the 0.025 mg/L LDR standard. This hypothetical concentration would decrease further as the size of the monolith is scaled up due to corresponding decrease in surface area-to-volume ratio.

3. Experiment Conclusions

Overall, the USE and EPA studies[3] characterized the release of mercury and major ions from LLDPE-HgS pellets alone and in contact with porewater from backfill soil and the release of mercury and major ions from HgS monoliths. Analysis of the batch testing samples from the pellets showed leaching of mercury throughout the varying liquid to solid column ratios (L/S), i.e., volume of eluant per unit mass of the solid; however, the concentration of mercury in column eluates remained less than the LDR treatment standard of 0.025 mg/L. The presence of backfill soil in the columns did not result in a quantifiable increase in mercury release. Comparison of EPA Method 1314 results to Eurofins' results showed some variation in the concentration of mercury in eluate throughout testing, though most data points remained less than the comparable LDR treatment standard. The leaching of mercury from the pellets throughout all experimentation may be indicative of an inconsistent polyethylene encapsulation, which could be due to swelling of the pellets, cracking the coating, variations in polyethylene thickness during the production of the pellets, or inconsistencies in washing of the pellets during production.

Imaging of the pellets through both optical microscopy and scanning electron microscopy/energy dispersive X-ray spectroscopy (SEM/EDS) also indicated a change in the polyethylene encapsulation of the pellets, with cracks in the polyethylene shown in the optical

[3] See USE 7/2021 petition for leaching studies of HgS powder and LLDPE-HgS pellets. See USE 9/22/2025 petition for leaching studies of LLDPE-HgS monoliths. EPA studies are found in Evaluation of the Leaching Potential of Mercury from Polyethylene-Encapsulated Mercury Sulfide Material for Disposal in the docket.

microscope images of post-column testing pellets and a higher exposure of mercury particles shown in the wet pellet images on SEM/EDS.

The monolithic form of the polyethylene HgS material showed minimal release of mercury throughout Method 1315 testing. Overall, the initial flux of mercury was less than 2.4E-6 mg/m^2/sec (0.21 mg/m^2/d), and a maximum cumulative release less than 0.16 mg/m^2 when assuming the LLOQ for leaching results measured at less than the LLOQ. The monoliths had minimal mercury release throughout testing, indicating that USE's proposed alternative treatment process using the monolithic form is a viable option for treatment and disposal of elemental mercury stores under the site-specific conditions evaluated and established in this proposed approval. Additional calculations to compare the Method 1315 cumulative release to TCLP conditions indicate that the comparative concentration of mercury from Method 1315 results would be more than two orders of magnitude less than the concentration of mercury set by LDR limits. This comparison supports the viability of LLDPE HgS monoliths as a treatment technique for elemental mercury.

B. Bases for Proposed Approval of USE' Petition for Variance

Pursuant to 40 CFR 268.44(h), the EPA is proposing to approve USE's variance to allow for the land disposal of treated elemental mercury at their Beatty, Nevada facility. The Agency finds that the existing treatment standard is inappropriate because it requires that elemental mercury recovered from retorting of D009 and U151 high mercury wastes or Bevill exempt wastes from the U.S. gold mining industry be reentered into commerce and prohibits land disposal, but there is no market for elemental mercury. Instead, it is being accumulated at treatment facilities around the country. The continued storage of elemental mercury in its natural liquid form poses an ongoing potential hazard to human health and the environment. See 40 CFR 268.44(h)(2)(i) requiring a petitioner demonstrate that the specified treatment is technically inappropriate, even though it is technically possible. The Agency further concludes that the treatment and disposal approach proposed in this action will minimize threats to human health

and the environment posed by land disposal. Further, the Agency finds that USE's proposed approach is more effective at minimizing threats to human health and the environment than the existing LDR standard requiring elemental mercury be reentered into commerce because there is no market for it, and it is being stored indefinitely throughout the country.

As explained above, the existing LDR regulations require non-organic containing high mercury waste be treated via RMERC to recover elemental mercury so that the potential leachable concentration of mercury in the RMERC residue wastes, considered low mercury wastes, do not exceed regulatory leachate levels of 0.20 mg/L, as measured by the toxicity characteristic leaching procedure (TCLP). While subject to treatment to prevent leaching of mercury, low mercury wastes may be land disposed in a designated Subtitle C landfill. However, the regulations require the recovered elemental mercury to be reentered into commerce because at the time the regulations were established there was both a domestic and an international market for elemental mercury. Domestic demand for mercury fell by more than 75% from 1988 (1503 metric tons) to 1997 (346 metric tons), because environmental concerns led to both voluntary and regulatory reductions in the use of elemental mercury. For example, mercury was eliminated as a paint additive and the use of mercury in batteries was reduced. Other factors contributing to this decline in the domestic market include the military phase-out of mercury fulminate as a primer in explosives and the decreasing number of chlor-alkali facilities using the mercury cell method for chlorine production. With respect to the international market, MEBA and the Lautenberg Acts have virtually eliminated the international market for elemental mercury recovered from high mercury wastes. For these reasons, the EPA finds that the existing requirement to place elemental mercury into the market is technically inappropriate and that the proposed treatment alternative is appropriate, allowing for the land disposal of elemental mercury in a manner that is protective of human health and the environment.

The EPA also finds that the disposal environment in Beatty, Nevada is appropriate for the long-term disposal of HgS waste as treated via existing agreement between USE and Bethlehem

Apparatus. The disposal location is critical because environmental factors can significantly affect the solubility of mercury from treated wastes and the leaching studies the EPA performed considered the proposed disposal environment. USE must dispose of HgS wastes in a monofill located in an arid environment to limit potential interaction of differing wastes and control contaminant interactions. The monofill will also have an independent leachate collection system to further prevent interaction or migration of waste from the unit.

For all these reasons, EPA finds that the conversion of elemental mercury from RMERC to HgS powder and subsequent blending of the HgS powder with LLDPE and extrusion in monolithic form into non-reactive containers, under the terms of the proposed variance, will minimize threats to human health and the environment posed by land disposal of elemental mercury waste. The EPA finds that the disposal site location and environmental conditions (i.e., in a monofill with an observed pH between 8.3 and 9.4) further support a conclusion that approval of this variance with conditions listed in section VI., below, will minimize the threats to human health and the environment from land disposal of treated elemental mercury. Moreover, the EPA concludes that the studies confirm that the method of proposed treatment of elemental mercury reduce its volatility and solubility/leachability and that it is thus appropriate for long-term management in the proposed disposal environment.[4] To ensure proper treatment and disposal continues after the variance is issued, the EPA is requiring specific measures that must be put into place to prevent the treated HgS waste from being degraded after treatment, during transportation, and after disposal in the monofill.

For all these reasons, pursuant to 40 CFR 268.44(h), the EPA is proposing to approve a site-specific variance for elemental mercury recovered from high mercury wastes as treated via existing agreement between USE and Bethlehem Apparatus, to be disposed of in a monofill in USE's Beatty, Nevada Subtitle C landfill, subject to the conditions in section VI., below.

[4] In the 2003 Notice of Data Availability (68 FR 4482) the EPA specified these demonstrations for treated waste that petitions related to high mercury waste must meet above and beyond a standard treatability variance.

VI. Conditions for Treatment and Disposal of HgS Wastes

In addition to the alternative treatment protocols identified in section IV. of this proposed approval and further detailed in USE's September 22, 2025, petition, USE must adhere to the following conditions.

1. Prior to construction of the monofill and acceptance/disposal of any HgS waste at the Beatty, Nevada facility, USE must obtain all necessary federal, state and local permits.

2. For HgS waste, USE must meet the concentration based LDR standard of 0.025 mg/L using TCLP, Method 1311; however, USE must also conduct periodic confirmation testing on two (2) batches at least quarterly for the first two (2) years and annually on two (2) batches thereafter of the HgS waste using the most recently approved revision of LEAF Method 1315 with modifications appropriate for mercury (See EPA "Summary Document" in the docket for details) to confirm continued compliance with the concentration-based LDR standard of 0.025 mg/L. Additional confirmation testing may be established by NDEP as part of the permitting process.

3. To confirm that excess mercury is not present in the HgS powder prior to blending with LLDPE, for at least one (1) of every twenty (20) batches of HgS powder destined to be blended with LLDPE and disposed at the Beatty, Nevada facility, USE must request that Bethlehem Apparatus provide analytical data to the EPA.

4. HgS waste must be disposed within a permitted Subtitle C monofill at the USE Beatty, Nevada TSD facility.

5. Disposal of HgS waste at the Beatty, Nevada monofill is predicated on compliance with USE's Subtitle C permit conditions for the treated HgS waste.

6. The mercury waste management facilities, including any waste treatment, storage or disposal areas, must be designed and constructed such that the containment system, leachate management system, stormwater collection and control system, and future cover and closure systems are independent of other environmental control systems for the facility. The stormwater control systems for the mercury waste management facilities must not allow stormwater run-off to or

run-on from other waste management units and must be designed to contain at least the water volume resulting from a 24-hour, 100-year event. This condition must be met during the life of the facility for operation, closure, and post-closure periods.

7. Leachate from other portions of the facility must not be used for dust suppression at the monofill. Leachate from the monofill itself may only be used for dust suppression if the leachate collected from the monofill is analyzed and does not contain any hazardous constituents.

8. Unless a Future Amendment to this variance is approved as described in section VII., below, USE can only accept HgS waste as treated via existing agreement between USE and Bethlehem Apparatus.

VII. Future Amendments to this Variance

Prior to the acceptance of HgS powder or HgS waste at the Beatty, NV facility from any facility other than Bethlehem Apparatus's Hellertown, Pennsylvania location, USE must submit a request for a modification of this variance through a revised petition submitted pursuant to 40 CFR 268.44 for approval by the EPA. To ensure such a process change does not alter the performance of the treatment process for HgS waste, the following steps are required for the Agency to determine that the process and treatment residuals are equivalent to those analyzed for this variance.

A. If USE proposes to use an alternate vendor for conversion of elemental mercury to HgS powder that will then be blended into LLDPE and extruded into a monolith, USE must:

1. Ensure any alternate vendor has secured all necessary permits for such treatment processes from state and federal regulators.

2. Demonstrate and receive approval from EPA that the conversion process is equivalent to the Bethlehem Apparatus process. The demonstration must detail equivalency for the following process controls: type of equipment used, conversion temperature, color of the HgS powder, type and quantity of sulfur added for reaction completion without significant excess sulfur, external environmental conditions at the time of conversion (humidity and temperature), control of

mercury losses through volatilization and residual concentrations of other mercury species. If any process controls differ from the Bethlehem Apparatus process, USE must submit such revisions to EPA for approval and request a technical meeting to discuss such revisions with the Agency prior to receiving HgS waste from the alternate vendor.

3. Provide third-party analysis from at least five (5) samples of HgS powder from different batches to the EPA. The analysis must demonstrate that leaching does not exceed 0.025mg/L using TCLP and EPA Method 1315 with modifications appropriate for mercury.

B. If USE proposes to move the LLDPE-HgS blending and extrusion process from Bethlehem Apparatus to its Beatty, NV facility, USE must:

1. Secure all necessary permits for such treatment processes from state and federal regulators.

2. Demonstrate and receive approval from EPA that the blending and extrusion process is equivalent to the Bethlehem Apparatus process. The demonstration must detail equivalency for the following process controls: type of equipment used, temperature of the blending and extrusion process, residence time of HgS in the mixing chamber, mixing speed, external environmental conditions at the time of blending (humidity and temperature) and control of mercury losses thorough volatilization. If any process controls differ from the Bethlehem Apparatus process, USE must submit such revisions to the EPA for approval and request a technical meeting to discuss such revisions with the Agency prior to commencement of the treatment process.

3. Provide third-party analysis of at least three (3) samples of the treated LLDPE-HgS monolithic waste using TCLP and EPA Method 1315 from different batches of HgS powder.

Table 1. Proposed Modification to 40 CFR 268.44(o) for the High Mercury Waste Treatment Petition

Wastes Excluded from the Treatment Standards Under § 268.40							
				Wastewaters		**Nonwastewaters**	
Facility name and address	**Waste code**	**See also**	**Regulated hazardous constituent**	**Concentration (mg/L)**	**Notes**	**Concentration (mg/kg)**	**Notes**

US Ecology Nevada, Inc. Beatty, Nevada.	D009, U151[21]	NA	Mercury	NA	NA	0.025 mg/L TCLP	[22, 23]

[21] The waste codes included in this column are only for those mercury wastes identified as the high mercury subcategory in 268.40.
[22] This site-specific treatment standard applies only to elemental mercury resulting from RMERC of D009 or U151 high mercury subcategory wastes containing greater than or equal to 260 mg/kg mercury treated via the approved alternative treatment method described in EPA-HQ-OLEM-2025-2038. This alternative treatment method converts elemental mercury post-RMERC to mercury sulfide powder and blends the mercury sulfide powder with linear low-density polyethylene and extrudes the mixture as a monolithic block directly into a nonreactive container.
[23] Disposal of elemental mercury resulting from RMERC of D009 or U151 wastes that have complied with the alternative treatment standards identified in note 22 must be disposed within a permitted Subtitle C monofill at the US Ecology Beatty, Nevada facility. The monofill must be hydraulically segregated from other disposal units at the facility. Leachate must not be used for dust suppression at the monofill, including leachate from the monofill itself. This treatment variance does not relieve US Ecology of its responsibilities in the management of hazardous waste under 40 CFR parts 260 through 271. This treatment variance is conditioned on US Ecology's complying with section VI. Conditions for Treatment and Disposal of HgS Wastes detailed in EPA-HQ-OLEM-2025-2038.

VIII. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This action is not a significant regulatory action and was therefore not submitted to the Office of Management and Budget (OMB) for review.

B. Executive Order 14192: Unleashing Prosperity Through Deregulation

This action is expected to be an Executive Order 14192 deregulatory action. This proposed rule is expected to provide burden reduction by replacing an unachievable LDR standard that led to the requirement for indefinite storage of high concentration mercury wastes by DOE. The proposed site-specific LDR standard would allow for the treatment and disposal of high concentration mercury wastes.

John W. Busterud,
Assistant Administrator,
Office of Land and Emergency Management.

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