[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 417, 431, and 435

[Docket No.: FAA-2014-0418; Notice No. 14-05]

RIN 2120–AK06

Changing the Collective Risk Limits for Launches and Reentries and Clarifying the Risk Limit Used to Establish Hazard Areas for Ships and Aircraft

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The FAA proposes to amend the collective risk limits for commercial launches and reentries. Under this proposal, the FAA would separate its expected-number-of-casualties (E_c) limits for launches and reentries. For commercial launches, the FAA proposes to aggregate the E_c posed by the following hazards: impacting inert and explosive debris, toxic release, and far field blast overpressure. The FAA proposes to limit the aggregate E_c for these three hazards to 1×10^{-4}. For commercial reentries, the FAA proposes to aggregate the E_c posed by debris and toxic release, and set that E_c under an aggregate limit of 1×10^{-4}. Under the FAA's proposal, the aggregate E_c limit for both launch and reentry would be expressed using only one significant digit.

The FAA also proposes to clarify the regulatory requirements concerning hazard areas for ships and aircraft. The proposed rule would require a launch operator to establish a hazard area where the probability of impact does not exceed: 0.000001 (1×10^{-6}) for an aircraft; and 0.00001 (1×10^{-5}) for a water-borne-vessel.

DATES: Send comments on or before [INSERT DATE 90 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Send comments identified by docket number FAA-2014-0418 using any of the following methods:

- Federal eRulemaking Portal: Go to http://www.regulations.gov and follow the online instructions for sending your comments electronically.
- Mail: Send comments to Docket Operations, M-30; U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, S.E., Room W12-140, West Building Ground Floor, Washington, DC 20590-0001.
- Hand Delivery or Courier: Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, S.E., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- Fax: Fax comments to Docket Operations at 202-493-2251.

Privacy: The FAA will post all comments it receives, without change, to http://www.regulations.gov, including any personal information the commenter provides. Using the search function of the docket web site, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the Federal Register published on April 11, 2000 (65 FR 19477-19478), as well as at http://DocketsInfo.dot.gov.

Docket: Background documents or comments received may be read at http://www.regulations.gov at any time. Follow the online instructions for accessing the docket or go to the Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, S.E., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: For technical questions concerning this action, contact Rene Rey, AST-300, Office of Commercial Space Transportation, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, D.C. 20591; telephone (202) 267-7538; e-mail Rene.Rey@faa.gov.

For legal questions concerning this action, contact Alex Zektser, AGC-250, Office of the Chief Counsel, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, DC 20591; telephone (202) 267-3073; email Alex.Zektser@faa.gov.

SUPPLEMENTARY INFORMATION:

Authority for this Rulemaking

The FAA's authority to issue rules on commercial space transportation safety is found in Title 49 of the United States Codes, section 322(a), which authorizes the Secretary of Transportation to carry out the Commercial Space Launch Act of 1984, as amended and re-codified at 51 United States Code (U.S.C.) Subtitle V—Commercial Space Transportation, ch.509, Commercial Space Launch Activities, 51 U.S.C. 50901-50923 (the Act). The Act authorizes the Secretary of Transportation and thus the FAA, through delegations, to oversee, license, and regulate commercial launch and reentry, and the operation of launch and reentry sites as carried out by U.S. citizens or within the United States. 51 U.S.C. §§ 50904, 50905. The Act directs the FAA to exercise this responsibility consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. 51 U.S.C. § 50905. Section 50901(a)(7) directs the FAA to regulate only to the extent necessary, in relevant part, to protect the public health and safety and safety of property. The FAA is also responsible for encouraging, facilitating, and promoting commercial space launches and reentries by the private sector. 51 U.S.C. § 50903.

I. Background

This rulemaking addresses the risks associated with commercial space launch and reentry. Launch is conducted using expendable launch vehicles (ELVs) and reusable launch vehicles (RLVs). Reentry is conducted with RLVs or other reentry vehicles. An ELV is a launch vehicle whose propulsive stages are flown only once. An RLV is a launch vehicle that is designed to return to Earth substantially intact and, therefore, may be launched more than one time or that contains vehicle stages that may be recovered by a launch operator for future use in the operation of a substantially similar launch vehicle. A reentry vehicle is a vehicle designed to return from Earth orbit or outer space substantially intact, and includes a reentering RLV.[1]

Parts 417, 431 and 435 of Title 14 of the Code of Federal Regulations (14 CFR), limit the collective risk posed to the public by commercial launches and reentries by, among other things, limiting the expected number of casualties (E_c). These E_c regulations are based primarily on E_c limits that the United States (U.S.) Air Force imposed on launches from federal launch ranges at the time the FAA began establishing E_c limits.[2] In addition to imposing E_c limits on risk posed by launches and reentries to collective members of the public, these regulations also impose separate limits on the risk posed by these operations to individual members of the public.

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[1] See 14 CFR 401.5 (definitions of expendable launch vehicle, reusable launch vehicle, and reentry vehicle).
[2] See, e.g., Commercial Space Transportation Licensing Regulations, Final Rule (Launch Licensing Rule), 64 FR 19586, 19605 n.11 (Apr. 21, 1999).

A. Launch Risk Limits of an ELV

The FAA's limitations to collective risk associated with commercial launches of ELVs are set out in part 417. Section 417.107(b) applies to all commercial ELV launches, and it allows a launch operator to initiate the flight of an ELV only if the collective risk to the public is within: (1) an E_c limit of 30×10^{-6} for impacting inert and impacting explosive debris; (2) an E_c limit of 30×10^{-6} for toxic release; and (3) an E_c limit of 30×10^{-6} for far field blast overpressure.

The FAA first used an E_c limit of 30×10^{-6} in 1999, when, as part of a rulemaking to regulate ELV launches from federal launch ranges, the FAA adopted the U.S. Air Force's public risk E_c limit of 30×10^{-6} to limit the risk associated with debris.[3] At that time, the FAA only applied the E_c limit to the hazard caused by vehicle debris.[4] Subsequently, the FAA proposed to extend the 30×10^{-6} E_c limit to all commercial ELV launches, which would be regulated by part 417.[5] In its part 417 NPRM, the FAA initially proposed to limit to 30×10^{-6} the combined risk posed by debris, toxic release, and far field blast overpressure.[6]

The FAA received a number of comments objecting to this proposal, arguing that the proposed aggregate 30×10^{-6} E_c limit for debris, toxicity, and far field blast overpressure was too low.[7] In response to these comments, the FAA considered regulating the hazards of toxicity, debris, and far field blast overpressure under a single E_c limit, but

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[3] Id.
[4] Id.
[5] Licensing and Safety Requirements for Launch, Notice of Proposed Rulemaking (Launch NPRM), 65 FR 63922, 63981 (Oct. 25, 2000).
[6] Id.
[7] See Licensing and Safety Requirements for Launch, Supplemental Notice of Proposed Rulemaking (Launch SNPRM), 67 FR 49456, 49461 (July 30, 2002).

ultimately set the limit at a higher level than the proposed 30×10^{-6}.[8] In support of this approach, the FAA noted that "a risk assessment that determines the total risk due to all hazards associated with a single launch would be an ideal approach."[9] However, the FAA ultimately rejected this approach, reasoning that a higher E_c limit "would have been difficult to justify in the absence of historical data on which to base it."[10] The FAA also noted that aggregating the E_c posed by toxicity, debris, and far field blast overpressure would be problematic because: (1) conservative methodology for estimating the E_c for toxicity, debris, and far field blast overpressure used assumptions unique to each hazard; and (2) toxicity, debris, and far field blast overpressure cause injury in different ways, and thus, it was difficult to normalize the injuries caused by these hazards in a manner that would allow them to be added together.[11]

As a result, the FAA decided to retain the 30×10^{-6} E_c limit that was being used by the U.S. Air Force. In order to address the commenter's concerns, in the final rule, the FAA separated the three hazards of toxicity, debris, and far field blast overpressure and placed each under its own E_c limit of 30×10^{-6}.[12] In addition, the rule imposed a separate E_c limit of 1×10^{-6} on risk to individual members of the public posed by each of these three hazards.[13]

B. Risk Limits of Reentry Vehicles

The FAA's risk limitations for launches and reentries of RLV's and other reentry vehicles are found in parts 431 and 435. Part 431 governs the launch and reentry of one type of a reentry vehicle: a reusable launch vehicle (RLV). Section 431.35(b)(1) prohibits

[8] Id. at 49463.
[9] Id. at 49461.
[10] Id.
[11] Id. at 49462.
[12] Licensing and Safety Requirements for Launch, Final Rule, 71 FR 50508, 50516 (Aug. 25, 2006).
[13] See id. at 50542; 14 CFR 417.107(b)(2).

the combined E_c of the launch and reentry of an RLV from: (1) exceeding 30 x 10^{-6} for vehicle or vehicle debris impact hazards to the collective members of the public; and (2) exceeding 1 x 10^{-6} for vehicle or vehicle debris impact hazards to individual members of the public.

Part 435 governs the launch and reentry of all other types of reentry vehicles. Section 435.35 subjects reentry vehicles to the RLV E_c limitations of § 431.35(a) and (b) for the combined risk associated with launch and reentry.

The FAA did not apply separate E_c limits to the launch and reentry of reentry vehicles because separate limits could have resulted in a launch E_c of 30 x 10^{-6} and a reentry E_c of 30 x 10^{-6}, which, the FAA noted, would have resulted in a total E_c of 60 x 10^{-6}.[14] Accordingly, the FAA rejected commenters' requests to set the launch and reentry of an RLV and other reentry vehicle under separate E_c limits.

C. New Developments in Implementing Risk Limits

Recent developments have led the FAA to review its collective risk limits. In 2010, the U.S. Air Force, after conducting over 5,000 launches under a 30 x 10^{-6} E_c limit, increased its collective-risk E_c launch limit from 30 x 10^{-6} per hazard to 100 x 10^{-6} for the aggregate public risk associated with debris, toxicity, and far field blast overpressure combined. The U.S. Air Force's new E_c standards also apply a separate E_c limit to reentry, limiting reentry risk to an E_c to 100 x 10^{-6} for the aggregate public risk associated with debris, toxicity, and far field blast overpressure. In addition, in 2010, the National Aeronautics and Space Administration (NASA) also revised its risk acceptability policy to limit the aggregate risk for launch to 100 x 10^{-6} for each mission. NASA's revision also

[14] Launch Licensing Rule, 64 FR at 19635.

sets the aggregate risk for reentry under a separate 100 x 10^{-6} E_c limit. Before this revision, NASA launched over 100 ELVs under an E_c of 30 x 10^{-6} for each hazard.[15]

Because the FAA's current E_c limits are based on a U.S. Air Force limit that both the U.S. Air Force and NASA, after considerable experience, have now rejected, the FAA believes that its existing collective risk limits may no longer be appropriate. In addition, as discussed below, experience has led the FAA to conclude that its current E_c limits create an obstacle to NASA's implementation of the National Space Policy.

In 2010, President Obama issued a National Space Policy that directed U.S. government departments and agencies to purchase and use commercial space capabilities and services to the maximum practical extent when such capabilities and services are available in the marketplace and meet United States Government requirements.[16] Pursuant to this policy, NASA expanded its use of the Commercial Orbital Transportation Services (COTS) program, which utilized commercial space operations to accomplish NASA missions. The COTS program was designed to stimulate efforts by the private sector to demonstrate safe, reliable, and cost-effective space transportation to the International Space Station.

As part of its COTS program, NASA entered into a Space Act Agreement with Space Exploration Technologies Corporation. (SpaceX). This agreement required SpaceX to launch and reenter a reentry vehicle with the goal of ultimately reaching the International Space Station (ISS). SpaceX conducted two missions under the COTS program.[17] NASA also entered into an agreement with Orbital Sciences Corporation (Orbital) with a similar

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[15] See "A History of the Use of the Risk Acceptability Criterion, 30 x 10^{-6} Casualties per Launch", ACTA Inc., Presented to the Committee on Launch Range Safety (May 24,1999).
[16] National Space Policy of the United States of America, at 10 (June 28, 2010) http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.
[17] NASA has now concluded the COTS program, and has entered into a new arrangement with SpaceX for future missions to the International Space Station.

goal of reaching the ISS. In addition to launches under the above programs, SpaceX has also recently performed a mission to launch a scientific research satellite for NASA into orbit.

The first ISS mission occurred in 2010, when SpaceX launched and reentered the first commercially-launched reentry vehicle into orbit. SpaceX's vehicle included systems that mitigated the risk associated with the launch and reentry of that vehicle. In spite of these mitigations, the E_c for vehicle debris from the combined launch and reentry of SpaceX's vehicles exceeded the 30×10^{-6} limit imposed by § 431.35(b)(1)(i), which applies to reentry vehicles through § 435.35. Because the E_c for vehicle debris would have exceeded the E_c limits, SpaceX applied to the FAA for a waiver.

In order to grant a waiver, the FAA had to determine whether, among other things, the grant would jeopardize public health and safety or safety of property,[18] and concluded that, in spite of the mission's total E_c of 47×10^{-6}, SpaceX's mission would not jeopardize public health and safety or safety of property.[19] The FAA issued SpaceX a waiver from § 431.35(b)(1)(i).[20] The FAA's determination relied on the fact that, when viewed separately, the launch had an E_c under 30×10^{-6} and the reentry also had an E_c under 30×10^{-6}. The FAA treated the launch and reentry as separate events because SpaceX's reentry vehicle would perform a health check after completing a launch, and the results of the health check would be used to determine whether to commence reentry. This health check was an intervening event, as contemplated in the original rulemaking,[21] and allowed

[18] 51 U.S.C. § 50905(b)(3); 14 C.F.R. 404.5(b).
[19] *Waiver of Acceptable Mission Risk Restriction for Reentry and Reentry Vehicle*, 75 FR 75619 (Dec. 6, 2010).
[20] Id.
[21] See id.

the FAA to treat launch and reentry as separate events. SpaceX's mission was successful, and resulted in no harm to members of the public.

SpaceX's second COTS mission occurred in 2012, when SpaceX launched and reentered another reentry vehicle that also exceeded the FAA's E_c limits. The U.S. Air Force[22], pursuant to § 417.203(d) requirements, estimated E_c for debris from SpaceX's 2012 launch to be between 98×10^{-6} and 121×10^{-6} at the time that SpaceX applied to the FAA for launch and reentry licenses. Even though these E_c numbers exceeded the 30×10^{-6} E_c limits of parts 417 and 431, after the FAA examined the details of SpaceX's vehicle and mission plans, the FAA concluded that SpaceX's launch would not jeopardize public health and safety or safety of property.[23] A major factor in the FAA's determination was that the low end of the E_c estimate, 98×10^{-6}, which included significant conservatism, was lower than the 100×10^{-6} E_c limit used by the U.S. Air Force.

Also for the waiver, the FAA examined SpaceX's reentry and concluded the reentry would not jeopardize public health and safety or safety of property because, if the reentry was viewed separately from launch, the E_c for reentry was under 30×10^{-6}.[24] Accordingly, the FAA again issued SpaceX a waiver from the 30×10^{-6} Ec limits.[25] SpaceX's 2012 mission was ultimately successful and harmed no member of the public.

The third ISS mission was conducted by Orbital and took place in 2013. The launch phase of this mission had a far-field-blast-overpressure E_c that exceeded 30×10^{-6}. The FAA granted a waiver to the E_c limits for this mission relying on the fact that the E_c for debris, toxic release, and blast overpressure combined would not exceed the 100×10^{-6}

[22] Section 417.203(d) states, in part, that the "FAA will accept a flight safety analysis used by a Federal launch range without need for further demonstration of compliance to the FAA . . . ."
[23] *Waiver of Acceptable Risk Restriction for Launch and Reentry*, 77 FR 24556 (Apr. 24, 2012).
[24] The reentry portion of the waiver analysis for SpaceX's 2012 mission summarily adopts the reasoning set out in the waiver for SpaceX's 2010 mission.
[25] Id.

E_c limit used by the U.S. Air Force.[26] This mission was ultimately successful and harmed no member of the public.

Finally, in 2013, SpaceX conducted a mission in which it launched a research satellite into space for NASA. The far-field-blast-overpressure E_c for the launch phase of this mission exceeded the FAA's 30 x 10^{-6} limit, but was within the 100 x 10^{-6} limit used by the U.S. Air Force. Relying on the fact that this E_c would not exceed the limits used by the U.S. Air Force, the FAA found that this mission would not jeopardize public health and safety and the safety or property, and granted SpaceX a waiver from the E_c limitations.[27] This mission was ultimately successful and harmed no member of the public.

The FAA expects that future missions flown under contract with NASA to the ISS may present a collective risk that is similar to the risk presented by the SpaceX and Orbital ISS missions. This is because the collective risk posed by these missions is driven in large part by the flight path from the United States to the ISS that must be taken during launch. This flight path is expected to remain unchanged, and as such, the risk associated with these missions is unlikely to change significantly in the near future. The FAA also expects a significant number of other future commercial launches and reentries, such as SpaceX's research satellite mission, to exceed the existing E_c limits. This is because commercial space transportation is a relatively new industry, and the probability of failure of a new ELV or RLV is relatively high.[28] This high probability of failure often results in higher E_c estimates.

[26] A copy of this waiver can be found in the docket for this rulemaking.
[27] Waiver to Space Exploration Technologies Corporation of Acceptable Risk Limit for Launch, 78 FR 52998 (Aug. 27, 2013).
[28] See 14 C.F.R. part 417, Appendix A.

The FAA's existing collective risk limits are no longer appropriate because the U.S. Air Force has rejected the E_c standard on which these limits were based after operating over 5,000 launches under the 30 x 10^{-6} E_c collective-risk standard. NASA has likewise rejected the 30 x 10^{-6} E_c standard after operating approximately 129 launches under that standard. Based on this change in position by two agencies with significant launch and reentry risk experience and based on its own experience of having to issue E_c waivers, the FAA has concluded that its existing E_c limits regulate more than is necessary to protect public health and safety and safety of property. Accordingly, the agency now seeks to change its collective risk limitations for launch and reentry in a manner that would maintain public safety and be less burdensome on the regulated parties and the FAA.

II. Overview of Proposed Rule

The FAA proposes to change its collective risk limits for launch and reentry to more closely match the E_c standard currently used for government missions by the U.S. Air Force and NASA in a manner that properly addresses the level of uncertainty that exists in E_c calculations. For all launches, regardless of vehicle type, the FAA proposes to aggregate the risk posed to the collective members of the public from the following hazards: (1) impacting and inert explosive debris, (2) toxic release, and (3) far field blast overpressure. The proposed rule would prohibit an aggregate E_c of these three hazards from exceeding 1 x 10^{-4}. Because of the uncertainty in E_c calculations, this E_c limit would be expressed using only one significant digit.

For all reentries, for the reasons it provided in the SpaceX waivers, the FAA proposes to split up launch and reentry risk limits for collective members of the public so that launch and reentry no longer have to take place under a single E_c limit for both activities. Launches of RLV's and other reentry vehicles would be governed by the proposed launch limit of 1×10^{-4} for all three hazards.

Reentries would be subject to a separate 1×10^{-4} E_c limit that would account for the aggregated risk posed by vehicle debris and toxic release. While the existing reentry risk limits do not require an operator to account for risks arising out of a toxic release, the next generation of reentry vehicles could present significant toxicity dangers to the public. Accordingly, the FAA proposes to establish a risk limit for this reentry hazard. In addition, due to the uncertainty associated with the E_c calculations, the 1×10^{-4} reentry E_c limit would be expressed using one significant figure in the same manner as the launch E_c limit.

The FAA also proposes to clarify the regulatory requirements of part 417 concerning hazard areas for ships and aircraft. Section 417.107(b) currently requires a launch operator to establish aircraft and water-borne vessel hazard areas "that provide an equivalent level of safety" to the hazard areas provided for launch from a federal launch range.

Under proposed section 417.107(b)(4), a hazard area for aircraft would satisfy part 417 if the probability of impact with debris capable of causing a casualty on any given aircraft in the vicinity of that hazard area did not exceed 0.000001 (1×10^{-6}). Under proposed section 417.107(b)(3), a hazard area for water borne vessels would satisfy part 417 if the probability of impact with debris capable of causing a casualty on any given water borne vessel did not exceed 0.00001 (1×10^{-5}).

This proposed rule would achieve a quantified net benefit by eliminating the costs associated with waivers for commercial space launches with an aggregate E_c between 90×10^{-6} and 149×10^{-6} and for reentries with a debris E_c exceeding 30×10^{-6}. The resulting savings for both the industry and the FAA with an estimated mid-point would be approximately 695,754 ($456,699 present value at a 7% discount rate). The lower and the higher estimates are approximately $0.3 million and $1 million ($283,619 and $688,866 present value at a 7% discount rate), respectively. This proposed rule would also result in the unquantified benefit of expanding launch capability by avoiding mission delays and scrubs. The costs of this proposed rule, if any, are minimal.

III. Discussion of the Proposal

A. Maintaining the Status Quo on Risk Limits to an Individual Member of the Public

Launch and reentry are each governed by two separate E_c limits: (1) an E_c limit on risk posed to the collective members of the public; and (2) a limit on risk posed to an individual. Although the specific numerical limits for collective and individual risk are different, they currently function under a similar regulatory structure. Specifically, individual risk limits prohibit the launch risk to an individual from exceeding an E_c of 1×10^{-6} for each hazard (debris, toxic release, and far field blast overpressure) for launch of an ELV vehicle.[29] For reentry of an RLV or other reentry vehicle, the pertinent regulations prohibit the risk to an individual from exceeding an E_c of 1×10^{-6} per mission.[30]

To date, the FAA has had to issue a waiver to the collective E_c limit for every commercial space operation that sought to reach the ISS. In contrast, the FAA has never had to issue a waiver to the limits on risk posed to an individual. To date, the FAA has only had to consider one request for a waiver from the individual risk limits, and the FAA denied that request, stating that "[u]nlike public risk, individual risk can almost always be

[29] See 14 C.F.R. § 417.107(b)(2).
[30] See 14 C.F.R. §§ 431.35(b)(1)(ii) and 435.35.

mitigated through reasonable means."[31] Because the FAA has never needed to waive the limits governing risk to an individual, the FAA proposes no changes to its limits on individual risk. Moreover, the FAA's current individual risk limit is consistent with the U.S. Air Force and NASA's standards.

The FAA invites comment on this issue, and on whether the limits governing risk to an individual should be changed in light of the changes proposed by this NPRM to the E_c limits governing risk to the collective members of the public.

B. Aggregation of Launch Hazards and Setting an E_c Limit at 1×10^{-4}

Turning to the E_c limits governing risk to the collective members of the public, part 417, which governs the launch of ELVs, prohibits ELV launches from exceeding the following collective E_c limits: (1) a limit of 30×10^{-6} for impacting inert and explosive debris; (2) a limit of 30×10^{-6} for toxic release; and (3) a limit of 30×10^{-6} for far field blast overpressure. Proposed section 417.107(b)(1) would state that an ELV launch operator may initiate the flight of a launch vehicle only if the total risk associated with the launch to all members of the public, excluding persons in water-borne vessels and aircraft, did not exceed an expected average number of 0.0001 casualties ($E_c \leq 1 \times 10^{-4}$). The total risk would consist of the risk posed by impacting inert and impacting explosive debris, toxic release, and far field blast overpressure. As it currently requires, the FAA would determine whether to approve public risk due to any other hazard associated with the proposed flight of a launch vehicle on a case-by-case basis. Again, as it currently requires, this E_c criterion would apply to each ELV launch from lift-off through orbital insertion, including each planned impact, for an orbital launch, and through final impact for a suborbital launch.

[31] Letter to Christopher H. DeMars, Orbital Sciences Corporation, from Kenneth Wong, Manager, AST Licensing and Evaluation Division (Dec. 13, 2013). A copy of the FAA's waiver denial letter may be found in the docket.

As discussed above, during the rulemaking that created the part 417 E_c limits, the FAA wanted to set debris, toxicity, and far field blast overpressure under a single aggregate E_c limit, noting that such a limit would be "ideal."[32] This is because, in setting collective risk limits, what matters is the number of people who could be seriously injured by a launch rather than the number of people who could be injured by a specific hazard. For example, under current E_c limits, an ELV that has an E_c of 30×10^{-6} for toxicity, an E_c of 30×10^{-6} for debris, and an E_c of 30×10^{-6} for far field blast overpressure would be allowed to initiate launch without a waiver. For this ELV, the total E_c posed by the three hazards would be 90×10^{-6} (30×10^{-6} for toxicity + 30×10^{-6} for debris + 30×10^{-6} for far field blast overpressure). Conversely, an ELV with an E_c of 31×10^{-6} for debris and an E_c of 0 for toxicity and far field blast overpressure would not be allowed to launch under current regulations because its debris E_c would exceed 30×10^{-6}. Thus, in this example, an ELV with total average expected serious injuries of 90×10^{-6} would be allowed to launch under the existing regulations, while an ELV with significantly lower total average expected serious injuries of 31×10^{-6} would not be allowed to launch simply because of the manner in which those potential injuries are caused.

Because, as the above example shows, the existing regulatory approach does not properly limit the total number of expected average injuries, the FAA noted during the part 417 rulemaking that this was not the ideal regulatory approach.[33] However, the FAA was ultimately forced to settle for this approach because at the time, the FAA did not have

[32] Launch SNPRM, 67 FR at 49461.
[33] See id.

historical data on which to base a higher E_c limit,[34] which would have been necessary in order to aggregate the risk posed by toxicity, debris, and blast overpressure.[35]

The FAA now has the requisite historical data. In 2010, the U.S. Air Force, after conducting over 5,000 launches under the 30×10^{-6} E_c limit that formed the basis for the FAA's E_c regulations, has recently changed its limits as a result of its operational experience. The U.S. Air Force now uses an E_c limit for launch of 100×10^{-6} and an E_c limit for reentry of 100×10^{-6}. Each of these limits applies to the combined risk posed by toxicity, debris, and far field blast overpressure. Similarly, in 2010 NASA, after conducting approximately 129 launches under an E_c standard of 30×10^{-6}, also changed its requirements to aggregate the risk posed by toxicity, debris, and far field blast overpressure under an E_c limit of 100×10^{-6}.[36] The FAA did not have the benefit of the U.S. Air Force and NASA's 2010 changes in position during its part 417 rulemaking.

In particular, at this time there have been over 100 U.S. launches and reentries where the predicted risks to people on the ground significantly exceeded 100×10^{-6} E_c, all without any casualties as expected. For example, debris risks from the 135 space shuttle launches and reentries routinely exceeded 100×10^{-6} E_c. Specifically, all of NASA's 21[37] post–Columbia launches exceeded 100×10^{-6} E_c on Kennedy Space Center property[38], and at least 9 of those exceeded 30×10^{-6} E_c for members of the public outside of Kennedy

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[34] Id.

[35] In the rationale for its decision not to aggregate the risk posed by toxicity, debris, and blast overpressure, the FAA also stated that it would be difficult to normalize among these three hazards. That part of the FAA's rationale is discussed below.

[36] NASA Procedural Requirements (NPR) 8715.5A (Sep. 17, 2010). A copy of this document may be found in the docket.

[37] See "Aggregate Data" (2014) , which may be found in the docket.

[38] NASA and the FAA employ different definitions of the public. Under FAA definitions, persons on Kennedy Space Center merely to view the launch without a mission role would qualify as members of the public and be part of a risk analysis.

Space Center. In addition, 20 post–Columbia re-entries exceeded 100 x 10^{-6} E_c to the public by at least a factor of three.

The U.S. Air Force also approved at least two Titan IVB launches that exceeded 100 x 10^{-6} E_c either due to debris, toxics, or far field blast overpressure hazards. For example, in 1998, the U.S. Air Force successfully launched a Titan IV B-12[39] mission with an E_c of about 200 x 10^{-6} E_c due to far field blast overpressure hazards in the launch area. Another example occurred in 2005 when the U.S. Air Force approved a government launch of the Titan IV B-30 mission with a predicted debris risk between a factor of 1.5 to 3 above 100 x 10^{-6} E_c attributable to downrange overflight.[40] Neither of these missions harmed members of the public.[41]

The FAA has already begun to rely on the U.S. Air Force's new E_c limits as part of its collective-risk analysis. For example, in its analysis of SpaceX's proposed 2012 launch, the FAA estimated that the launch would result in a debris E_c ranging from 98 x 10^{-6} to 121 x 10^{-6}. However, even though these E_c totals were over the FAA's 30 x 10^{-6} E_c limit, the FAA ultimately concluded that SpaceX's launch would not pose a danger to persons or property because the low end of the E_c estimate (98 x 10^{-6}) was lower than the 100 x 10^{-6} E_c limit that is now being used by the U.S. Air Force.[42] The FAA has also heavily relied on the U.S. Air Force's standards in granting the three other waivers described above.

Accordingly, because the government launches on which the FAA waivers were based provide the FAA with the historical data necessary to select a higher E_c limit, the

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[39] SeeAggregate Data
[40] See RTI International, Titan IV B-30 Downrange Risks. A copy of this document may be found in the docket.
[41]The elevated risks associated with those Titan launches were deemed acceptable by the U.S. Air Force based on rules that allowed a Range Commander to accept collective risks from launch involving "national need" that exceed the normal risk criteria. See Common Risk Criteria Standards for National Test Ranges (RCC) 321-07, § 1.4(c) (2007).
[42] 77 FR at 24556

FAA proposes to revise part 417 to aggregate the collective risks posed by toxicity, debris, and far field blast overpressure associated with commercial ELV launches. Under the FAA's proposal, the risks posed by toxicity, debris, and far field blast overpressure to the collective members of the public would continue to be calculated separately for each hazard. The final E_c totals for these hazards would then be aggregated and rounded (as discussed more fully below) so that they are expressed using only one significant digit.

Aggregating the risks posed by toxicity, debris, and far field blast overpressure should not present the problems regarding conservatism and normalizing across hazards that the original rulemaking discussed. This is because the E_c calculations for toxicity, debris, and far field blast overpressure only count the injuries that qualify as Level 3 or higher on the Abbreviated Injury Scale (AIS) of the Association for the Advancement of Automotive Medicine.[43] The AIS is an anatomical scoring system that provides a means of ranking the severity of an injury and is widely used by emergency medical personnel. Within the AIS system, injuries are ranked on a scale of 1 to 6, with Level 1 being a minor injury, Level 2 moderate, Level 3 serious, Level 4 severe, Level 5 critical, and Level 6 a non-survivable injury. Even though toxicity, debris, and far field blast overpressure may cause injuries in different ways, the meaning of the E_c results for these three hazards fundamentally do not differ. This is because the E_c total for each hazard determines how many injuries that are AIS Level 3 or higher a particular hazard would cause.

In its original rulemaking, the FAA treated conservatisms in calculations as a reason not to assess the risk of a combination of hazards.[44] The FAA was concerned that aggregation of the risks posed by toxicity, debris, and blast overpressure could be

[43] See Launch SNPRM, 67 FR at 49465 (explaining how E_c is calculated).
[44] Id. at 49462.

problematic because assumptions that are unduly conservative for one hazard may not be unduly conservative for calculating the E_c of another hazard. For example, when assessing the risks posed by far field blast overpressure, the conservative approach, in the absence of data detailing true locations, would be to assume all the population was located inside buildings and thus exposed to the danger of flying glass. When assessing the risk posed by a release of toxic substances, on the other hand, the conservative approach would be to assume that at least a portion of the exposed population was outdoors, thus increasing the likelihood of harm from the release.[45]

This concern may be allayed by the use of realistic assumptions, and by recognizing that the use of AIS Level 3 provides a basis for normalizing across all three hazards. Using realistic assumptions[46], as well as the AIS framework discussed above, a license applicant may account for a person's location at the time of the launch or reentry and determine the extent of possible injuries that person could sustain as a result of the operation. Regardless of which hazard caused injuries to the person, that person would have to be injured at AIS Level 3 or higher in order for the injury to be considered serious for E_c analysis purposes. Because the AIS analysis used in E_c calculations looks at the severity of an injury and not how an injury is caused, the FAA does not anticipate problems normalizing E_c calculations in order to aggregate the serious injuries that could be caused by debris, toxic release, and far field blast overpressure.

Even if an applicant based its hazard-specific E_c calculations on conservative assumptions, the error from aggregating those assumptions would be minimal. This is

[45] Id. at 49462.
[46] E_c calculations that are based on realistic assumptions will result in lower E_c totals than E_c calculations that are based on conservative assumptions. As such, it would behoove license applicants to use realistic rather than conservative E_c assumptions in their calculations.

because "[c]onditions that are conducive to driving up the risk associated with one hazard usually make another hazard less significant."[47] For example, the 2012 SpaceX launch had a debris E_c ranging from 98 x 10^{-6} to 121 x 10^{-6}, a toxicity E_c that was less than 10 x 10^{-6}, and a far field blast overpressure E_c of essentially 0. If these numbers were added together, any uncertainty caused by the addition would not have a significant effect on the resulting total because most of that total E_c was caused by a single hazard (debris) that was calculated using a single set of assumptions. In any case, as discussed above, the E_c for all three hazards is calculated using the same AIS Level 3 standard thus allowing a launch operator to focus on the severity of an injury instead of how an injury is caused. This normalizes calculations across all the hazards and allows the serious injuries caused by the hazards to be aggregated regardless of the assumptions that underlie the estimates of those injuries.

C. Use of One Significant Digit for Launch and Reentry E_c Limits

Proposed sections 417.107(b)(1), 431.35(b)(1) and 435.35 would express the proposed risk limit as one significant digit, as an E_c limit of 1 x 10^{-4}. In selecting a limit under which to set the aggregated risk posed to the collective members of the public by toxicity, debris, and far field blast overpressure, the FAA considered the 100 x 10^{-6} E_c limit that is now being used by the U.S. Air Force. To date, the FAA has employed two significant digits. In exploring whether it had a basis to employ three significant digits, the FAA had to explore the advisability of employing more than one in the first place. Due to the uncertainties associated with E_c calculations, which are discussed more fully below, the FAA proposes to employ one significant digit.

[47] See Launch SNPRM, 67 FR at 49461.

Significant digits are used to express a measure of mathematical certainty. Thus, trailing zeroes are significant only if they are used to express a measure of precision. For example, assume a person has a height of 168 centimeters, and this person wants to express his height as 168.000 centimeters. The three trailing zeroes in 168.000 would be significant only if the person had his height measured by a device capable of measuring that height to the thousandth place. In that instance, the zeroes would convey that the device determined that this person's height, as measured to the thousandth place, is exactly 168.000 centimeters. Otherwise, if the three trailing zeroes are not being used to convey this message, they are not significant and should be removed so as to not convey a false measure of precision.

An E_c limit of 100×10^{-6} would be 0.000100 if expressed as a decimal. There are two trailing zeroes in this number (0.0001<u>00</u>), implying that the E_c is measured to the millionth place of precision. However, due to the modeling uncertainties associated with one of the variables in calculating $E_{c,}$ namely, the probability of failure discussed below, the FAA proposes to use only one significant digit as the final expression of E_c results.

As discussed above, the purpose of significant digits is to identify the number of digits after the decimal that reflect the level of precision in a numerical result. The number of digits in a properly prepared and formally formatted numerical result indicates the level of precision of that result; more digits indicate higher level of precision, fewer digits indicate lower level of precision. The last significant digit reported indicates that the result comes from empirical data to within +/- 1 of the reported number. That is, if the last significant digit reported is a 4, then the reader can confidently assume that the value is closer to 4, and not 3 or 5. For complex mathematical calculations, the numerical input (or intermediate calculation) with the fewest significant digits establishes the number of significant digits that can be reported legitimately in the final numerical result (where legitimate means that the certainty of the final result is properly reflected.) When using scientific notation to report a numerical result, every digit reported is considered significant. For example, the number 30×10^{-6} is not the same as 3×10^{-5} in the sense that the first number has 2 significant digits and the second has only 1 significant digit.

Examining how many significant digits should be used to express E_c limits, we note that there are two types of uncertainty associated with calculating E_c: aleatory and epistemic uncertainty. Aleatory uncertainty is the randomness in the occurrence and consequences of an accident, and epistemic uncertainty represents the uncertainty in the ability of the model to compute the true point value of risk.

Aleatory uncertainty is the result of inherently random processes: the uncontrollable variability of real events even under tightly controlled conditions. Aleatory uncertainty is due to the randomness inherent in the occurrence and consequences of an accident. For risk analysis, improved modeling cannot reduce aleatory uncertainty. A key example of aleatory uncertainty arises out of the prevailing weather conditions for a launch risk analysis. The true E_c is dependent upon the prevailing weather conditions during launch, and no amount of analysis will reduce the variability associated with weather conditions. The uncertainty in the true E_c due to weather conditions is substantial for a typical baseline launch risk analysis that represents the weather conditions in a given month based upon historical data, and assumes that a launch is equally likely under any of those weather conditions. The uncertainty in the true E_c for a day of launch risk analysis is much smaller, but the weather input data will still produce some variability in the E_c due to errors and variability in the weather measurements and forecasts. There are numerous other sources of aleatory uncertainty in an E_c analysis, and there are different ways these aleatory uncertainties can be accounted for. These aleatory uncertainties may include: the natural variations in the normal and malfunction trajectories, population and sheltering characteristics (e.g. between day and night), the velocities induced during break-up, the aerodynamic properties of the debris, and the yield from an explosive impact. All of these aleatory uncertainties directly influence the predicted consequence of a failure, and thus the E_c estimate.

Epistemic uncertainty is the result of the uncertainty in some of the model input parameters, the potential influence of unknowns and the approximate nature of the model itself. The model and its input parameters require data or knowledge that are not known perfectly and can only be estimated, creating model inadequacies that produce systemic uncertainty, referred to as bias, in determining the correct answer. The probability of failure is typically the greatest source of epistemic uncertainty for a launch or reentry risk analysis. The probability of failure uncertainty is so significant because: (1) it is typically the dominant source of uncertainty in the overall E_c associated with a launch or reentry of a new vehicle, (2) the probability of a failure has the most direct influence on public risks posed by a launch or reentry (especially during those phases of flight where public risk is the greatest), and (3) it is present regardless of the hazard involved (i.e. debris, toxics, or far field blast overpressure). Given the fact that even a structural fatigue test result is best modeled using a probability distribution, the probability of failure for a system as complex as a launch or reentry vehicle is often shrouded in substantial uncertainty, particularly for a new vehicle.

The FAA has examined multiple analyses performed to quantify the uncertainty in launch and reentry risk analyses for various circumstances, including those where the risks are predominantly in the launch area, where a flight safety system is used, and those due to down range over-flight of large land masses where a flight safety system would not likely be activated. The uncertainty assessments examined the uncertainty in the E_c results due to all sources, epistemic and aleatory, and the results of these sensitivity studies quantified the uncertainties related to both the probability of the launch risk and the consequence of the launch risk. The results of these uncertainty analyses show that, even for relatively mature vehicles, the inability to determine the true probability of failure generally creates too much uncertainty to justify more than one significant digit in the E_c results for launch or reentry.

Furthermore, the results demonstrate that there is generally enough aleatory uncertainty alone to make a second significant digit in the reported E_c illegitimate, even if there was no uncertainty with all the critical input data such as the probability of failure and debris catalogs. Thus, considering both the aleatory uncertainty and the epistemic uncertainty in launch and reentry risk analyses, the calculation of a most likely E_c must be reported with caution so as not to overstate the confidence levels associated with the result. The magnitude of uncertainty in E_c results computed with current state-of-the-art models demonstrates that no more than one significant digit should be used. Any more than one significant digit in the E_c result implies greater certainty in that digit, and greater confidence in that digit by the safety community, than can be justified.

The FAA notes that there could be instances in which the use of more than one significant digit is justified. However, at this time, the FAA does not have sufficient data to set a generally-applicable regulatory E_c limit using more than one significant digit.

Accordingly, at this time, the FAA proposes an E_c limit on collective risk to the public that uses only one significant digit. Once more data become available, the FAA may revisit this issue in a future rulemaking.

The way that the FAA's one-significant-digit proposal would work in practice is that the E_c for each hazard would be calculated as it is now calculated. Those E_c values could then be added together, any known double counting would be corrected, and the result would be rounded to the closest significant digit. For example, take a launch that has the following E_cs: a debris E_c of 9×10^{-5}, a toxicity E_c of 9×10^{-6}, and a far-field blast overpressure E_c of 5×10^{-5}. When the E_cs for these three hazards are added together, the total is 149×10^{-6}, or equivalently 1.49×10^{-4}, at least until the overall level of certainty is accounted for. This number would then be rounded so that it is expressed using only one significant digit. Thus, 1.49 would be rounded to 1, and the resulting total E_c would be 1×10^{-4}. Consequently, the hypothetical launch discussed here would comply with of the 1×10^{-4} aggregate E_c standard that the FAA proposes to apply to the collective risk associated with ELV launches.

Conversely, if the E_c results for the hazards associated with an ELV launch were such that they totaled to 151×10^{-6}, this total would be rounded to an E_c of 2×10^{-4} in order to be expressed using one significant digit. In that scenario, the launch would violate the proposed 1×10^{-4} aggregate E_c standard for risk to the collective members of the public.

The FAA notes that its proposed aggregate E_c limit of 1×10^{-4} is more stringent than the total E_c of some of the safely-conducted NASA and U.S. Air Force launches that have been discussed above. As such, the FAA invites comments as to whether the aggregate E_c limit should be set at a level that is less stringent than 1×10^{-4} and what the reasons for such an increase would be. Also, if the E_c limit is set at a level that is less stringent than 1 x 10^{-4}, should additional restrictions be added to the regulations in order to compensate for the additional public risk caused by the higher E_c limit?

D. Splitting Up Launch and Reentry E_c for Reentry Vehicles

The FAA also proposes to separate the E_c limits for launch and reentry of all reentry vehicles rather than applying a single risk limit, as it does now, to both phases of a mission. The FAA's risk limits for reentry can be found in §§ 431.35(b)(1) (for RLVs) and 435.35 (for all other reentry vehicles). Both sections impose the same E_c limits because § 435.35 requires compliance with the RLV E_c limitations of § 431.35.

The collective risk limit imposed on reentry-vehicle operations applies to launch and reentry combined, which means that the debris risk from a launch added to the debris risk from the ensuing reentry may not exceed an E_c of 30 x 10^{-6}. The regulations do not apply separate risk limits to launch and reentry conducted as a single mission because at the time of the original rulemaking, the FAA wanted to ensure that the accumulated mission risk did not exceed an E_c of 30 x 10^{-6}.[48] The FAA reasoned that setting RLV launch and reentry under separate E_c limits could have resulted in a total mission E_c of 60 x 10^{-6} (a launch E_c of 30 x 10^{-6} + a reentry E_c of 30 x 10^{-6}). However, the FAA acknowledged there could be circumstances where it would be appropriate to separate launch from reentry risk, such as where different operators were involved and could be apportioned allowable risk thresholds, or where intervening events or time made reentry risks sufficiently independent of launch risks as to warrant separate consideration.[49]

[48] Reentry Rule, 64 FR at 19635.
[49] Id.

Assigning a single risk limit to launch and reentry combined is neither necessary nor justifiable. Under § 417.107(b), a mission that does not include a reentry (which would usually be conducted with an ELV-only vehicle) may be initiated with a debris E_c to the collective members of the public of 30 x 10^{-6}. However, if a mission that included a reentry was to be launched in the same manner, carrying a reentry vehicle as a payload, that mission would be unable to commence a reentry, as its 30 x 10^{-6} launch E_c would "use up" all of the E_c allotted for the combined launch and reentry mission. Thus, in order to be able to initiate a reentry, a reentry vehicle is required to be launched under a more stringent E_c standard than other payloads. Stated another way, under current regulations, a launch without a reentry is subject to a less stringent E_c limit than a launch that includes a reentry because the reentry-less launch does not have to budget any of the allowable E_c toward reentry risk.

Parts 431 and 435 currently combine launch and reentry under a single E_c standard because when the FAA promulgated the regulations governing reentry, proposed reentry vehicles were primarily envisioned as reusable launch vehicles, which are both a launch and reentry vehicle. As a result, the FAA did not have experience with missions in which launch and reentry functioned independently of each other. As it turned out, the first reentry vehicle the FAA ultimately licensed was not an RLV but a capsule, which is only a reentry vehicle. The capsule's reentry highlighted that the decision-making behind the reentry was sufficiently independent to require separate consideration and thus its own risk assessment.

This is also shown by the FAA's waiver analysis of SpaceX's 2010 and 2012 missions, which noted that after launch, SpaceX's vehicle would perform a health check, and that the results of this health check would determine whether the vehicle would initiate a reentry.[50] For both missions, the FAA found the health check made the collective risk associated with launch and reentry "sufficiently independent to warrant separate consideration . . ."[51] Both the 2010 and 2012 SpaceX waivers examined the launch of each mission under a separate 30 x 10^{-6} E_c limit than the reentry for that mission.

SpaceX is not alone in performing independent checks. Section 431.43(e)(1) requires all operators to conduct a health check before commencing a reentry. This requirement is in § 431.43(e)(1), which states that an RLV operator must "[m]onitor and verify the status of safety-critical systems before enabling reentry flight," shows that launch and reentry are sufficiently independent to warrant separate consideration.

A number of other factors support setting launch and reentry risk separately. As an initial matter, reentry is independent from launch because the two are separate events. A launch may not always be successful, and a single risk limit that encompasses both launch and reentry makes reentry risk calculations unnecessarily dependent on the probability of failure associated with launch. Separating launch and reentry risk criteria is the preferred approach because under a separate reentry risk limit, the reentry would have to meet the risk criteria assuming that the launch had succeeded.

In addition, a reentry trajectory does not have to be finalized, at the earliest, until launch concludes. For example, a reentry vehicle could have multiple viable reentry trajectories, and the operator of that vehicle would not have to pick one of those trajectories until the vehicle was ready to commence reentry after launch had already taken place. In that scenario, it would not make sense to limit the operator's reentry decision by an event

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[50] See 75 FR at 75621 and 77 FR at 24558.
[51] 75 FR at 75621.

that had already taken place (the launch), which the operator could not affect after it had occurred.

In addition, launch and reentry could be handled by different entities. For example, one company (Company 1) could launch a reentry vehicle operated by another company (Company 2). Just like in the previous scenario, it would not make sense to limit Company 2's decisions regarding its reentry based on a launch that had already taken place.

We note that launch and reentry are also distinct because they generally pose risks to distinct populations, and the tolerable level of collective risk is logically correlated with the nature and size of the exposed population. A general difference between the nature of the populations exposed to launch and reentry risks is that launches generally expose fewer people that are near the launch site or under the launch trajectory, but reentry risks are often widely distributed over populations that dwell within the latitudes bounded by the orbital inclination.

As discussed above, the U.S. Air Force and NASA, both of which have significant operational experience administering collective risk limits, recently set launch and reentry under separate E_c limits of 100 x 10^{-6}. This decision by the U.S. Air Force and NASA also supports the FAA's proposal to assign separate E_c limits to launch and reentry. The specific E_c limits that the FAA proposes are discussed in the next section.

We note, however, that the proposed rule would assign separate the E_c limits to launch and reentry only for reentry from orbit. The FAA proposes to leave unchanged the requirement that suborbital launches and reentries are subject to a single launch E_c limit that encompasses the entire operation from launch through final impact. The FAA invites comments on whether the E_c limit for the launch and reentry of suborbital reentry-vehicle operations should be separated in the same manner as the E_c limit for reentries from orbit.

E. Including Toxicity in the Reentry E_c Limits of Parts 431 and 435 and Harmonizing That Part With Part 417

Sections 431.35 and 435.35 govern the E_c associated with the operation of reentry vehicles. The FAA proposes to change the structure of these regulations as follows. As discussed above, the E_c associated with a licensed launch would be regulated separately from reentry. For launch, the FAA proposes to harmonize the E_c launch requirements for ELVs and reentry vehicles by setting the E_c launch limit for reentry vehicles under the same aggregate 1×10^{-4} limit that this proposal would apply to ELV launches under part 417. This launch limit would regulate the aggregate risk associated with toxicity, impacting inert and explosive debris, and far field blast overpressure. In addition, just like the aggregate E_c launch limit that governs ELVs under part 417, the aggregate E_c launch limit that governs reentry vehicles under parts 431 and 435 would be expressed using only one significant digit. Using this approach, the E_c associated with a licensed launch would be regulated the same way regardless of what vehicle or payload was used in the launch.

With regard to reentry, §§ 431.35 and 435.35 currently account only for the risk posed by debris to the collective members of the public. This proposed rule would clarify that, just like launch, the debris regulations for reentry encompass both impacting inert and explosive debris. The FAA is also proposing to require a launch operator to also account for the risks of toxic release. While there have not been past instances of a reentry where toxicity risk was above a minimal level, the FAA is concerned about missions that are being planned for the near future involving a reentry vehicle touching down on land during a reentry. These types of missions may require a reentry vehicle to carry a substantial load of fuel during reentry, which would significantly increase the risk of toxic release posed by the reentry. For example, the FAA performed a sensitivity study on the release of a reentry vehicle's propellants during reentry and found that a ground release of the propellants is the worst case scenario for a toxic release, as opposed to venting the propellant during reentry or the vehicle exploding during reentry and releasing all of its propellant into the atmosphere at a high altitude. In other words, the study results demonstrated an inversely proportional relationship between altitude release and the casualty area, where the higher the altitude release, the lower the casualty area. The two methods of dispersion considered for a ground release were a "Hot Spill" method, which is where a propellant tank explodes on impact and releases a toxic vapor cloud and a "Pool Evaporation" method, which is where a propellant tank ruptures on impact and leaks out the propellant, forming a liquid pool. Because of the possible risk posed by these types of missions and methods of toxic dispersion, the FAA is proposing to add toxic releases to the E_c limit governing reentry. No current reentry vehicles have the capability of reentering to land, so the FAA seeks comment on the necessity of this proposal.

The U.S. Air Force and NASA have a total reentry E_c limited to a 100×10^{-6} limit. However, as discussed above, E_c calculations currently contain a level of uncertainty that generally prevents them from being accurately expressed using more than one significant digit. Accordingly, the FAA proposes to set the reentry E_c limit for collective risk to 1×10^{-4} expressed using a single significant digit. This reentry limit would govern the aggregated risk posed by vehicle debris and toxic release.

F. Hazard Areas

The FAA also proposes to clarify the existing limits on probability of impact for ships and aircraft. This proposed clarification would not constitute a change from what is currently required. Specifically, § 417.107(b)(3) and (4) currently require the launch operator of an ELV to implement and establish ship and aircraft hazard areas that provide an equivalent level of safety to that provided by ship and aircraft hazard areas implemented for launch from a federal launch range. This provision memorializes the level of safety that was provided by hazard areas for launches from a federal launch range in 2006, when the FAA issued § 417.107(b)(3).[52] Because the current provision does not specify a specific federal launch range, a launch operator could arguably pick an equivalent hazard-area level of safety from amongst the federal launch ranges.

While each federal launch range has its own safety criteria for hazard areas, the federal launch range with the least burdensome limit for hazard areas imposes a probability of impact (P_i) limit of 1×10^{-6} for aircraft hazard areas and a P_i limit of 1×10^{-5} for water-borne-vessel hazard areas.[53] Currently, § 417.107(b)(3) and (4) permits a launch operator to set a hazard-area level of safety that is equivalent to the one used by federal launch ranges with the least burdensome hazard area limit. Accordingly, the FAA proposes to make transparent the criteria for establishing hazard areas, which are that an aircraft $P_{i,}$ may not exceed 1×10^{-6} and a water-borne vessel P_i may not exceed 1×10^{-5}.

The FAA's proposal would define P_i as probability of impact with debris capable of causing a casualty. This is because the federal launch ranges defined P_i in this manner in 2006. Specifically, an $1E^{-6}$ probability of impact was the criterion used by the Eastern

[52] As of the date of this writing, December 2013, federal launch ranges have not changed the pertinent standards from what they used in 2006.
[53] Common Risk Criteria Standards for National Test Ranges (RCC) 321-07 (2007).

Range in 2002[54] and that same criterion was used in 2007.[55] The 2007 version of the RCC 321-07 made clear that the ship and aircraft protection criteria in use by U.S. ranges are "based on the probability of impact with 'debris capable of producing a casualty' for ships and aircraft".[56] This is an important clarification because some debris fragments are too small to threaten the safety of people onboard aircraft or ships.

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 and Executive Order 13563 direct that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Public Law 96-354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Public Law 96-39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, the Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more

[54] Common Risk Criteria Standards for National Test Ranges (RCC) 321-02 Supplement at 3 (2002).
[55] Common Risk Criteria Standards for National Test Ranges (RCC) 321-07 at 5-49
[56] See pages 3-3 and 3-4 of Range Commanders Council Risk Committee of the Range Safety Group, *Common Risk Criteria for National Test Ranges*, RCC 321-07, White Sands Missile Range, New Mexico, 2007).

annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this proposed rule.

In conducting these analyses, the FAA has determined that this proposed rule: (1) has net benefits that justify the minimum costs; (2) is not an economically "significant regulatory action" as defined in section 3(f) of Executive Order 12866; (3) is not "significant" as defined in DOT's Regulatory Policies and Procedures; (4) would not have a significant economic impact on a substantial number of small entities; (5) would not create unnecessary obstacles to the foreign commerce of the United States; and (6) would not impose an unfunded mandate on state, local, or tribal governments, or other private sectors by exceeding the threshold identified above.

Department of Transportation Order DOT 2100.5 prescribes policies and procedures for simplification, analysis, and review of regulations. If the expected cost impact is so minimal that a proposed or final rule does not warrant a full evaluation, this order permits that a statement to that effect and the basis for it be included in the preamble if a full regulatory evaluation of the cost and benefits is not prepared. Such a determination has been made for this proposed rule. These analyses are summarized below.

Parties Potentially Affected by this Rulemaking

- Satellite and RLV owners
- License applicants for launches and reentries
- Commercial space transportation suppliers
- The Federal Aviation Administration and the general public

Principal Assumptions and Sources of Information

- *Benefit-Cost Analysis for the collective risk limits during launches and reentries* (GRA study 2013 by GRA, Incorporated[57])
- As discussed below, the principal assumption underlying the proposed rule is that the acceptable public risk of launch or reentry mission is an expected casualty E_c value of 1×10^{-4} or less.
- FAA Office of Commercial Space Transportation forecast of suborbital launches using subject experts' judgment
- FAA Office of Commercial Space Transportation estimation of the commercial space industry hours related to waiver applications
- All monetary values are expressed in 2012 dollars
- Projected impacts for a 10-year period from 2013 to 2022

Cost-Benefit Analysis

Under current regulations, the FAA prohibits the expected casualty (E_c) for each physically distinct source of risk (impacting inert and explosive debris, toxic release and far field blast overpressure) from exceeding 30×10^{-6} or an expected average number of 0.00003 casualties per launch. The aggregate E_c equals the sum of these risks, i.e., $(30 \times 10^{-6}) + (30 \times 10^{-6}) + (30 \times 10^{-6})$, for a total of 90×10^{-6}. However, launches currently are not subject to this single aggregate E_c limit. If there is a reentry using an RLV or other reentry vehicle, an additional regulatory provision becomes applicable, which prohibits the combined E_c of the launch and reentry from exceeding $30 \text{ x } 10^{-6}$ for impacting debris.[58]

[57] GRA study can be found in the docket.

[58] This limit is specified in 14 CFR 431.35, which applies only to reusable launch vehicles. However, 14 CFR 435.35 incorporates and applies 14 CFR 431.35 to all reentry vehicles.

Under this proposal, the FAA would separate its expected casualties (E_c) for launches and reentries. The proposed rule would adopt an aggregate E_c requirement for a launch not to exceed 1×10^{-4} posed by the following hazards: (1) impacting inert and explosive debris, (2) toxic release, and (3) far field blast overpressure. The FAA also proposes a separate aggregate E_c requirement for a reentry not to exceed 1×10^{-4} posed by the hazards of debris and toxic release.

An E_c value of 1×10^{-4} mathematically equals 100×10^{-6}, which is the E_c value currently used on federal ranges for civil and military launch and reentry missions. However, because the proposed aggregate E_c limit would use only one significant digit in the format of 1×10^{-4}, this proposal would, in effect, allow a commercial launch or reentry with an aggregate E_c limit up to 149×10^{-6} under current calculations to proceed without requiring the applicant to seek an FAA waiver. This is because 149×10^{-6} rounds down to 1×10^{-4} when expressed using only one significant digit.

Based on analysis of the historical data, the FAA found the proposed criteria are supported by the commercial mission experiences and post-mission safety data available since 1989. The FAA's launch data indicated during this time there were 45 suborbital launches and 193 orbital launches, for a total of 238 launches[59]. At least four of these launches used an E_c that was allowed to go above the existing 30×10^{-6} E_c limits. However, none of these launches resulted in any casualties or other adverse impacts on public safety.

As discussed in the preamble above, the FAA believes managing the precision of rounding digits below and above the E_c limit is imprecise for administering launch or re-

[59] AST/FAA launch data as of Feb 1, 2013, excluding 21 failed launches. This data can be found at http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license. See also Appendix A in GRA study, which can be found on the docket for this rule.

entry licenses given the uncertainties associated with the probability of failure variable that goes into an E_c calculation. By using only one significant digit, the proposed E_c limit for launch would become slightly less restrictive than the three existing launch E_c limits combined (i.e., 90×10^{-6}). The regulatory-compliance difference between 90×10^{-6} and 149×10^{-6} falls under an accepted safety margin because the level of imprecision associated with E_c calculations means that there is no substantive difference between these two E_c figures. However, changing the regulations to use only one significant digit would improve efficiency by providing some flexibility to the government and license applicants in the launch approval process. In addition, using a single E_c limit that applies to an aggregate risk in place of three separate hazard-specific E_c limitations would further increase efficiency. As a result, the proposed rule would maintain a level of safety for commercial launches commensurate with the current level of safety associated with civil and military counterparts, but would be cost relieving by eliminating some waiver processes necessary under the current regulations as discussed below.

The proposed criteria would also separately address the public risk limits of toxic release and inert and explosive debris risks for reentry operations by establishing public safety requirements similar to the ones used at the federal launch ranges. Based on current practices of administering reentry licenses, the FAA found it was unrealistic and unnecessary to administer reentry licenses with a strict E_c limit of 30×10^{-6} for the combination of launch and reentry debris hazards. Aggregating E_c limits of toxic release and debris risks, the proposed E_c limit for reentry would be commensurate with the current safety requirements applied to civil and military reentries, and more conservative than past federal launch ranges' practices that gave waivers to allow non-commercial reentry missions to proceed with E_c risks on the order of 1x 10^{-3}.

The proposed rule would merely revise reentry E_c limits of toxic release and debris risks to be close to the current reentry licensing practice, on which we assess the current economic baseline of the revised E_c limits. The FAA expects that the nominal increase in the debris E_c limit on reentry proposed in this rule will impose no or minimal societal costs. This is because, while the FAA has not been asked to grant a waiver in which E_c for reentry would exceed 30 $x10^{-6}$, the FAA has historically issued a number of waivers to commercial launches that allowed those launches to exceed the regulatory E_c limits as long as those launches did not exceed the 100 x 10^{-6} E_c limits imposed by the federal ranges. The FAA has also issued waivers to two commercial reentries that allowed the E_c for those reentries to be considered separately from the E_c for launch. While the FAA, as part of its waiver process, has not yet had to consider whether a reentry operation should be issued a waiver to exceed the 30 x 10^{-6} E_c limit on reentry, the FAA expects that its launch waiver analysis would apply equally to reentry operations. Consequently, the FAA anticipates that many of the reentry operations that would be affected by this rule may be eligible for an FAA waiver in the absence of this rule. The only impact that this rule will have on those operations is to eliminate the need to seek an FAA waiver. Accordingly, any change to risk on reentry made by this proposed rule would be nominal at most.

With regard to toxic release risks, by applying the revised E_c value of 1 x 10^{-4} to toxic release risks during a reentry operation, the proposed rule would provide an incremental margin of safety to the public that does not exist under the current rule. However, from a technical perspective, toxic release risks for reentry vehicles are expected to remain a minor factor in E_c calculations, because the toxic release requirement would affect only those vehicles that intend to return to land rather than the ocean. The propellant load for a reentering reentry vehicle will generally be minimal because most of the propellant will have been used during the mission. The FAA believes that this portion of proposed criteria pertaining to reentries of the next generation of vehicles would not raise costs to the commercial space transportation industry. Therefore, the FAA believes this proposed requirement has minimal costs and positive benefits. The FAA requests comments with regard to the minimal cost determination.

The proposed changes in the risk limits would apply to all three hazards combined rather than to each individual hazard. In addition, the proposed changes would theoretically permit launches or reentries without seeking waivers as long as the aggregated risks would not exceed 0.000149 expected casualties per launch or re-entry mission (i.e., 149×10^{-6}). Both the commercial space transportation industry and the government would have savings attributable to less paperwork by avoiding some waiver-application process expenses.

Based on historical records of requests and previous FAA-issued waivers from the current E_c limits, the FAA anticipates that an additional 38 waivers from the current E_c limits will be necessary from 2013 to 2022 in the absence of this rule.[60] If this rule is finalized as proposed, the FAA expects that these 38 waivers will not be needed. Thus, this rule would result in savings for both the industry and the FAA, as the industry would not have to expend resources to request waivers and the FAA would not have to expend resources to evaluate waiver requests.

[60] GRA Study 2013, Table 5-7, by GRA Incorporated.

The industry cost ranges from $4,472 for 56 hours to $12,776 for 160 hours of aerospace engineering time to prepare and submit the necessary documentation to the FAA for approval[61]. Multiplying the forecasted 38 waivers for the 10-year period by the lower and upper bound costs yields cost savings ranging from $169,936 to $485,488. The range estimates for the FAA's cost savings are based on the costs of FAA personnel time ranging from $4,530 for 58 hours to $14,841 for 190 hours[62] to process each waiver request. This range is related to the characteristics of the individual launch or reentry request. Multiplied by the forecasted 38 waivers granted, the total estimated savings of FAA personnel time to review requests and issue waivers range from $172,140 to $563,958. The resulting savings for both the industry and the FAA with an estimated mid-point would be approximately $695,754 ($456,699 present value at a 7% discount rate). The lower and the higher estimates are approximately $0.3 million and $1 million ($283,619 and $688,866 present value at a 7% discount rate), respectively.

The proposed rule may also result in cost-saving by reducing launch delays and mission scrubs. The FAA currently does not have sufficient data to quantify these savings, but believes the possible reduction of launch delays and mission scrubs may increase the overall capacity of the U.S. space transportation industry. Accordingly, the FAA seeks comments on cost-savings that could be generated by this proposed rule through reduced launch delays and mission scrubs.

In summary, the proposed rule would maintain safety levels for commercial space transportation commensurate with the current requirements applied to civil and military

[61] Aerospace engineer wage rate ($79.85 per hour) was based on GRA Study, 2013, Appendix C, Table C-3. The FAA's Office of Commercial Space Transportation provided the estimation of the commercial space industry hours related to a waiver application.

[62] The FAA calculated this estimation of the agency's expenditure and hours related to processing a waiver application.

launches and re-entries. In addition, the proposed rule would result in net quantified benefits for both industry and government. The net benefit would be achieved by avoiding costs pertaining to applying and granting waivers with E_c limits between 90 x 10^{-6} and 149 x 10^{-6}. Further, related industries may also benefit by avoiding unnecessary mission delays and scrubs. The FAA requests comments with regard to this determination.

B. Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (Public Law 96-354) (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration." The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA. However, if an agency determines that a rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required.

The FAA expects many small entities would benefit from this proposed rule because the proposed revisions to the current rule are cost-relieving and do not cause any segment of industry to incur compliance costs. Therefore, the FAA certifies that the proposed rule would not have a significant economic impact on a substantial number of small entities. The FAA solicits comments with regard to this certification and requests that supporting documentation be supplied.

C. International Trade Impact Assessment

The Trade Agreements Act of 1979 (Public Law 96-39), as amended by the Uruguay Round Agreements Act (Public Law 103-465), prohibits Federal agencies from establishing standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Pursuant to these Acts, the establishment of standards is not considered an unnecessary obstacle to the foreign commerce of the United States, so long as the standard has a legitimate domestic objective, such as the protection of safety, and does not operate in a manner that excludes imports that meet this objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this proposed rule and determined that the rule would not impose obstacles to foreign commerce, as foreign exporters would not have to change their current export products to the United States.

D. Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action." The

FAA currently uses an inflation-adjusted value of $151 million in lieu of $100 million. This proposed rule does not contain such a mandate; therefore, the requirements of Title II of the Act do not apply.

E. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. The FAA has determined that there would be no new requirement for information collection associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to conform to International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Environmental Analysis

FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 312f of NEPA and involves no extraordinary circumstances.

Executive Order Determinations

A. Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. The agency has determined that this action would not have a substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, would not have Federalism implications.

B. Executive Order 13211, Regulations that Significantly Affect Energy Supply, Distribution, or Use

The FAA analyzed this proposed rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The agency has determined that it would not be a "significant energy action" under the executive order and would not be likely to have a significant adverse effect on the supply, distribution, or use of energy.

Additional Information

A. Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. The agency also invites comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. To ensure the docket does not contain duplicate comments, commenters should send only one copy of written comments, or if comments are filed electronically, commenters should submit only one time.

The FAA will file in the docket all comments it receives, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. Before acting on this proposal, the FAA will consider all comments it receives on or before the closing date for comments. The FAA will consider comments filed after the comment period has closed if it is possible to do so without incurring expense or delay. The agency may change this proposal in light of the comments it receives.

Proprietary or Confidential Business Information: Commenters should not file proprietary or confidential business information in the docket. Such information must be sent or delivered directly to the person identified in the FOR FURTHER INFORMATION CONTACT section of this document, and marked as proprietary or confidential. If submitting information on a disk or CD ROM, mark the outside of the disk or CD ROM, and identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under 14 CFR 11.35(b), if the FAA is aware of proprietary information filed with a comment, the agency does not place it in the docket. It is held in a separate file to which the public does not have access, and the FAA places a note in the docket that it has received it. If the FAA receives a request to examine or copy this information, it treats it as any other request under the Freedom of Information Act (5 U.S.C. 552). The FAA processes such a request under Department of Transportation procedures found in 49 CFR part 7.

B. Availability of Rulemaking Documents

An electronic copy of rulemaking documents may be obtained from the Internet by—

1. Searching the Federal eRulemaking Portal (http://www.regulations.gov);

2. Visiting the FAA's Regulations and Policies web page at http://www.faa.gov/regulations_policies or
3. Accessing the Government Printing Office's web page at http://www.gpoaccess.gov/fr/index.html.

Copies may also be obtained by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue S.W., Washington, DC 20591, or by calling (202) 267-9680. Commenters must identify the docket or notice number of this rulemaking.

All documents the FAA considered in developing this proposed rule, including economic analyses and technical reports, may be accessed from the Internet through the Federal eRulemaking Portal referenced in item (1) above.

LIST OF SUBJECTS—

14 CFR Part 417

Launch and reentry safety, Aviation safety, Reporting and recordkeeping requirements, Rockets, Space Transportation and exploration.

14 CFR Parts 431 and 435

Launch and reentry safety, Aviation safety, Reporting and recordkeeping requirements, Rockets, Space Transportation and exploration.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend chapter III of title 14, Code of Federal Regulations as follows:

PART 417—LAUNCH SAFETY

1. The authority citation for part 417 continues to read as follows:

Authority: 51 U.S.C. 50901–50923.

2. In § 417.107, revise paragraphs (b)(1), (b)(3), and (b)(4) to read as follows:

§ 417.107 Flight safety.

* * * * *

(b) * * *

(1) A launch operator may initiate the flight of a launch vehicle only if the total risk associated with the launch to all members of the public, excluding persons in water-borne vessels and aircraft, does not exceed an expected average number of 0.0001 casualties ($E_c \leq 1 \times 10^{-4}$). The total risk consists of risk posed by impacting inert and explosive debris, toxic release, and far field blast overpressure. The FAA will determine whether to approve public risk due to any other hazard associated with the proposed flight of a launch vehicle on a case-by-case basis. The E_c criterion applies to each launch from lift-off through orbital insertion, including each planned impact, for an orbital launch, and through final impact for a suborbital launch.

* * * * *

(3) A launch operator must establish any water borne vessel hazard areas necessary to ensure the probability of impact (P_i) with debris capable of causing a casualty for water borne vessels does not exceed 0.00001 (1×10^{-5}).

(4) A launch operator must establish any aircraft hazard areas necessary to ensure the probability of impact (P_i) with debris capable of causing a casualty for aircraft does not exceed 0.000001 (1×10^{-6}).

* * * * *

PART 431— LAUNCH AND REENTRY OF A REUSABLE LAUNCH VEHICLE (RLV)

4. The authority citation for part 431 continues to read as follows:

Authority: 51 U.S.C. 50901–50923.

5. In § 431.35, revise paragraph (b)(1) to read as follows:

§ 431.35 Acceptable reusable launch vehicle risk.

* * * * *

(b) * * *

(1) To obtain safety approval, an applicant must demonstrate the following for public risk:

(i) The risk to the collective members of the public from the proposed launch meets the public risk criteria of § 417.107(b)(1) of this chapter;

(ii) The risk level to the collective members of the public, excluding persons in water borne vessels and aircraft, from each proposed reentry does not exceed an expected average number of 0.0001 casualties (E_c criterion of 1×10^{-4}) from impacting inert and explosive debris and toxic release associated with the reentry; and

(iii) The risk level to an individual does not exceed .000001 probability of casualty per mission (individual risk of $E_c \leq 1 \times 10^{-6}$).

* * * * *

PART 435— REENTRY OF A REENTRY VEHICLE OTHER THAN A REUSABLE LAUNCH VEHICLE (RLV)

6. The authority citation for part 435 continues to read as follows:

Authority: 51 U.S.C. 50901–50923.

7. Revise §435.35 to read as follows:

§ 435.35 Acceptable reusable launch vehicle risk.

To obtain safety approval for reentry, an applicant must demonstrate the following for public risk:

(a) The risk to the collective members of the public from the proposed launch meets the public risk criteria of § 417.107(b)(1) of this chapter;

(b) The risk level to the collective members of the public, excluding persons in water borne vessels and aircraft, from each proposed reentry does not exceed an expected average number of 0.0001 casualties (E_c criterion of 1×10^{-4}) from impacting inert and explosive debris and toxic release associated with the reentry; and

(c) The risk level to an individual does not exceed .000001 probability of casualty per mission (individual risk of $E_c \leq 1 \times 10^{-6}$).

Issued under authority provided by 49 U.S.C. § 106(f) and 51 U.S.C. §§ 50904-50905 in Washington, DC, on June 25, 2014.

Dr. George C. Nield

Associate Administrator for Commercial Space Transportation

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