

■ 2. Amend Appendix G, Section 3 by removing and reserving paragraph (b)(1).

Issued under authority provided by 49 U.S.C. 106(f), 40103, 40113, and 44701(a) in Washington, DC, on July 12, 2016.

**Michael Huerta,**  
*Administrator.*

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## DEPARTMENT OF TRANSPORTATION

### Federal Aviation Administration

#### 14 CFR Parts 417, 420, 431, and 435

[Docket No.: FAA-2014-0418; Amdt. Nos. 417-4, 420-7, 431-4 and 435-3]

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:** Final rule.

**SUMMARY:** The FAA is amending its regulations concerning the collective risk limits for commercial launches and reentries. These changes include: Separating the risk limits for commercial launches and reentries; aggregating the risk posed by impacting inert and explosive debris, toxic release, and far field blast overpressure; limiting the aggregate risk for these three hazards to  $1 \times 10^{-4}$ ; reducing the number of significant digits used in launch and reentry risk analysis; and various non-substantive clarifying revisions. These changes update FAA regulations to reflect the United States Government's greater experience with commercial launch and reentry and to align more closely the FAA's risk standards with those of other United States Federal agencies, while continuing to protect public safety.

**DATES:** Effective September 19, 2016.

**ADDRESSES:** For information on where to obtain copies of rulemaking documents and other information related to this final rule, see "How To Obtain Additional Information" in the **SUPPLEMENTARY INFORMATION** section of this document.

**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, DC 20591;

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#### SUPPLEMENTARY INFORMATION:

##### Authority for This Rulemaking

The Commercial Space Launch Act of 1984, as amended and 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), 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), in relevant part, directs the FAA to regulate private sector launches, reentries, and associated services only to the extent necessary 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. Overview of Final Rule

The FAA is adopting this final rule to revise certain regulations related to the collective risk limits for commercial launches and reentries in part 417 (Launch Safety), part 420 (License to Operate a Launch Site), part 431 (Launch and Reentry of a Reusable Launch Vehicle (RLV)), and part 435 (Reentry of a Reentry Vehicle Other Than a Reusable Launch Vehicle (RLV)) of Title 14 of the Code of Federal Regulations (14 CFR).

This final rule divides the risk analysis for launch and reentry, providing a separate risk budget for each. For all launches, regardless of vehicle type, this final rule requires a single expected number of casualties ( $E_c$ ) be calculated by aggregating the risk posed to the collective members of the public from three hazards: Impacting and inert explosive debris, toxic release, and far field blast overpressure. This final rule also revises the acceptable risk threshold for launch from an  $E_c$  of  $30 \times 10^{-6}$  for each hazard to an  $E_c$  of  $1 \times 10^{-4}$  for all three hazards combined. Furthermore, this final rule expresses the revised  $E_c$  limit using the correct number of significant digits to properly represent the uncertainty in  $E_c$  calculations. This final rule changes the FAA's collective risk limits for launch

and reentry to more closely match the  $E_c$  standard currently used by the United States (U.S.) Air Force and the National Aeronautics and Space Administration (NASA) for government missions, and to account for the level of uncertainty that exists in the  $E_c$  calculations.

This final rule also makes two revisions to § 417.107 to clarify the launch and reentry regulations. The first revision removes the phrase "including each planned impact" from § 417.107(b)(1) to clarify that public risk is assessed from lift-off through orbital insertion for orbital launches and from lift-off to final impact for suborbital launches. The second revision modifies § 417.107(b)(3) and (b)(4) to make transparent the criteria for establishing hazard areas by replacing the references to equivalent levels of safety for water borne and aircraft hazard areas required for launch from a federal launch range with the actual levels of safety provided by hazard areas for launches from a federal range in 2006, the year the FAA promulgated § 417.107. Under § 417.107(b)(3), a hazard area for water borne vessels satisfies part 417 if the probability of impact with debris capable of causing a casualty on any potential water borne vessel within the hazard area does not exceed  $0.00001$  ( $1 \times 10^{-5}$ ). Under § 417.107(b)(4), a hazard area for aircraft will satisfy part 417 if the probability of impact with debris capable of causing a casualty on any potential aircraft within that hazard area does not exceed  $0.000001$  ( $1 \times 10^{-6}$ ). These clarifying edits do not change the risk requirement for launch licensees or launch license applicants.

##### Summary of the Costs and Benefits of the Final Rule

The final rule will result in net benefits for both the commercial space transportation industry (industry) and government by reducing the number of waivers that must be prepared by the industry and processed by the government for launches with an aggregate  $E_c$  between  $90 \times 10^{-6}$  and  $149 \times 10^{-6}$ , and by averting unnecessary mission delays and scrubs. The resulting savings for both the industry and the FAA from reducing the number of waivers range from a low estimate of approximately \$8.3 million to a high estimate of \$16.7 million (\$5.8 million and \$11.7 million present value at a 7% discount rate, respectively).

##### II. Background

An operator conducts a launch using an expendable launch vehicle (ELV) or a reusable launch vehicle (RLV). An ELV is a launch vehicle whose

propulsive stages are flown only once. 14 CFR 401.5. 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. *Id.* Reentry is conducted with RLVs or other reentry vehicles. A reentry vehicle is a vehicle designed to return from Earth orbit or outer space to Earth substantially intact, and includes a reentering RLV. *Id.*

Parts 417, 420, 431, and 435 (collectively, the collective risk regulations) limit the collective risk that a commercial launch or reentry may pose to the public. The FAA's collective risk regulations, as originally promulgated, were based primarily on  $E_c$  limits that the U.S. Air Force imposed on launches from federal launch ranges at the time the FAA began establishing its own  $E_c$  limits.<sup>1</sup> 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.

In July 2014, the FAA published in the **Federal Register** a notice of proposed rulemaking (2014 NPRM) proposing various revisions to the FAA's launch and reentry regulations.<sup>2</sup> This final rule adopts the proposal outlined in the 2014 NPRM, with minor modifications and clarifications in response to comments from the public.

#### A. Statement of the Problem

Prior to the 2014 NPRM, developments in the industry and among U.S. Government agencies led the FAA to question its collective risk regulations. In 2010, the U.S. Air Force, after conducting over 5,000 launches under a  $30 \times 10^{-6}$   $E_c$  limit, determined that it could increase its  $E_c$  limit from  $30 \times 10^{-6}$  per hazard to  $100 \times 10^{-6}$  for the aggregate public risk associated with debris, toxicity, and far field blast overpressure without harming public safety. The U.S. Air Force's new  $E_c$  standards also apply a separate  $E_c$  limit to reentry, limiting reentry  $E_c$  to  $100 \times 10^{-6}$  for the aggregate public risk associated with all hazards, which typically include debris, toxicity, and

far field blast overpressure. In addition, in 2010 NASA also revised its risk acceptability policy to limit the  $E_c$  from launch and reentry missions to  $100 \times 10^{-6}$  each.

Because the FAA's collective risk regulations were based on the U.S. Air Force's former  $30 \times 10^{-6}$  limit—a limit that both the U.S. Air Force and NASA, after considerable experience, have now revised—the FAA questioned in the 2014 NPRM whether its collective risk limits, revised by this final rule, continued to represent appropriate public risk criteria for commercial ELV and RLV operations. In addition, the FAA's own experience led the agency to question whether those  $E_c$  limits created an obstacle to NASA's implementation of the National Space Policy (e.g., NASA proposed commercial flights to the International Space Station that would not meet FAA's current  $E_c$  limits).<sup>3</sup>

Finally, the FAA also sought to address in the 2014 NPRM whether its former collective risk regulations sufficiently distinguished between commercial launch and reentry risk. Instead of regulating risk based on whether the operation in question was a launch or a reentry, the former collective risk regulations focused on the type of vehicle used in the operation, namely whether the vehicle was an ELV, RLV, or a reentry vehicle.

#### B. Summary of the 2014 NPRM

The 2014 NPRM proposed several revisions to the FAA's risk framework. These proposals included: Aggregating launch hazards and establishing an  $E_c$  limit of  $1 \times 10^{-4}$ , thus reducing the number of significant digits in a launch or reentry risk analysis; separating the risk limits for the launch and reentry of a reentry vehicle; including toxic release as a hazard in the risk analysis for reentries; and clarifying the acceptable risk threshold for impact with ships and aircraft in hazard areas. For more detailed information, interested parties may consult the preamble of the 2014 NPRM.

#### C. General Overview of Comments

The comment period for the July 2014 NPRM closed on October 20, 2014. The FAA received comments from nine commenters, including ACTA Inc. (ACTA), Blue Origin, LLC (Blue Origin), Lockheed Martin Corporation (Lockheed Martin), Orbital Sciences Corporation (Orbital Sciences), Sierra Nevada Corp. (Sierra Nevada), Space Exploration Technologies Corp. (SpaceX), XCOR

Aerospace (XCOR), and two individual commenters. Most of the commenters supported the proposed changes, and some suggested additional changes that are discussed more fully below. Several commenters fully supported the proposed changes, and one commenter opposed the proposed changes. The comments focused on the following general areas of the proposal:

- Individual risk limits
- Separation of launch and reentry
- Significant figures
- Ship and aircraft hazard areas
- Including toxic release in the reentry risk analysis

### III. Discussion of Public Comments and Final Rule

#### A. Individual Risk

As discussed in the 2014 NPRM, this final rule does not substantively revise the FAA's limitation on risk posed to individuals found in §§ 417.107, 431.35, and 435.35.<sup>4</sup> The individual risk limits in § 417.107(b)(2) prohibit launch risk to an individual from exceeding  $1 \times 10^{-6}$  for each hazard (debris, toxic release, and far field blast overpressure) for launch of an ELV. For the launch of a RLV or other reentry vehicle, §§ 431.35(b)(1)(ii) and 435.35 continue to prohibit the risk to an individual from exceeding  $1 \times 10^{-6}$  per mission. The FAA proposed no change to this risk limit, so any change now would be outside the scope of the proposal. Nonetheless, the comments raise issues of interest and are addressed below.

XCOR agreed that no change is necessary because it is easier for launch operators to mitigate risk to a particular individual than the collective public, and because the FAA has never waived individual risk for launches in the past. On the other hand, Orbital Sciences recommended that the FAA “[e]xamine historical data for all U.S. launches to determine the highest level of risk realized by any individual member of the public and propose a more realistic . . . risk [figure] based on this successful precedent.” Orbital Sciences also recommended that the FAA adopt “identical risk limits for individual members of the public” for U.S. Government and commercial launches.

The FAA disagrees with Orbital Sciences' recommendation to revise the individual risk threshold. Unlike the FAA's collective risk limitation, the FAA is aware of only a small number of historical U.S. government launches for which the predicted individual risk for any one member of the public exceeded

<sup>1</sup> See, e.g., *Commercial Space Transportation Licensing Regulations, Final Rule (Launch Licensing Rule)*, 64 FR 19586, 19605 n.11 (Apr. 21, 1999).

<sup>2</sup> *Changing the Collective Risk Limits for Launches and Reentries and Clarifying the Risk Limit Used to Establish Hazard Areas for Ships and Aircraft*, 79 FR 42241 (July 21, 2014).

<sup>3</sup> See National Space Policy of the United States of America (June 28, 2010), available at [https://www.whitehouse.gov/sites/default/files/national\\_space\\_policy\\_6-28-10.pdf](https://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf).

<sup>4</sup> However, it should be noted that the FAA made a non-substantive change to 417.107(b)(2) to improve consistency and clarity.

$1 \times 10^{-6}$ . From a statistical perspective, this casualty-free launch record is the expected outcome because  $1 \times 10^{-6}$  corresponds to a one-in-a-million chance of a particular person being a casualty and there have been no more than a few thousand launches from the United States. The FAA therefore finds insufficient evidence at this time to justify relaxing the current individual risk limits, which are an integral part of an interdependent set of safety requirements that have produced a flawless public safety record for U.S. launches and reentries. Furthermore, the FAA notes that limiting risk to individual members of the public at the  $1 \times 10^{-6}$  level is consistent with the consensus standard produced by U.S. range safety organizations as adopted by NASA and the U.S. Air Force.

ACTA stated that maintaining the current individual risk thresholds perpetuates inconsistent individual risk standards for ELVs, RLVs, and reentry vehicles. ACTA observed that § 417.107(b)(1)(ii) limits individual risk to  $1 \times 10^{-6}$  for each hazard for ELVs. ACTA stated that this was inconsistent with the risk threshold for RLVs and reentry vehicles in § 431.35(b)(2)(ii), which limits total risk to an individual to  $1 \times 10^{-6}$  over the course of the entire mission, without any reference to specific hazards. As a result, ACTA argued, ELV missions would have a different individual risk criterion than missions involving an RLV or other reentry vehicle.

ACTA's recommendation to harmonize all individual risk limits is outside the scope of the current rulemaking. Also, the FAA has insufficient data to justify a change to the individual risk criteria for either launch or reentry, and thus no change was proposed. Finally, the current regulatory framework governing individual risk for launch and reentry risk has successfully protected the public since 2000.

#### B. Separating $E_c$ for Launch and Reentry

The FAA proposed to separate the  $E_c$  limits for the launch and reentry of all reentry vehicles, instead of applying a single risk limit to both phases of a mission.<sup>5</sup>

Blue Origin, Lockheed Martin, Orbital Sciences, and SpaceX fully supported the proposal to separate launch and reentry risk. ACTA supported the proposal to separately assess launch and reentry risk if reentry occurs after a health check, but noted that "separation of risk budgets for launch and reentry

ignores the risk contribution from a failure to initiate a planned reentry." In particular, ACTA noted that "[t]here does not appear to be any consideration for consequences if the health check prior to reentry fails. . . . [The vehicle's] orbit will eventually degrade and re-enter . . . [and the] risk of this potentially uncontrolled re-entry (if the health of the vehicle can never be restored) appears to be neglected."

ACTA is correct that the FAA does not regulate the risk associated with reentry vehicles or parts of reentry vehicles that do not initiate or attempt to initiate a purposeful reentry. As the FAA has explained, the Act limits the FAA's licensing of reentry to scenarios involving purposeful reentry;<sup>6</sup> therefore, the FAA is prohibited from considering the "possibility of a random uncontrolled reentry that occurs as a result of a reentry vehicle ceasing to function upon arrival in orbit."<sup>7</sup>

Although the 2014 NPRM did not propose to change the requirement that suborbital launches and reentries be subject to a single launch  $E_c$ , the FAA invited comment on the issue. Sierra Nevada commented that suborbital flights also should have separate risk limits for launch and reentry because each phase of flight required independent operational decisions.

XCOR, on the other hand, commented that suborbital vehicles should continue to have a single risk limit because, for a suborbital launch, "reentry is a physical inevitability"; there is "no intervening event between launch and reentry"; and that "reentry is closely proximate in time—four minutes, for most concepts to launch."

The FAA agrees with XCOR that a suborbital mission should continue to be analyzed using a single risk budget for the entire mission, from launch through final impact, because there is no intervening event between launch and reentry and because reentry is a physical inevitability. Moreover, separating launch and reentry risk limits for suborbital flights is beyond the scope of this final rule because it would require revising the definitions of "reentry" and "launch" found in § 401.5, changes the NPRM did not propose.

The FAA will require separate analysis of the risks associated with

launch and reentry 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. The FAA leaves unchanged, however, the requirement that suborbital launches and reentries must comply with a single launch  $E_c$  limit that encompasses the entire operation from launch through final impact.

#### C. Revising the Acceptable Risk Standard

The FAA proposed to revise the acceptable risk limit for launch to  $1 \times 10^{-4}$ , encompassing all three hazards—debris, toxic release, and far field blast overpressure. This would amend the risk framework's three components by aggregating the analysis of debris, toxics, and far field blast overpressure; establishing a new, unified risk standard for the three primary hazards combined; and revising the risk standard to be expressed using one significant figure. The commenters addressed each of these issues separately.

##### 1. Aggregating $E_c$ for Debris, Toxics, and Far Field Blast Overpressure

ACTA, Orbital Sciences, and SpaceX supported the proposal to aggregate risk calculations. The FAA received no negative comments on this component of the proposal. Therefore, this final rule replaces the prior requirement to satisfy three separate  $E_c$  criteria (one each for debris, toxics, and far field blast overpressure) with a single  $E_c$  criterion accounting for all three primary hazards.

##### 2. Revising the Number of Significant Figures

Numerous commenters, including Blue Origin, Lockheed Martin, Orbital Sciences, and SpaceX, supported the FAA's proposal to express the risk threshold using one significant figure. Lockheed Martin stated that the proposal "would improve efficiency and maintain a level of safety for commercial launches that is commensurate with the current high level of safety associated with civil and military launches."

ACTA and an individual commenter advocated against changing the number of significant figures. An individual commenter recommended that one significant figure would be more appropriate at the level of  $1 \times 10^{-5}$ . ACTA agreed with the proposal to increase the risk limitations insofar as "it is reasonable to apply a higher acceptability limit (around  $100 \times$

<sup>6</sup> Waiver of Acceptable Mission Risk Restriction for Reentry and a Reentry Vehicle, 75 FR 75619, 75620 (Dec. 6, 2010).

<sup>7</sup> The Waiver explained that "[b]ecause a random uncontrolled reentry arising out of a reentry vehicle ceasing to function upon arrival in orbit is not purposeful and is thus not licensed, an interpretation that section 431.35 applies to this type of reentry would conflict with" limitations on the FAA's authority.

<sup>5</sup> The separation of  $E_c$  limits for launch and reentry affects §§ 431.35(b) and 435.35.

10<sup>-6</sup>),” but also stated the FAA’s proposal to both raise the limit and reduce the number of significant figures resulted in an effective increase of “the acceptable risk limit to 50% above current Air Force and NASA practice.” Referring to the effects of revising the number of significant figures, ACTA stated that “the difference between 100 × 10<sup>-6</sup> and 149 × 10<sup>-6</sup> is real and significant.” ACTA also stated that, because of this “effective” 50% increase, the FAA’s proposal would not maintain safety levels for commercial space transportation commensurate with the current requirements for civil and military reentries. Finally, ACTA also disagreed with the FAA’s rationale for increasing the acceptable risk limit. In particular, ACTA stated that it is inappropriate to exceed the Range Commanders Council (RCC) 321 consensus standard; the success of a relatively small number of missions operated under waivers is statistically irrelevant; and the continued use of waivers is reasonable in a developing industry.

The FAA disagrees that the difference between 100 × 10<sup>-6</sup> and 149 × 10<sup>-6</sup> is real and significant because the uncertainty associated with many of the variables that go into determining E<sub>c</sub> are too large to justify using more than one significant digit. The FAA and others, including ACTA, have performed extensive uncertainty analyses for both launch area and downrange overflight. These analyses accounted for aleatory—irreducible—and epistemic—modeling—sources of uncertainty, including the inherent variability in the impact distribution due to wind and lift effects for irregular debris following failure; probability of failure; casualty area for people in shelters that are impacted by debris; size of the debris impact probability distribution; yield from exploding propellant and propellant tanks; probability of injury from a blast wave for people in buildings or unsheltered; and population density. Uncertainty also exists in the E<sub>c</sub> estimate for overflight because of the uncertainty in the time of launch, cargo debris, and different methods to characterize the normal trajectory dispersions based on input data provided by the launch operator.

A standard public risk analysis for launch or reentry produces a single E<sub>c</sub> value, but these state-of-the-art analyses demonstrate that the modeling uncertainties are too large to justify calculating E<sub>c</sub> to more than one significant figure.<sup>8</sup> In fact, the

uncertainty in a vehicle’s probability of failure alone is generally large enough to render meaningless any calculated differences involving more than one significant digit, such as a calculated difference of 100 × 10<sup>-6</sup> compared to 149 × 10<sup>-6</sup> in E<sub>c</sub> estimates for a commercial launch.<sup>9</sup> Specifically, during SpaceX’s third Falcon 9 mission (F9-003), two probability of failure analysis approaches applied by the two major federal ranges for commercial launches, which the FAA deemed equally valid based on the requirements in § 417.224, produced mean probability of failure estimates during Eurasian over-flight that varied by approximately 40 percent. Also, the uncertainty in the E<sub>c</sub> estimate scales linearly with the statistical uncertainty associated with any probability of failure analysis method, even when the assumptions of the model are absolutely true. For example, applying the binomial approach in part 417, appendix A, § 417.25(b)(5)(iii), to a new vehicle with a record of no failures in the first two flights produces a reference probability of failure estimate of 0.28. Even if the assumption of Bernoulli trials<sup>10</sup> inherent in the binomial approach is absolutely true, which is doubtful given the evolutionary nature of expendable launch vehicles, particularly during the first several flights, there is about a 20

result, to quantify the uncertainty in the E<sub>c</sub> estimate. ACTA itself developed a tool that computes the uncertainty in the point estimate of E<sub>c</sub> by using multiple input data sets within the range of feasibility given the uncertainty associated with the input data, together with a multiple sets of factors applied to each sub-model to account for the estimated biases and uncertainties in the applicable sub-models.

<sup>9</sup> Of course, the probability of failure uncertainty is very large for relatively new vehicles, which are most likely to have risk estimates near the 1 × 10<sup>-4</sup> E<sub>c</sub> limit. However, even vehicles with extensive flight history, such as the Delta II, have probability of failure estimates that vary by a factor of two or more based on the analysis approaches applied by the two major federal ranges where commercial launches most often occur. For example, the Delta II demonstrated nine failures in 227 launches in advance of the GRAIL mission. Valid probability of failure analysis methods produced mean estimates of probability of failure for the GRAIL launch between less than 2% to more than 4%, depending on whether and how reliability growth was accounted for.

<sup>10</sup> All expendable launch vehicle failure probability analysis methods used by Federal ranges today assume that launches may be treated as Bernoulli trials: That the vehicle has a constant “true probability” of failure for each and every launch, and that the outcome of each launch is statistically independent of all others. A toss of an evenly weighted coin is a classic example of a Bernoulli trial. Of course, launches are not exactly Bernoulli trials because no two launches are precisely the same. For example, the vehicle may be modified or improved as needed during a sequence of launches, particularly if it has failed on previous launches, and there are natural variations due to environmental conditions during the vehicle manufacturing, processing, and launch.

percent chance that the true probability of failure is at least twice the reference probability of failure estimate. It is impossible to know the true probability of failure for any launch vehicle flight. The FAA believes that the uncertainty in the probability of failure alone always renders meaningless any more than one significant digit in any commercial launch or re-entry E<sub>c</sub> estimate.

ACTA provided three alternatives to the FAA’s July 2014 proposal. These alternatives included (1) using “the approach specified in RCC 321–10” in which increasing degrees of analysis and mitigation are required as the risk increases above 30 × 10<sup>-6</sup> and again at 100 × 10<sup>-6</sup>; (2) “[e]xpress[ing] the limit that log<sub>10</sub>(EC) is less than –4.0 (to two significant figures”); and (3) “[a]pply[ing] a limit of 9 × 10<sup>-5</sup> rather than 1 × 10<sup>-4</sup> which results in an effective limit of 95 × 10<sup>-6</sup>.”

The FAA appreciates the potential value in using the RCC 321–10 approach, in which increasing degrees of analysis and mitigation are required as the risk increases. Such a dramatic change, however, is beyond the scope of this rulemaking. The FAA disagrees with ACTA’s recommendations to “[e]xpress the limit that log<sub>10</sub>(EC) is less than –4.0 (to two significant figures” or “[a]pply[ing] a limit of 9 × 10<sup>-5</sup> rather than 1 × 10<sup>-4</sup> which results in an effective limit of 95 × 10<sup>-6</sup>” because either of those approaches would still imply more significant digits in the E<sub>c</sub> estimate than justified based on the E<sub>c</sub> uncertainty analyses summarized above.

### 3. Establishing an Acceptable Risk Limit of 1 × 10<sup>-4</sup>

Under the 2014 NPRM, §§ 417.107(b)(1), 431.35(b)(1)(i), and 435.35(b) would establish an acceptable collective risk limit of 1 × 10<sup>-4</sup>. Two commenters, Lockheed Martin and SpaceX, supported the proposal without additional significant comment. SpaceX noted that the proposal would align the FAA’s risk limit with the standards set by other organizations within the U.S. Government.

Orbital Sciences supported the proposal but also recommended that the FAA “[e]xamine historical data for all U.S. launches and determine the highest level of collective risk realized by the public [to] propose a more realistic . . . collective risk [number] based on this successful precedent.” Similarly, Blue Origin recommended that the collective risk number be revised higher than proposed, to 1 × 10<sup>-3</sup>. Blue Origin noted that Federal ranges have, in the past, waived risks associated with non-commercial reentry to as high as 1 × 10<sup>-3</sup>, and stated, “[t]he commercial

<sup>8</sup> In fact, an uncertainty analysis produces a set of point estimates, each of which is an equally valid

spaceflight industry should be held to the standard that the nation's civil and military programs are held to *in practice*.<sup>11</sup> Blue Origin suggested that reducing the need for waivers would increase transparency and “more closely reflect FAA’s regulatory practice, rather than relying on a waiver process such as practiced by NASA and” the U.S. Air Force. Blue Origin further stated that, if the FAA adopts “a risk level that differs from [the FAA’s] actual practice, the commercial spaceflight industry will be left not knowing what the real, actual risk level will be in practice,” suggesting that reducing the agency’s reliance on waivers would provide an important measure of stability and predictability to the commercial space industry.

The FAA disagrees with Orbital Sciences’ and Blue Origin’s recommendations to increase the  $E_c$  limit beyond  $1 \times 10^{-4}$ . The United States has achieved a flawless public safety record for orbital launch and re-entry missions in part because of a comprehensive and interdependent set of public safety requirements developed and implemented by numerous, cooperating entities within the U.S. government. Three U.S. government entities, the U.S. Air Force, NASA, and the FAA, have oversight of the safety of launches. Both the U.S. Air Force and NASA, working alone and collaborating through organizations such as the RCC and the Common Standards Working Group, have examined the available data and determined that  $100 \times 10^{-6}$ , also expressed as  $1 \times 10^{-4}$ , is an appropriate standard for acceptable risk.<sup>12</sup> There are an insufficient number of casualty-free launches and reentries with  $E_c$  greater than  $1 \times 10^{-4}$  to justify departing from the standard adopted by the U.S. Air Force and NASA. In the few cases where waivers were granted by the FAA, prior to and including 2014, the respective  $E_c$  was always less than the risk levels previously approved for government launches. Hence, any precedent for granting waivers for prior non-commercial reentries is not sufficient justification for implementing a more lenient risk limit, especially in light of the increased scrutiny given to each waiver applicant.

Moreover, a fundamental tenet of risk management, both as applied to the regulation and general safety management of various industries, is to set acceptability criteria for collective

risk that are below the level that may be acceptable in unusual circumstances or on a short term basis. For aviation risk management, the FAA has identified risk-informed Continued Airworthiness Assessment Methodologies (CAAM) that include short term acceptable risks that are orders of magnitude greater than long term acceptable risk levels.<sup>13</sup> Thus, AC 39–8 is another example of the FAA adopting a risk management approach where basic acceptability criteria are more stringent than may be acceptable in unusual circumstances or on a short term basis. Note that the FAA’s use of quantitative risk analysis results is consistent with the risk-informed approach to regulatory decision-making adopted by the Nuclear Regulatory Commission (NRC). In 1999, the NRC wrote that “a ‘risk-informed’ approach to regulatory decision-making represents a philosophy whereby risk insights are considered together with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety.”<sup>14</sup>

In light of these considerations and all currently available data, the FAA finds that a collective  $E_c$  limit of  $1 \times 10^{-4}$  reflects an appropriate consensus safety risk standard for launch and re-entry. Consistent with Executive Orders 13563 and 13610, the FAA plans to periodically review and revise this public risk standard, if warranted, based upon factors such as the quantity of launch and reentry activities, demonstrated reliability and safety record and benefits provided, technological capabilities, and maturity of the industry.

ACTA and an individual commenter cautioned against justifying any increase to the acceptable risk standards by reference to either a relatively small number of successful launches or the uncertainty of launch risk calculations. The individual commenter recommended that any increase to the acceptable risk limits be premised on a determination that higher numbers still adequately ensure public safety.

The FAA disagrees with ACTA’s and the individual commenter’s premise concerning the basis of this final rule.

<sup>13</sup> Federal Aviation Administration, Advisory Circular No. 39–8, *Continued Airworthiness Assessments of Powerplants and Auxiliary Power Unit Installations of Transport Category Planes*, Washington, DC, September 2003.

<sup>14</sup> U.S. Nuclear Regulatory Commission, *Commission Issuance of White Paper on Risk-Informed and Performance-based Regulation*, Yellow Announcement # 019, Washington, DC, dated March 11, 1999.

Contrary to their assertion, the FAA is not relying on the historical success of a relatively small number of past launches as a justification for increasing the acceptable risk standard. Rather, the FAA, by statute, is authorized to regulate “only the extent necessary” to protect public health and safety. 51 U.S.C. 50901(a)(7). The U.S. Air Force and NASA, two federal agencies with significant expertise in this area, have both examined the currently available data and concluded that it does not justify an aggregated  $E_c$  limit lower than  $100 \times 10^{-6}$ . Furthermore, there are published materials that explain the rationale for the collective risk limit adopted both by the U.S. Air Force and NASA.<sup>15 16 17</sup> The currently available data does not justify a regulatory restriction on  $E_c$  for commercial licensees that is more stringent than the standards adopted both by the U.S. Air Force and NASA.

#### *D. Clarifying Hazard Areas for Ships and Aircraft*

Prior to this final rule, § 417.107(b)(3) and (4) required the launch operator of an ELV to implement and establish ship and aircraft hazard areas providing an equivalent level of safety to that provided by the ship and aircraft hazard areas implemented for launch from a Federal launch range. 71 FR 50508. The FAA proposed to amend § 417.107(b)(3) and (4) to clarify the requirements for hazard areas for ships and aircraft, respectively, by removing references to an “equivalent level of safety to that provided by [ship or aircraft] hazard areas implemented for launch from a Federal range” and replacing them with a numeric limit on the probability of impact with debris capable of causing a casualty.

Orbital Sciences recommended that no change be made to the hazard area regulations. Orbital Sciences stated that the proposal to implement a specific risk standard, even if it is quantitatively the same as the Federal launch ranges’ standard, creates the possibility that the Federal launch ranges will change their standard and the FAA’s regulation will become obsolete. The FAA disagrees with Orbital Sciences’ recommendation. Regardless of whether the Federal

<sup>15</sup> See Range Commanders Council Risk Committee of the Range Safety Group, *Common Risk Criteria for National Test Ranges, RCC 321–10*, White Sands Missile Range, New Mexico, 2010.

<sup>16</sup> Wilde P., *Public Risk Criteria and Rationale for Commercial Launch and Reentry*, 5th IAASS Symposium, Versailles, France, October 2011.

<sup>17</sup> Wilde, P. *Public Risk Tolerability Criteria for Space Launch and Reentry*, Presented at the 51st Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space, Vienna, Austria, 18 Feb. 2014.

<sup>11</sup> Emphasis in original.

<sup>12</sup> See Range Commanders Council Risk Committee of the Range Safety Group, *Common Risk Criteria for National Test Ranges, RCC 321–10*, White Sands Missile Range, New Mexico, 2010.

launch ranges change their risk criteria for ships and aircraft, the Administrative Procedure Act, with limited exceptions, prohibits the FAA from changing its regulatory requirements without notice and comment. 5 U.S.C. 553. Therefore, even if the FAA maintained these provisions using a purportedly outdated standard, a change to the Federal launch range requirements would not automatically flow through to FAA regulations, and licensed launch operators would have to abide by the Federal launch range standard in effect when the FAA first promulgated the regulation. Accordingly, if the Federal launch ranges change their standard, the FAA will have to initiate its own rulemaking in order to harmonize its water-borne vessel and aircraft hazard areas limits with the Federal launch ranges'. To prevent this confusion, the FAA is revising § 417.107(b)(3) and (4) to identify the numeric requirements.

An individual commenter questioned the proposed clarifications regarding the ship and aircraft hazard areas. Specifically, the individual commenter pointed out that the proposal, which is based on the probability of impact with debris capable of causing a casualty, could be either excessively conservative or non-conservative depending on the details of the analysis, such as the threshold characteristics of the debris and the size of the area considered vulnerable to such debris impact. ACTA provided similar comments, stating the regulations (1) do "not define the area for computing impact" with a vessel or aircraft, and (2) do not clarify that operators must account for "the near-field explosive effects of propellants impacting in the vicinity of [a] ship."

The individual commenter's recommendation to substantively amend the hazard area risk standards is outside the scope of this rulemaking. As described in the 2014 NPRM, this final rule does not substantively change the hazard area risk standards. 79 FR 42241, 42249–50. The hazard area revisions only clarify the FAA's standards by using a specific number, rather than an unquantified reference to Federal launch range standards. The FAA therefore rejects the commenter's recommendations to make substantive changes to the rule.

ACTA's comments also included numerous additional observations related to the hazard area regulations. ACTA stated that the regulations do not "specify how (or even if) hazard areas are to be used to implement mitigation" to protect specific individuals or the general public. This observation, however, ignores other sections of the

regulations that do address how hazard areas are to be used to implement mitigation techniques, such as issuing public warnings and performing surveillance. To meet the public risk criteria of § 417.111(b), § 417.223 requires "a flight hazard area analysis that identifies any regions of land, sea, or air that must be surveyed, publicized, controlled, or evacuated in order to control the risk to the public from debris impact hazards." Furthermore, § 417.111(j) requires a launch operator to "implement a plan that defines the process for ensuring that any unauthorized persons, ships, trains, aircraft or other vehicles are not within any hazard areas identified by the flight safety analysis or the ground safety analysis," and explicitly includes hazard areas identified under §§ 417.107 and 417.223.

ACTA also criticized the proposal for failing to justify "why the acceptable risk limit to the general public on ships is higher than for people on land." The premise of this comment is not correct. Specifically, § 417.107(b)(2) provides that a launch operator may initiate flight only if the risk to any individual member of the public does not exceed a  $1 \times 10^{-6}$  probability of casualty, regardless of the location of that individual member of the public. Thus, the FAA's risk criteria provide equal protection to each individual member of the public, on ships or on land. Moreover, to the extent ACTA is criticizing the water-borne vessel hazard areas requirement, the FAA is not changing the water-borne vessel hazard area requirement; it is merely clarifying the requirement by removing a reference to where the requirement can be found and replacing it with the actual requirement.

ACTA also was concerned that the criteria for ship and aircraft do not explicitly exclude "mission-support vessels and aircraft," creating an inconsistency with the remainder of the regulation. Although ACTA is correct that the criteria do not apply to vessels and aircraft that support the launch, the FAA's launch and reentry regulations address only *public* safety, which § 401.5 defines as "for a particular licensed launch, the safety of people and property that are not involved in supporting the launch . . ." It, therefore, is unnecessary to explicitly exclude "mission-support vessels and aircraft" from the public safety criteria for launch.

Finally, ACTA recommended that § 417.107(b)(3) and (4) state that "a launch operator must make reasonable effort to ensure that the probability of casualty to members of the public on

water borne vessels or in aircraft does not exceed the limit specified in [§ 417.107(b)(2)]." ACTA stated that this revision would establish a "specific risk value" while at the same time giving operators flexibility as to "the method of protection" or risk mitigation. The regulations already allow a launch operator to employ different methods of mitigating risk so the FAA will not adopt ACTA's proposal.

#### *E. Including Toxic Release in the Reentry Risk Analysis*

The FAA proposed to include the risks associated with toxic release in the  $E_c$  limitations for the reentry of an RLV or other reentry vehicle. Blue Origin opposed the proposal to include toxic release in the reentry risk calculation. Blue Origin, quoting from the regulatory evaluation in the 2014 NPRM, stated that "toxic release risks for reentry vehicles are 'expected to remain a minor factor in  $E_c$  calculations,' because most of the propellant will have been used during the mission . . ." The FAA is revising its position, and disagrees with Blue Origin's assertion, because the FAA is aware of plans that involve the return to land with a significant hypergolic, highly toxic, propellant load carried until touchdown. The FAA therefore continues to include toxic release in the reentry risk analysis at this time.

#### *F. Miscellaneous*

Sierra Nevada recommended that the FAA define orbital insertion to help "reduce misinterpretation of the regulations" because "[s]etting a specific boundary would allow commercial space companies to clearly understand the boundaries for expected casualty limits."

The FAA agrees with Sierra Nevada's comments that § 417.107(b)(1) can be amended to prevent potential misinterpretation.<sup>18</sup> The FAA takes this opportunity to clarify that risk associated with planned impacts after orbital insertion should not be included in an  $E_c$  analysis governed by § 417.107. Accordingly, to minimize confusion, the FAA is removing the phrase "including each planned impact" from § 417.107(b)(1) to state only that the operator account for risk through orbital insertion. The risk assessment conducted under § 417.107(b)(1) must

<sup>18</sup> The FAA notes that its 2014 waiver for the Orion Exploration Test Flight 1, which authorized an  $E_c$  of up to  $218 \times 10^{-6}$ , improperly accounted for public risks outside the scope of § 417.107(b)(1) by considering public risk associated with planned impacts after orbital insertion in the  $E_c$  calculation. *Notice of Waiver*, Mar. 10, 2014 (79 FR 13375); *Notice of Amended Waiver*, Dec. 5, 2014, (79 FR 72240).

only include impacts through—meaning up to and including—the moment of orbital insertion. More specifically,  $E_c$  encompasses risks associated with planned events occurring from launch through the moment of orbital insertion, but not the risks associated with on-orbit activities. For example, the § 417.107 risk analysis must include the planned impact of a first stage jettisoned prior to orbital insertion regardless of whether the actual impact of the first stage occurs before or after orbital insertion.<sup>19</sup> This is true whether the first stage makes a controlled or uncontrolled impact. In contrast, the § 417.107 risk analysis does not require accounting for the planned impact of an upper stage jettisoned after the vehicle has achieved orbital insertion.

An individual commenter observed that the 2014 NPRM proposed to revise the  $E_c$  requirements in parts 417, 431, and 435, but neglected to revise the corresponding  $E_c$  requirements in part 420, *License to Operate a Launch Site*. This was an oversight. This final rule revises §§ 420.19(a)(1); 420.23(a)(2), (b)(3), and (c)(1)(ii); 420.25(b); 431.43(d)(2); paragraph (d) of Appendix C to part 420; and paragraphs (a)(5), (e)(2), and (e)(3) of Appendix D to part 420 to account for the  $E_c$  revisions made throughout chapter III of title 14 of the Code of Federal Regulations.

Previously, § 417.107(b)(2) referenced  $E_c$  when describing the risk limit to any individual member of the public. This reference may cause confusion because  $E_c$  is a measure of collective risk to public safety, not individual risk. To prevent any potential confusion, this final rule makes a non-substantive change to § 417.107(b)(2) to remove the reference to  $E_c$ .

The FAA is streamlining the terminology in the collective risk requirements. Specifically, we are removing the colloquial term “average” from “expected average,” which is redundant and unnecessary. In statistics there are three measures of central tendency or “averages”: The median, mode, and mean. The expected value is synonymous with the mean value specifically, thus the term “expected” is technically precise and sufficient.

#### G. Differences Between the 2014 NPRM and the Final Rule

As described above, there are two differences between the FAA’s proposal in the 2014 NPRM and this final rule as adopted. These changes include: (1)

removing the phrase “including each planned impact” from § 417.107(b)(1) and (2) revising part 420 to account for revisions to the  $E_c$  standard in parts 417, 431, and 435.

#### 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 (Pub. L. 96–354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Pub. L. 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 (Pub. L. 104–4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of 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 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 final rule.

In conducting these analyses, the FAA has determined that this final rule: (1) Has net benefits that justify the 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) will not have a significant economic impact on a substantial number of small entities; (5) will not create unnecessary obstacles to the foreign commerce of the United States; and (6) will 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 final rule does not warrant a full evaluation, this order permits that a statement to that effect and the basis for

it to 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 final rule. Based on the facts and methodology explained for the NPRM, the FAA provided cost-savings estimates for the proposed rule and requested comments. The FAA did not receive any comments on the estimates and thus the FAA follows the same approach herein. These analyses are summarized below.

##### Parties Potentially Affected by This Rulemaking

- Satellite 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<sup>20</sup> by GRA, Incorporated)
- FAA Office of Commercial Space Transportation forecast of suborbital launches using subject experts’ judgments
- All monetary values are expressed in 2014 dollars
- Projected impacts for a 10-year period from 2016 to 2025

##### Cost-Benefit Analysis

The FAA issued a notice of proposed rulemaking (NPRM) to amend 14 CFR parts 417, 431, and 435 by changing the collective risk limits for launches and reentries and clarifying the risk limit used to establish hazard areas for ships and aircraft. The NPRM was published in the **Federal Register** on July 21, 2014 (79 FR 42241).

Prior to this final rule, the FAA prohibited 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  $30 \times 10^{-6}$  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  $90 \times 10^{-6}$ . However, launches were not subject only to this single aggregate  $E_c$  limit. If there was a reentry using a reentry vehicle, an additional regulatory provision became applicable that prohibited the combined  $E_c$  of the launch and reentry from exceeding  $30 \times$

<sup>19</sup> For example, the return to Earth and successful landing of the first stage of SpaceX’s Falcon 9 launch vehicle was considered part of launch and was accounted for in the calculation of launch risk.

<sup>20</sup> GRA study can be found in the docket.



$10^{-6}$  for vehicle or vehicle debris impact hazards.<sup>21</sup>

Under this final rule, the FAA separates its expected casualties ( $E_c$ ) for launches and reentries. The final rule adopts an aggregate  $E_c$  requirement for a launch not to exceed  $1 \times 10^{-4}$  posed by the following hazards: (1) Impacting inert and explosive debris, (2) toxic release, and (3) far field blast overpressure. The FAA also finalizes a separate aggregate  $E_c$  requirement for a reentry not to exceed  $1 \times 10^{-4}$  posed by the hazards of debris and toxic release.

An  $E_c$  value of  $1 \times 10^{-4}$  mathematically equals  $100 \times 10^{-6}$ , which is the  $E_c$  value currently used on federal ranges for civil and military launch and reentry missions. However, because the aggregate  $E_c$  limit uses only one significant digit in the format of  $1 \times 10^{-4}$ , this final rule, in practice, allows a commercial launch or reentry with an aggregate  $E_c$  limit up to  $149 \times 10^{-6}$  to proceed without requiring the applicant to seek an FAA waiver.

Based on analysis of the historical data, the FAA found the criteria are supported by the commercial mission experiences and post-mission safety data available since 1989. The FAA's launch data indicate during this time there were 45 suborbital launches and 193 orbital launches, for a total of 238 launches.<sup>22</sup> At least four of these launches used an  $E_c$  that was allowed to go above the existing  $30 \times 10^{-6}$   $E_c$  limits. None of those four launches resulted in any casualties or other adverse impacts on the public safety.

As discussed in the preamble above, the FAA believes managing the precision of rounding digits below and above the  $E_c$  limit (*i.e.*,  $1 \times 10^{-4}$ ) is unrealistic and unnecessary for administering launch or reentry licenses. By using only one significant digit, the  $E_c$  limit for launches become less restrictive than the three existing launch  $E_c$  limits combined (*i.e.*,  $90 \times 10^{-6}$ ). The regulatory-compliance difference between  $90 \times 10^{-6}$  and  $149 \times 10^{-6}$  falls under the accepted FAA commercial launch 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 will improve efficiency to 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 will further increase efficiency. As a result, the FAA believes the final rule maintains a level of safety for commercial launches commensurate with the current level of safety associated with civil and military counterparts, but will be cost-relieving by eliminating some waiver processes necessary prior to this rule.

The criteria 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 current practice. Based on past practices of administering reentry licenses, the FAA found it was unrealistic and unnecessary to administer reentry licenses with a strict  $E_c$  limit of  $30 \times 10^{-6}$  for the combination of launch and reentry debris hazards. Aggregating  $E_c$  limits of toxic release and inert and explosive debris risks, the  $E_c$  limit for reentry will be commensurate with the safety requirements applied to civil and military reentries, and more conservative than past federal ranges' practices that gave waivers to allow non-commercial reentry missions to proceed with  $E_c$  risks on the order of  $1 \times 10^{-3}$ .

The final rule revises reentry  $E_c$  limits for toxic release and inert and explosive debris risks to be close to the current FAA 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 in this rule will impose no or minimal societal costs. This is because 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  $100 \times 10^{-6}$   $E_c$  limits imposed by the federal ranges. The FAA has issued waivers to 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  $30 \times 10^{-6}$   $E_c$  limit on reentry, the FAA expects that its launch waiver analysis will apply equally to future reentry operations. Consequently, the FAA anticipates that many of the future reentry operations would be eligible for an FAA waiver in the absence of this rule. Therefore, this rule will eliminate

extra expenses of processing such waivers.

The FAA finalizes the NPRM's proposal to include the risks associated with toxic release in the  $E_c$  limitations for the reentry of a reentry vehicle. By including toxic release risks during a reentry operation, the final rule provides an incremental margin of safety to the public that did not exist prior to this final rule.

The propellant load for a reentry vehicle using parachutes to land is generally minimal because most of the propellant will have been used before landing. The  $E_c$  risk for reentry vehicles landing in the ocean will likely be below the collective  $E_c$  limit. Toxic release risks for reentry will remain a minor factor in  $E_c$  calculations until a licensee plans to land a reentry vehicle on the ground, under power, using highly toxic hypergolic propellants carried all the way to touchdown. Currently, toxic release risk during launch generally exceeds an  $E_c$  of  $1 \times 10^{-4}$  when a reentry vehicle with hypergolic propellants on board has to separate from its launch vehicle during an abort-to-orbit, forcing an unplanned landing on land. Hence, a reentry vehicle planning to land on the ground in such an abort-to-orbit scenario will not get a government launch license under current U.S. Air Force regulations. The FAA has not received applications for reentry vehicles that are capable of landing on land without substantial risks of releasing hypergolic propellants, although the FAA learned through conversations with the U.S. Air Force that the industry is in the early planning stage of developing this type of vehicle. However, if a reentry risk analysis found the reentry vehicle imposed a substantial toxic release risk to a launch site or outside of the hazard area, the reentry operator is required under proposed regulation to choose an alternative landing site to ensure any potential toxic release does not exceed the collective  $E_c$  of  $1 \times 10^{-4}$ . Because operators were required to do a reentry risk analysis prior to this final rule, there will be no additional compliance costs resulting from this final rule. The necessary reentry risk analysis required for toxics only by this final rule can be done within 3 weeks of time by 1.5 analysts being paid at \$35 per hour for the total of \$6,300 per study. The FAA considers this analysis cost to be minimal.

The changes in the risk limits apply to all three hazards combined rather than to each individual hazard. This final rule permits launch or reentry operations without requiring operators to seek FAA waivers as long as the

<sup>21</sup> 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.

<sup>22</sup> 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](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.



aggregated risks will not exceed 0.0001 expected casualties per launch or reentry mission (*i.e.*,  $1 \times 10^{-4}$ ). Both the commercial space transportation industry and the government will receive savings attributable to less paperwork by avoiding some waiver-application process expenses.

Based on historical records of requests and FAA-issued waivers from the previous  $E_c$  limits, the FAA estimates that launch operators would seek additional 38 waivers from 2016 to 2025 in the absence of this rule.<sup>23</sup> After the promulgation of this final rule, the FAA expects these 38 waivers will not be needed. Thus, this final rule will result in savings for both the industry and the FAA, as the industry does not have to expend resources to request waivers and the FAA will not have to expend resources to evaluate waiver requests.

The methodology of this final regulatory impact analysis (RIA) mirrors the RIA associated with the NPRM. The cost of a formal waiver request to industry ranges from \$137,097 for 1,717 hours to \$195,094 for 2,443 hours of aerospace engineering time to prepare and submit the necessary documentation to the FAA for approval.<sup>24</sup> Multiplying the forecasted 38 waivers for the 10-year period by the lower and upper bound costs yields cost savings ranging from \$5.2 million to \$7.4 million. The estimates for the FAA's cost savings are based on the costs of FAA personnel time ranging from \$81,231 for 1,040 hours to \$243,693 for 3,120 hours<sup>25</sup> 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 \$3.1 million to \$9.3 million. The resulting savings for both the industry and the FAA with an estimated mid-point will be approximately \$12.5 million (\$8.8 million present value at a 7% discount rate). The lower and the higher estimates are approximately \$8.3 million and \$16.7 million (\$5.8 million and \$11.7 million present value at a 7% discount rate), respectively.

The final 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 sought comments on cost-savings in the NPRM and did not receive comments on the estimated benefits of reduced launch delays and mission scrubs. Therefore, the FAA maintains the same benefit determination.

In summary, the final rule maintains safety levels for commercial space transportation commensurate with the current requirements applied to launches and reentries. In addition, the final rule will result in net benefits for both industry and government. The net benefit will be achieved by avoiding costs pertaining to applying and granting waivers with  $E_c$  limits between  $90 \times 10^{-6}$  and  $149 \times 10^{-6}$ . Further, related industries may also benefit by averting unnecessary mission delays and scrubs.

#### *B. Regulatory Flexibility Determination*

The Regulatory Flexibility Act of 1980 (Pub. L. 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 will benefit from this final rule because the regulatory revisions to the collective  $E_c$  limits are cost-relieving. The FAA solicited comments in the NPRM and did not receive comments with regard to this certification. Therefore, the FAA Administrator certifies that this rule does not have a significant economic

impact on a substantial number of small entities.

#### *C. International Trade Impact Assessment*

The Trade Agreements Act of 1979 (Pub. L. 96–39), as amended by the Uruguay Round Agreements Act (Pub. L. 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 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 assesses the potential effect of this final rule and thus determines that the rule does not impose obstacles to foreign commerce, as foreign exporters do 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 (Pub. L. 104–4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a final 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 \$155 million in lieu of \$100 million. This final 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 is no new requirement for information collection associated with this final rule.

#### *F. International Compatibility and Cooperation*

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to conform to International Civil Aviation

<sup>23</sup> GRA Study 2013, Table 5–7.

<sup>24</sup> Basis is provided in GRA Study 2013, Appendix C, Table C–3.

<sup>25</sup> GRA Study 2013, Appendix C, Tables C–1 and C–2 for the basis of this value.

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.

## V. Executive Order Determinations

### A. Executive Order 13132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. The agency determined that this action will 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, does not have Federalism implications.

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

The FAA analyzed this final 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 is not a "significant energy action" under the executive order and it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

## VI. How To Obtain Additional Information

### A. Rulemaking Documents

An electronic copy of a rulemaking document may be obtained by using the Internet—

1. Search the Federal eRulemaking Portal (<http://www.regulations.gov>);
2. Visit the FAA's Regulations and Policies Web page at [http://www.faa.gov/regulations\\_policies/](http://www.faa.gov/regulations_policies/) or
3. Access the Government Publishing Office's Web page at <http://www.gpo.gov/fdsys/>.

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

### B. Comments Submitted to the Docket

Comments received may be viewed by going to <http://www.regulations.gov> and following the online instructions to search the docket number for this action. Anyone is able to search the electronic form of all comments received into any of the FAA's dockets by the name of the individual

submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.).

### C. Small Business Regulatory Enforcement Fairness Act

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires the FAA to comply with small entity requests for information or advice about compliance with statutes and regulations within its jurisdiction. A small entity with questions regarding this document, may contact its local FAA official, or the person listed under the **FOR FURTHER INFORMATION CONTACT** heading at the beginning of the preamble. To find out more about SBREFA on the Internet, visit [http://www.faa.gov/regulations\\_policies/rulemaking/sbre\\_act/](http://www.faa.gov/regulations_policies/rulemaking/sbre_act/).

## List of Subjects

### 14 CFR Part 417

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

### 14 CFR Part 420

Environmental protection, Launch safety, Reporting and recordkeeping requirements, 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 Amendment

In consideration of the foregoing, the Federal Aviation Administration amends 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) through (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 number of  $1 \times 10^{-4}$  casualties. 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 for an orbital launch, and through final impact for a suborbital launch.

(2) A launch operator may initiate flight only if the risk to any individual member of the public does not exceed a casualty expectation of  $1 \times 10^{-6}$  per launch for each hazard.

(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  $1 \times 10^{-5}$ .

(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  $1 \times 10^{-6}$ .

\* \* \* \* \*

## PART 420—LICENSE TO OPERATE A LAUNCH SITE

- 3. The authority citation for part 420 continues to read as follows:

**Authority:** 51 U.S.C. 50901–50923.

- 4. In § 420.19, revise paragraph (a)(1) to read as follows:

### § 420.19 Launch site location review—general.

(a) \* \* \*

(1) A safe launch must possess a risk level estimated, in accordance with the requirements of this part, not to exceed an expected number of  $1 \times 10^{-4}$  casualties ( $E_c$ ) to the collective members of the public exposed to hazards from the flight.

\* \* \* \* \*

- 5. In § 420.23, revise paragraphs (a)(2), (b)(3), and (c)(1)(ii) to read as follows:

### § 420.23 Launch site location review—flight corridor.

(a) \* \* \*

(2) Includes an overflight exclusion zone where the public risk criteria of  $1 \times 10^{-4}$  would be exceeded if one person were present in the open; and

\* \* \* \* \*

(b) \* \* \*

(3) Includes an overflight exclusion zone where the public risk criteria of  $1 \times 10^{-4}$  would be exceeded if one person were present in the open; and

\* \* \* \* \*

(c) \* \* \*

(1) \* \* \*

(ii) An overflight exclusion zone where the public risk criteria of  $1 \times$

$10^{-4}$  would be exceeded if one person were present in the open.

\* \* \* \* \*

■ 6. In § 420.25, revise paragraph (b) to read as follows:

**§ 420.25 Launch site location review—risk analysis.**

\* \* \* \* \*

(b) For licensed launches, the FAA will not approve the location of the proposed launch point if the estimated expected casualty exceeds  $1 \times 10^{-4}$ .

■ 7. In Appendix C to part 420, revise paragraphs (a)(2) and (d)(1) and (2) to read as follows:

**Appendix C to Part 420—Risk Analysis**

(a) \* \* \*

(2) An applicant shall perform a risk analysis when a populated area is located within a flight corridor defined by either appendix A or appendix B. If the estimated expected casualty exceeds  $1 \times 10^{-4}$ , an applicant may either modify its proposal, or if the flight corridor used was generated by the appendix A method, use the appendix B method to narrow the flight corridor and then redo the overflight risk analysis pursuant to this appendix. If the estimated expected casualty still exceeds  $1 \times 10^{-4}$ , the FAA will not approve the location of the proposed launch point.

\* \* \* \* \*

(d) \* \* \*

(1) If the estimated expected casualty does not exceed  $1 \times 10^{-4}$ , the FAA will approve the launch site location.

(2) If the estimated expected casualty exceeds  $1 \times 10^{-4}$ , then an applicant may either modify its proposal, or, if the flight corridor used was generated by the appendix A method, use the appendix B method to narrow the flight corridor and then perform another appendix C risk analysis.

■ 8. In Appendix D to part 420, revise paragraphs (a)(5) and (e)(2) and (3) to read as follows:

**Appendix D to Part 420—Impact Dispersion Areas and Casualty Expectancy Estimate for an Unguided Suborbital Launch Vehicle**

(a) \* \* \*

(5) If the estimated  $E_c$  is less than or equal to  $1 \times 10^{-4}$ , the FAA will approve the launch point for unguided suborbital launch vehicles. If the estimated  $E_c$  exceeds  $1 \times 10^{-4}$ , the proposed launch point will fail the launch site location review.

\* \* \* \* \*

(e) \* \* \*

(2) If the estimated expected casualty does not exceed  $1 \times 10^{-4}$ , the FAA will approve the launch point.

(3) If the estimated expected casualty exceeds  $1 \times 10^{-4}$ , then an applicant may modify its proposal and then repeat the impact risk analysis in accordance with this appendix D. If no set of impact dispersion areas exist which satisfy the FAA's risk

threshold, the applicant's proposed launch site will fail the launch site location review.

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

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

**Authority:** 51 U.S.C. 50901–50923.

■ 10. 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 number of  $1 \times 10^{-4}$  casualties from impacting inert and explosive debris and toxic release associated with the reentry; and

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

\* \* \* \* \*

■ 11. In § 431.43, revise paragraph (d)(2) to read as follows:

\* \* \* \* \*

(d) \* \* \*

(2) The expected number of casualties to members of the public does not exceed  $1 \times 10^{-4}$  given a probability of vehicle failure equal to 1 (pf=1) at any time the IIP is over a populated area;

\* \* \* \* \*

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

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

**Authority:** 51 U.S.C. 50901–50923.

■ 13. 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 number of  $1 \times 10^{-4}$  casualties from impacting inert and explosive debris and toxic release associated with the reentry; and

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

Issued under authority provided by 49 U.S.C. 106(f), and 51 U.S.C. 50903, 50905 in Washington, DC, on July 11, 2016.

**Michael P. Huerta,**

*Administrator.*

[FR Doc. 2016–17083 Filed 7–19–16; 8:45 am]

**BILLING CODE 4910–13–P**

**DEPARTMENT OF HOMELAND SECURITY**

**Coast Guard**

**33 CFR Part 165**

[Docket Number USCG–2016–0650]

**RIN 1625–AA00**

**Safety Zone; Houma Navigation Canal Miles 23 to 23.5, Dulac, LA**

**AGENCY:** Coast Guard, DHS.

**ACTION:** Temporary final rule.

**SUMMARY:** The Coast Guard is establishing a temporary safety zone for all navigable waters surface to bottom, of the Houma Navigation Canal from mile marker 23 to 23.5. The safety zone is needed to protect personnel, vessels, and the marine environment from potential hazards created by replacement work of the Falgout Canal Pontoon Bridge. Entry of vessels or persons into this zone is prohibited unless specifically authorized by the Captain of the Port Morgan City or a designated representative.

**DATES:** This rule is effective without actual notice from 7:00 a.m. until 7:00 p.m. daily from July 20, 2016 through July 27, 2016. For the purposes of enforcement, actual notice will be used from 7:00 a.m. until 7:00 p.m. daily from July 7, 2016 through July 20, 2016.

**ADDRESSES:** To view documents mentioned in this preamble as being available in the docket, go to <http://www.regulations.gov>, type USCG–2016–0650 in the “SEARCH” box and click “SEARCH.” Click on Open Docket Folder on the line associated with this rule.

**FOR FURTHER INFORMATION CONTACT:** If you have questions on this rule, contact MSTC Justin Helton, Marine Safety Unit Houma, U.S. Coast Guard; telephone 985–850–6457, email [Justin.K.Helton@uscg.mil](mailto:Justin.K.Helton@uscg.mil).