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FAA-00-7953-24

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 413, 415, and 417

[Docket No. FAA-2000-7953; Notice No. 02-12] 7/16/02

RIN 2120-AG37

Licensing and Safety Requirements for Launch

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Supplemental notice of proposed rulemaking (SNPRM).

SUMMARY: The Federal Aviation Administration (FAA) is amending an earlier proposal to amend the commercial space transportation regulations governing licensing and safety requirements for launch. The FAA takes this action to propose certain changes, respond to comments on the earlier proposal, and clarify assumptions underlying the costs analysis associated with the original proposal. The intended effect of this action is to allay commenters' concerns that the costs of launching from a federal launch range will increase as a result of this rulemaking.

October 28, 2002 BF 7/16/02

DATES: Send your comments on or before [INSERT DATE ~~60~~ 90 DAYS AFTER DATE of PUBLICATION IN THE FEDERAL REGISTER]. The FAA will host a public meeting in Washington, D.C. at 800 Independence Avenue, SW on ~~[INSERT DATE THREE WEEKS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]~~ September 6, 2002 BF 7/16/02 from 8:30 a.m. to 4:00 p.m.

Pub 7-30-02 Part III

 7-24-02

ADDRESSES: Address your comments to the Docket Management System, U.S. Department of Transportation, Room Plaza 401, 400 Seventh Street, SW, Washington, DC 20590-0001. You may also submit and review comments through the Internet at http://dms.dot.gov.

FOR FURTHER INFORMATION CONTACT: For technical information: Michael Dook, (202) 385-4707. For legal information: Laura Montgomery, (202) 267-3150. If you would like to present a statement at the public meeting, or if you have questions about the logistics of the meeting, contact Brenda Parker, (202) 385-4713 before ~~August 9, 2002~~ August 23, 2002.

SUPPLEMENTARY INFORMATION:

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I. Comments Invited

You may participate in this rulemaking by submitting written data, views, or arguments. We also invite comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this document. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket number and be submitted in duplicate to the DOT Rules Docket address specified above.

You may also present comments at the public meeting. The FAA will prepare an agenda of speakers, which will be available at the meeting. If we receive your request after the date specified above, your name may not appear on the written agenda. To accommodate as many speakers as possible, the amount of time allocated to each speaker may be less than the amount of time requested. Persons requiring audiovisual equipment should notify the FAA when requesting to be placed on the agenda.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking, will be filed in the docket. You may review the public docket containing comments to these proposed regulations in person in the Dockets Office between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. The DOT Rules Dockets Office is on the plaza level of the NASSIF Building at the Department of Transportation at the above address. We will consider all comments received on or before the closing date before taking action on this proposed rulemaking. Late-filed comments will be considered to the extent practicable, and consistent with statutory deadlines. The proposals in this document may be changed in light of the comments received.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this document must include a pre-addressed, stamped postcard with those comments on which the following statement is made: "Comments to Docket No. FAA-2000-7953." The postcard will be date stamped and mailed to the commenter.

Public Meeting Procedures

The FAA will present a description of the SNPRM at the public meeting. The FAA will use the following procedures to facilitate the meeting:

(1) The meeting is designed to give interested parties an overview of the contents of the SNPRM to facilitate the public comment process. Therefore, the meeting will be informal and non-adversarial. No individual will be subject to cross-examination by any other participant; however, FAA representatives may ask questions to clarify a statement and to ensure a complete and accurate record. Participants will also have the opportunity to ask questions about the SNPRM.

(2) There will be no admission fee or other charge to attend or to participate in the meeting. The meeting will be open to all persons who are scheduled to present statements or who register between 8:30 a.m. and 9 a.m. on the day of the meeting. While we will make every effort to accommodate all persons wishing to participate, admission will be subject to availability of space in the meeting room. The meeting may adjourn early if scheduled speakers complete their statements in less time than is scheduled for the meeting.

(3) Speakers may be limited to a 10-minute statement. If possible, we will notify speakers if additional time is available.

(4) We will try to accommodate all speakers. If the available time does not permit this, we will generally schedule speakers on a first-come-first-served basis. However, we reserve the right to exclude some speakers if necessary to present a balance of viewpoints and issues.

(5) Sign and oral interpretation can be available at the meeting, as well as an assistive listening device, if requested at least 10 calendar days before the meeting.

(6) Representatives of the FAA will chair the meeting. A panel of FAA personnel involved in this proposal will be present.

(7) We will make a transcript of the meeting using a court reporter. We will include in the public docket a transcript of the meeting and any material accepted by the FAA representatives during the meeting. Any person who is interested in buying a copy of the transcript should contact the court reporter directly. Additional transcript purchase information will be available at the meeting.

(8) The FAA will review and consider all material presented by participants at the meeting. Position papers or material presenting views or arguments related to the SNPRM may be accepted at the discretion of the presiding officer and subsequently placed in the public docket. We request that persons participating in the meeting provide six copies of all materials presented for distribution to the FAA representatives. You may provide other copies to the audience at your discretion.

(9) Statements made by FAA representatives are intended to facilitate discussion of the issues or to clarify issues. Any statement made during the meeting by an FAA representative is not intended to be, and should not be construed as, an official position of the FAA.

Availability of SNPRM

You can get an electronic copy of this SNPRM using the Internet through the FAA's web page at http://www.faa.gov/avr/arm/nprm/nprm.htm or the Government Printing Office's web page at http://www.access.gpo.gov/su_docs/aces/aces140.html.

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the amendment number or docket number of this SNPRM.

II. Background

Under existing regulations, the FAA evaluates, on an individual basis, a launch operator seeking an FAA license to launch from a non-federal launch site. A non-federal launch site is not located at a federal launch range. We issue a safety approval when we determine that the launch demonstrates an equivalent level of safety to that provided by a launch from a federal launch range. See 14 CFR part 415, subpart F for more details. For a licensed launch operator launching from a federal launch range, 14 CFR part 415, subpart C applies. For launch from a federal launch range, the FAA issues a safety approval if an applicant satisfies subpart C and has contracted with a federal launch range for safety-related launch services and property whose provision and use are within the experience of the federal launch range. 14 CFR 415.31.

On October 25, 2000, the FAA proposed licensing and safety requirements for the conduct of a launch. Licensing and Safety Requirements for Launch; Notice of Proposed Rulemaking, 65 FR 63921 (Oct. 25, 2000) ("October 2000 NPRM" or "NPRM"). The FAA proposed requirements for obtaining a license for a launch from a non-federal launch site. The proposed requirements for obtaining a license would not, however, apply to any launch from a non-federal launch site where a federal launch range performed the safety functions. For this type of launch, the licensing requirements of 14 CFR part 415, subpart C apply. The FAA proposes no revisions to subpart C of part 415.

The October 2000 NPRM also proposed to codify the safety requirements that a launch operator must satisfy to protect the public from the hazards of launch. The safety requirements would apply to all licensed launches of expendable launch vehicles, whether from a federal launch range or a non-federal launch site.

The FAA received comments to the original proposal on April 23, 2001.[1] Comments on the October 2000 NPRM generally fall into three categories: comments that caused the FAA to propose changes to the NPRM here; comments that did not cause changes, but did cause the FAA to address commenters' concerns in this preamble; and comments that the FAA is still considering and will address in the final rule. The next two sections of this preamble address the first two categories of comments. Interested readers should also see the section-by-section analysis portion later in this preamble for a description of the specific changes. The changes to the October 2000 NPRM proposed in this SNPRM include addressing how and when the proposed regulations would apply to pre-existing launch systems, changes to the measure of acceptable risk, and changes to the debris thresholds that would be used in flight safety analysis. The FAA is, through this supplemental notice of proposed rulemaking ("SNPRM"), also revising and reorganizing its proposed regulations regarding flight safety analysis. The FAA is still

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[1] Aircraft Owners and Pilots Association, Apr. 13, 2001; The Boeing Company, Int'l Launch Services, Lockheed Martin Corporation, Orbital Sciences Corporation, and Sea Launch Company (the "Joint Commenters") in Consolidated Industry Response to FAA NPRM, Licensing and Safety Requirements for Launch, October 25, 2000, Vol.s 1 and 2 (Apr. 23, 2000) ("JC Vol. I" and "JC Vol. II"); Comments, Hugh Q. Cook, (Mar. 13, 2001); Comments to Licensing and Safety Requirements for Launch: Notice of Proposed Rulemaking October 25, 2000, Kistler Aerospace Corporation, (Apr. 23, 2001); Letter from Tom Marsh, Lockheed Martin Corporation, (Apr. 6, 2001); Comments on DOT NPRM Licensing and Safety Requirements for Launch, Docket No. FAA-2000-7953, Lou Gomez, NMOSC (undated); Orbital Sciences Corporation (Apr. 23, 2001); Sea Launch Company, L.L.C (Apr. 20, 2001); XCOR Aerospace Comments in Response to FAA Notice of Proposed Rulemaking on Licensing and Safety Requirements for Launch (undated) ("XCOR Comments"). Under separate cover, a number of commenters filed cost impact assessments: Boeing Proprietary Cost Impact Analysis in Response to NPRM on Licensing and Safety Requirements (Docket No. FAA-2000-7953), (Apr. 20, 2001) ("Boeing Costs"); Lockheed Martin Cost Impact Analysis ("Lockheed Cost Estimates")(proprietary); Orbital NPRM Cost Impact Assessment, Orbital Sciences Corporation (Apr. 23, 2001)("Orbital Cost Impact Assessment")(proprietary);Sea Launch Company, L.L.C. (Apr. 20, 2001) ("Sea Launch Costs")(proprietary).

reviewing and considering the many technical comments and suggestions, which will be addressed in the final rule.

Since 1998[2], the FAA and the Air Force ranges have been working together to achieve common safety standards that may be universally applied to licensed and government launches. The FAA anticipates that for licensed launches that are conducted at federal launch ranges, the ranges will continue to implement these requirements. As explained in past rulemakings, the FAA conducts a baseline assessment of the adequacy of the federal launch ranges to determine whether the FAA may rely on the safety requirements of the ranges and on their implementation of those requirements.[3] The FAA's baseline assessments document the capabilities, safety program, standards and policies of each federal launch range. The FAA recognizes, of course, that the federal launch ranges of the Department of Defense and National Aeronautics and Space Administration have their own missions separate from the support of commercial or otherwise licensed launches. Accordingly, the FAA proposes to codify the ranges' safety requirements to fulfill, in part, the FAA's own responsibilities for safety. Codification identifies those requirements upon which the FAA relies for licensed launch operators to achieve safety, and, in the unlikely event that either of the ranges can no longer provide support on a non-interference

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[2] In recognition of the efforts of the FAA and the ranges to achieve common safety standards, an interagency working group led by the Office of Science and Technology Policy and the National Security Council of the White House recommended, among other things, that the FAA and the U.S. Air Force "continue their cooperative development of common safety requirements to be applied to government and commercial launches at federal and non-federal launch sites." White House Office of Science and Technology Policy and National Security Council, The Future Management and Use of the Space Launch Bases and Ranges, 38 (Feb. 8, 2000). At the same time, the working group recommended that the FAA and the U.S. Air Force formalize their respective responsibilities for the safety of space launches through a memorandum of agreement. Id. at 39. The report urged that the federal ranges retain current responsibilities for the safety of government activities, and retain safety of commercial flight activities at the Eastern and Western Ranges. On January 16, 2001, the FAA Administrator and the Assistant Secretary of the Air Force entered into a Memorandum of Agreement Between Department of the Air Force and Federal Aviation Administration on Safety for Space Transportation and Range Activities. A copy of the MOA is available on AST's web site (http://ast.faa.gov).

basis for commercial launch, ensures that a launch operator is informed of the safety requirements with which it must comply. Because the different ranges experience different meteorological, geographical and population environments, the ranges do not always implement their requirements in the same manner. The FAA attempted, in the NPRM, to identify the underlying intent shared by the ranges' safety requirements, and then presented those principles in the NPRM,[3] in a more generally applicable and abstract form, which may be unfamiliar to those accustomed to launching from a particular range.

III. Changes to October 2000 Proposal

A. Grandfathering

Although the proposed requirements are derived from existing range requirements, there are, for any number of different reasons, launch vehicles and launch operators who would not comply with the requirements as proposed in the NPRM. For example, in the NPRM, the FAA noted that there might be instances where the ranges had granted waivers to the requirements of Eastern and Western Range 127-1, Range Safety Requirements ("EWR 127-1"). NPRM, 65 FR 63941. Additionally, the FAA recognizes that there are launch operators operating under older versions of EWR 127-1 who would not meet current federal range standards or, therefore, the proposed FAA requirements. In the NPRM, the FAA noted that launch operators might experience cost impacts from bringing their operations into compliance with the proposed requirements, and requested comments on the FAA's plan not to "grandfather" such noncompliances.

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[3] See Commercial Space Transportation Licensing Regulations, 64 FR 19586, 19596-97 (Apr. 21, 1999).

The FAA received comments suggesting that, in addition to existing waivers, other candidates for grandfathering exist. JC Vol. I at 9. The comments noted that the ranges grandfather sub-systems on launch vehicles that become non-compliant when the ranges implement new safety requirements. Additionally, comments called the FAA's attention to the ranges' "tailoring" process, by which a range determines whether a launch operator's proposed alternative, although not compliant with the letter of the range requirements, nonetheless meets the intent behind the requirement. Commenters urged the FAA to accept existing tailoring agreements. For all these scenarios, including waivers, tailoring and existing range grandfathering arrangements, launch operators urged that the FAA "grandfather" current launch systems. Launch operators urged cost and range practice as the reasons for grandfathering. The FAA is considering adopting some of the suggestions contained in the comments to this rulemaking, but requests additional comment and information in light of the considerations discussed below.

1. Applicability and effective dates of requirements

Commenting launch operators requested that the FAA provide more detail regarding how and whether grandfathering would work. The FAA specifies an effective date for each rule promulgated. There are a number of options for determining an effective date. A rule might apply, for example, to all launches that took place after a certain date, regardless of when the launch vehicle was designed or built. Usually, for such a decision an agency would provide a fairly lengthy lead-time. Alternatively, a rule might apply to all launch vehicle components manufactured after a certain date. Again, a lengthy lead-time might be necessary to allow a licensee to incorporate any changes into its design and subsequently manufactured hardware.

Finally, in accordance with Department of Transportation and FAA usage, the FAA's proposed regulatory requirements will not employ the term "grandfather," but will, instead, describe how and when part 417 would or would not apply.

For a meets intent certification or noncompliance to qualify under the FAA's proposed version of grandfathering, the federal range approval of such relief from a safety requirement would have to exist as of the effective date of proposed part 417. The FAA intends to allow sufficient time between the issuance of the final rule and the date that part 417 would become effective for federal ranges to make decisions on pending requests for relief that might be in work at the time a final FAA rule is issued. For launches from Air Force ranges, the Air Force and the FAA intend to have the joint relief process, discussed in section IV.C of this supplemental notice, in place prior to the effective date of part 417. This will allow for a smooth transition from pre-existing Air Force relief approvals that would qualify for the FAA's proposed version of grandfathering, to the joint process that will be used to resolve future requests for relief from launch safety requirements.

2. Range approach to implementing new safety requirements

At the Air Force's launch ranges, EWR 127-1 governs. The Air Force's range safety organizations periodically update these requirements, and determine the extent to which those updates will affect existing launch vehicles and systems. Commenting launch operators noted that "the existence of such new requirements does not necessarily make an existing system unsafe or expose the public to greater safety risks." JC Vol. I at 9. EWR 127-1 recognizes this, and grandfathers and maintains the approvals of previously approved systems unless the Chief of Safety or the launch operator determines one of the following:

a. Existing programs make major modifications or include the use of currently approved components, systems, or subsystems in new application (through tailoring if desire[d]) Exception: Previously approved existing components, systems, or sub-systems that do not increase the risks, do not degrade safety, or can survive new environments [that] are equivalent to or lower [less severe] than the originally approved qualification levels shall be honored and do not have to meet new requirements [do not have to be upgraded] as long as data and analyses show that the criteria have been met.
b. The Range User has determined that it is economically and technically feasible to incorporate new requirements into the system.
c. The system has been or will be modified to the extent safety approvals no longer apply. NOTE: Risk and hazard analyses developed jointly by Range Safety and the Range User shall be used to determine applicability of the safety approvals.
d. A previously unforeseen or newly discovered safety hazard exists that is deemed by either Range Safety or the Range User to be significant enough to warrant the change.
e. The system does not meet the requirements existing when the system was originally accepted. NOTE: This category includes systems that were previously approved, but when obtaining the approval, the noncompliances to the original requirement were not identified.
f. A system or procedure is modified and a new requirement reveals that a significant risk exists.
g. Accident and incident investigations and reports may dictate compliance with the document.

EWR 127-1, Appendix 1C, 1C.1.4, 1-35 (Dec. 31, 1999).

As review of the above range exceptions shows, a host of possibilities may trigger a requirement for a launch operator to change its launch vehicle or systems to conform to the latest safety requirements. These possibilities may be divided into two general conditions: where a launch operator is implementing other changes to its launch vehicle, and where the safety considerations are so overriding that a change is required. Accordingly, although grandfathering may be automatic under the range regime, grandfathering is not unlimited.

The issue of grandfathering highlights how the Air Force has successfully dealt with the issue of providing for appropriate public safety while taking into consideration the issues of cost, schedule, and mission assurance. The FAA recognizes that there are parallels that can be drawn between the Air Force's approach to ensuring public safety, including the use of grandfathering, and the FAA's regulatory focus on ensuring public safety without placing undue burden on the launch industry. Since publishing the NPRM, the FAA has considered further the Air Force's approach to grandfathering and how the Air Force has successfully implemented its grandfathering policies to ensure public safety without placing undue burden on the launch industry. Upon the urging of the commenters, the FAA proposes to adopt a similar approach to determining when non-compliance with a particular requirement may be permitted to continue.

3. Applicability of proposed requirements to pre-existing range meets intent certifications

Under this SNPRM, proposed section 417.1(b) would permit a launch operator not to have to demonstrate an equivalent level of safety to the FAA for certain range "meets intent" determinations if the launch operator was licensed by the FAA and launched from a federal range. In the NPRM the FAA, while proposing not to grandfather noncompliances with the proposed requirements, was silent with respect to how it would treat meets intent certifications. This meant that all launch operators would be required to satisfy all the FAA's proposed launch safety requirements once those requirements went into effect. To satisfy a requirement, a launch operator would have to meet the requirement as stated in the FAA's proposed regulations or demonstrate that an alternative approach provided an equivalent level of safety. For existing launch vehicles operating from federal ranges, the federal range safety organizations have granted "meets intent certifications" for substitutes preferred by the launch operators to some of the current range safety requirements. Because the current federal range safety requirements provide the basis for the FAA's proposed requirements, any grant by a federal launch range of a meets intent certification creates the possibility that the launch operator would not necessarily comply in a literal sense with a proposed FAA requirement.

The federal ranges have granted meets intent certifications when they found that a launch operator's proposed approach, although literally non-compliant with a requirement, complied with the overall intent of the requirement. To obtain meets intent approval from a federal range, a launch operator's proposed substitute has to maintain an equivalent level of safety despite not meeting the exact requirement. EWR 127-1 at 1-vii (Dec. 31, 1999). For all intents and purposes, a range safety meets intent certification constitutes one form of the FAA's equivalent level of safety. Additionally, a federal range's tailoring of launch safety requirements for specific launch vehicle programs often includes meets intent certifications that apply to a launch vehicle program on a permanent basis.

The FAA now proposes through section 417.1(b) that a launch operator would not need to demonstrate an equivalent level of safety to the FAA for satisfying an FAA requirement for a licensed launch from a federal range, if two conditions were met. The first condition would be that the launch operator would have to have a license from the FAA to launch from the federal launch range and the license would have to be in effect as of the effective date of part 417. This is reasonable because, to date, through its baseline assessments, the FAA has relied on the federal range determinations that a particular substitute to a range requirement met the intent of that same requirement. In the context of meets intent certifications, the FAA sees no need to revisit or second-guess that past reliance. Under this SNPRM, the possessor of "meets intent certification" could continue to rely on the range's determination, where a future or different licensee could not. Additionally, even the same licensee would not be able to rely on a pre-existing meets intent certification for any other vehicle or application other than the one for which it was originally granted.

Thus, the second condition would be for the launch operator to have a written pre-existing "meets intent certification" for the requirement from the federal launch range from which the launch will take place, or a substitute that the same range approved during tailoring of the range safety requirements for that launch operator. This proposal is consistent with the ranges' own approach to "grandfathering." Under current practice, range grandfathering applies only at one launch site. See Appendix 1C, 1C.1.4 a (permitting grandfathering unless a currently approved component, system or subsystem is to be used in a "new application"). If a launch operator has launched a vehicle from one range and proposes to launch from a different range, the other range will review the substitution for acceptability.

Review due to a change in launch site is necessary because different conditions at different launch sites may dictate different decisions. If, for example, not performing an environmental test is acceptable at one range, different environments at a different launch site may require that the test be conducted. Environmental factors such as salt, fog and temperature may vary from site to site, as may the potential for extreme environments, such as earthquakes on the west coast and hurricanes on the east coast, thus changing the need for and requirements governing component testing. Similarly, with a change in trajectory profile brought about by launching from a different site, vibrations could occur at different times of flight. The ranges see a need to address and consider these changes and determine whether a substitution acceptable at one launch site is acceptable at another. The FAA agrees with this reasoning and proposes to maintain this practice.

Under this SNPRM, the "meets intent certification" would have to exist as of the effective date of part 417 and the duration of the "meets intent certification" would have to include the licensed launch in question. If a pre-existing meets intent certification did not apply to a future licensed launch, the launch operator would have to demonstrate an equivalent level of safety to the FAA. For example, the ranges have granted some launch operators meets intent certifications that allowed them to fly without a flight termination system on an upper stage of their launch vehicles. Such range approvals are highly dependent on launch specific conditions and do not necessarily apply outside of certain launch azimuths. The FAA recognizes, however, that even for a meets intent certification granted only for a specific launch there may be a possibility that the reasons that merited grant of a meets intent certification will apply again and the FAA will be able to find an equivalent level of safety. However, just as the ranges reserve the right to make that determination for a different set of circumstances, so, too, will the FAA. For future FAA-licensed launches from federal ranges, launch specific decisions such as these will be handled through a coordinated FAA and federal range review process as discussed in section IV.C of this SNPRM.

4. Pre-existing range waivers and non-compliances that satisfy range grandfathering practices

Under proposed section 417.1(b)(1) of this SNPRM, the FAA would not apply a requirement of proposed part 417 to a licensed launch if the launch operator is currently licensed by the FAA to launch from a federal range, and if the range has either previously approved a waiver for the requirement or if the noncompliance is in accordance with federal range "grandfathering" practices. Unlike a meets intent certification where a launch operator satisfies a requirement through an alternative that provides an equivalent level of safety, a launch operator at a federal range might not satisfy a current range safety requirement and, therefore, would not satisfy one of the FAA's proposed launch safety requirements. A federal range may have approved such non-compliances as specific waivers or the non-compliance may have resulted from the launch vehicle program being initiated under an earlier version of the range safety requirements and being subject to Air Force grandfathering policies.

In the NPRM the FAA proposed not to grandfather non-compliances, but requested public comments on the issue. Upon consideration of input from industry and the federal range safety organizations, the FAA now believes that it would be appropriate to provide a form of grandfathering that is nearly identical to the Air Force's grandfathering policy. The FAA's version of grandfathering, namely, partially limiting the reach of its requirements, would apply to federal range waivers and other noncompliances that have been grandfathered by a federal range. Since the NPRM was published, the FAA has considered further how grandfathering is implemented in current practice at the federal ranges, including recognizing that there is a degree of safety assurance that can be derived from the demonstrated flight history of an existing vehicle.

The FAA now proposes to permit, with some exceptions, that a requirement of this part would not apply to a licensed launch from a federal range, if certain conditions were met. These conditions would be the same as those the FAA is proposing for pre-existing meets intent certifications, as discussed above. The first condition would be that the launch operator would have to have a license from the FAA to launch from the federal launch range and the license would have to be in effect as of the effective date of proposed part 417. A launch operator who had a launch license on the day that part 417 became effective would satisfy this condition.

Although the possessor of the waiver will be able to rely on the range determination, a future or different licensee will not. Additionally, the same licensee would not be able to rely on a pre-existing waiver for any vehicle or application other than the one for which it was originally granted.

The second condition would be that the launch operator, as of the effective date of proposed part 417, had, for that requirement, a written waiver from the federal launch range, or a pre-existing noncompliance that satisfied the federal launch range grandfathering criteria. The FAA intends this provision to encompass noncompliances regardless of the avenue through which they arise. In the first instance, a range may grant a waiver. In the second, a range may have approved a launch vehicle or system under requirements in place some time previously. Although the range requirements may change, a launch operator is not always required to upgrade the launch vehicle or system as discussed above. This provision would apply to both forms of pre-existing non-compliance.

The condition that a range approval be in writing would apply to range waivers. See EWR 127-1 at 1-38, Appendix IC, IC.2.4 (describing required range approvals). For a launch vehicle that has been grandfathered, the range maintains a version of the range safety requirements that apply to the vehicle. These are the requirements that are "tailored for that vehicle." For any new safety requirement that the range determines must apply to an existing launch vehicle, the range will update the tailored set of range safety requirements.

Just as with the FAA's proposed approach to pre-existing meets intent certifications, the FAA would condition not applying a requirement for a licensed launch on an existing non-compliance being already approved for the licensed launch in question. If the range approval of a pre-existing non-compliance did not apply to a future licensed launch, the launch operator would have to meet the requirement as written or demonstrate an equivalent level of safety to the FAA and the Air Force in the joint relief process discussed in section IV.C of this notice. Because waivers are granted for situations where an equivalent level of safety is not achieved, the FAA considers it even more important than with pre-existing meets intent certifications that the FAA review the acceptability of a waiver when there are differences from the circumstances that warranted grant of the waiver in the first place. As with the meets intent certification, the FAA recognizes that the reasons for a waiver may exist again. However, just as the ranges reserve the right to make that determination for a different set of circumstances, so, too, will the FAA.

5. Limits to grandfathering

As discussed previously, range grandfathering is not necessarily guaranteed under current practice at the federal ranges. Depending on the criticality of an issue and, given time and opportunity, a federal launch range will strive to bring a launch operator's vehicle and operations into compliance with current safety requirements. Accordingly, the FAA proposes to codify that practice as well in proposed section 417.1(b)(2).

Like the ranges, even if the launch operator were to satisfy the conditions of proposed section 417.1(b)(1) for a specific requirement of proposed part 417, the FAA proposes that a launch operator must comply with proposed part 417, including by providing a demonstration of an equivalent level of safety, whenever the launch operator makes modifications that affect the launch vehicle's operation or safety characteristics. As with the Air Force's current practice, proposed § 417.1(b)(2) would require a launch operator to upgrade if the FAA or the launch operator determined that a previously unforeseen or newly discovered safety hazard existed that was a source of significant risk to public safety, or if a federal range previously accepted a component, system, or subsystem, but did not identify a noncompliance to an original federal range requirement. In the past, this meant that a launch operator making a major change to its launch vehicle had to upgrade the launch vehicle to satisfy current safety requirements. For example, modifications made to a launch vehicle to allow the use of strap-on solid rocket boosters where none were originally approved would be considered major modifications that could affect the vehicle's operation and safety characteristics. As a result, many aspects of the original flight termination system would have to be upgraded to comply with the most current requirements. This change would have the effect of codifying the federal launch ranges' current practice.

The FAA also proposes, as under current practice, that a launch operator bring its launch vehicle or launch into compliance with a requirement when it uses the launch vehicle or a component, system, or subsystem in a new application. A new application may include launching the vehicle from a new launch site or using a safety component on a different stage of the vehicle other than the stage for which it was originally approved.

6. Grandfathering of a launch vehicle program at an Air Force range

The FAA recognizes that the Air Force and licensed launch operators at Air Force ranges often consider a launch vehicle program as a whole grandfathered. The FAA's proposed grandfathering provisions would govern the applicability of individual safety requirements. As is current practice in implementing the Air Force's requirements, the FAA's proposed requirements may be applied to a launch vehicle program such that all aspects of the existing program are grandfathered without the need to upgrade to satisfy the safety requirements of proposed part 417. The Air Force and the FAA are involved in an extensive effort to identify and maintain common launch safety requirements through an interagency group consisting of both Air Force and FAA personnel, called the Common Standards Working Group.[4] The Common Standards Working Group worked to ensure that the FAA's proposed requirements are consistent with the Air Force's grandfathering requirements and can be implemented without duplication of effort. A launch vehicle program that is fully compliant with the Air Force's grandfathering requirements could be fully compliant under the FAA's proposed requirements. This would be possible in the event that all the non-compliances or meets intent certifications for a particular launch vehicle satisfied the FAA's proposed criteria.

B. Risk Limit for Each Hazard

1. Changes to NPRM proposal

In proposed section 417.107 of the NPRM, the FAA proposed to aggregate the risks attributable to all mission hazards and set a cap on the total mission risk of all hazards at an expected average casualty of 30×10^{-6}. The FAA received comments in opposition to this proposal from the public, and addressed the concerns with the other members of the Common Standards Working Group. The changes proposed here constitute the results of the consensus reached between the FAA and the U.S. Air Force through the Common Standards Working Group. In summary, the FAA, with the agreement of the U. S. Air Force, now proposes through this rulemaking to adopt the current practice at the 45th Space Wing and to set a cap on the risk presented by each hazard. Because of the differences in underlying assumptions and

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[4] The Common Standards Working Group consists of, in addition to FAA representatives, Air Force representatives from Air Force Space Command, the Air Force Space and Missile Center, Air Force Safety Center, safety personnel from both the Eastern and Western Ranges, and each of their contractors working in support of this joint effort.

methodologies for assessing the risk of each hazard, the FAA will not require or consider a limit on the total mission risk created by all the hazards of launch. For any given launch, the risk attributable to the whole mission tends to arise out of one hazard. Accordingly, as a general matter, the FAA still expects the aggregated risk of most launches to remain near an E_c of 30×10^{-6}.

In the NPRM, the FAA proposed to require that an aggregate of the hazards created by a particular launch not exceed an E_c of 30×10^{-6}. NPRM, 65 FR 63921, 63981 (proposed section 417.107(b)). This meant that a launch operator would have had to account for all hazards, including, but not limited to, the risks associated with debris, toxic releases and far field blast overpressure. The FAA proposed this limit after consultations with Air Force safety personnel at the 30th and 45th Space Wings. Both wings were receptive to this approach because it supported a theoretical goal of launch risk management, which is to quantify all hazards in a single, normalized risk measure. As noted in the NPRM, the 30th Space Wing found that one hazard typically served as the source of the risk attributable to a mission. NPRM, 65 FR 63921, 63936. Conditions that are conducive to driving up the risk associated with one hazard usually make another hazard less significant. Accordingly, representatives of the 30th Space Wing advised that launch availability would not be jeopardized at Vandenberg Air Force Base with a total mission risk cap of 30×10^{-6}. Thus, although the 30th Space Wing advised that it did not, in practice, set a ceiling for aggregate risk at 30×10^{-6}, launches from Vandenberg could meet the standard.

As discussed in the NPRM, the experience of the 45th Space Wing differed. The current practice of the Eastern Range, as described in the NPRM, was to cap two hazards, debris and far field blast overpressure, at an E_c of less than or equal to 30×10^{-6}. NPRM, 65 FR 63921, 63936.

Although the Eastern Range estimates that it accepts a risk at an E_c of 233×10^{-6} for the risk attributable to a launch's potential toxic releases, its analysis does not account for a variety of factors that may reduce risk but are difficult to quantify. A review of licensed launches between September 4, 1997, and August 23, 2000, shows that only two out of 39 licensed launches took place with an E_c for toxic releases in excess of 30×10^{-6}. Eastern Range Aggregate Risk Study, RTI Int'l (Oct. 2, 2001). One occurred on May 4, 1999, with an E_c for toxics of 57×10^{-6} for the launch of a Delta III. The other occurred on July 10, 1999, with an E_c for toxics of 114×10^{-6} for a Delta II launch vehicle. Because all indications pointed to the ability of Western Range launches to continue to satisfy an aggregated risk criteria, and because the Eastern Range stated that most of the higher toxic risk numbers applied only to federal government launches, such as the Shuttle and Titan vehicles[5], both ranges and the FAA agreed to propose the aggregated mission risk cap in the October 2000 NPRM.

The FAA received comments opposed to aggregating mission risk. Launch operators commenting on the October 2000 NPRM stated they expect the E_c values from downrange debris risk alone to be close to or surpass the 30×10^{-6} criteria with flight azimuths entailing African or European overflight. JC Vol. I at 8 (emphasis in original); accord Boeing Cost Impact at 2. The launch operators therefore believed that a single, collective E_c at the proposed level would restrict launch availability and cause launch delays, both of which increase launch costs.[6]

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[5] The Air Force advises the FAA that it will accommodate this discrepancy to the common standards through its own grandfathering or waiver process.

[6] The FAA would like to clarify a misunderstanding on the part of the launch operators commenting about how risk is calculated. In the Joint Comments, the launch operators argue that "[t]he fact is, that the actual public risk can only be realized at one given point in the launch timeline. If a launch vehicle is terminated during up-range flight, there is no threat to the down-range public. Conversely, by the time down-range public is potentially endangered, the up-range public is clear of risk." JC Vol. I at 9. Risk calculations must assess the risk for the entire launch. When making risk calculations to determine whether the public risk criterion is satisfied for a launch, risk is not calculated during the launch but before the flight takes place and accumulated for all stages of flight. The risk

In light of the concerns raised by launch operators, the FAA again revisited current practice at the ranges through consultations with the Common Standards Working Group. The working group explored in detail the philosophies and limits behind current risk assessment approaches and what was proposed in the NPRM. Air Force current requirements permit different aggregation practices. See EWR 127-1, 1-41, Appendix 1D, 1D.1b ("The overall risk levels may or may not be an additive value that includes risks resulting from debris, toxic and blast overpressure exposures." (Emphasis added))(cited in NPRM, 65 FR at 63936). The current practices at each of the two ranges remain as described in the NPRM. Results of the study conducted in 2001 indicated that there were only a few commercial launches in the past five years that would not have satisfied the aggregation criteria. Having explored a number of alternatives, the FAA now proposes to codify a less restrictive practice of not aggregating risks as proposed by the Common Standards Working Group.

Although the Common Standards Working Group agrees that a risk assessment that determines the total risk due to all hazards associated with a single launch would be an ideal approach, the group also agrees that there are a number of reasons not to codify such an approach at this time. The Common Standards Working group proposes separate risk criteria for each hazard because it is current practice for the 45th Space Wing, the range from which the majority of commercial launches take place, and because it reflects the disparate approaches to and abilities in modeling the risks of each hazard. Currently, the differences between the hazards create differences in how to measure the risks attributable to each of those hazards. A risk

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calculation must account for all stages of flight if it is to be used to determine whether flight should be initiated, which is the intended use of the public risk criterion. The mutual exclusivity of failure scenarios has long been recognized and appropriately accounted for in the risk analyses performed at the Air Force ranges. When calculating risk, one of the important variables, namely, the probability of the launch vehicle's failure (Pf), is measure accounts for a number of things, including the probability of the undesired event occurring (usually related to the launch vehicle's probability of failure), the characteristics of the hazard, and the characteristics of any exposed populations. At this most general level, both ranges assess risk to account for each of these factors. When it comes to addressing each hazard, however, differences arise. Although the models of the two Air Force ranges tend to account for similar factors, the input to those models differs at each coast.

Because the FAA and the Air Force intend for their methodologies to account for the same factors, such as serious injury, population and the like, the Common Standards Working Group had to review the current practice underlying the risk assessment for each hazard. That review demonstrates how difficult it is to normalize among hazards.

Population characteristics are, at the most abstract level, treated similarly in that the methodologies and models attempt to describe the location or other attributes of an exposed population in a reasonably conservative manner. But what constitutes a reasonably conservative estimate for one hazard may differ for another hazard, which makes assessing each hazard through a separate inquiry a reasonable exercise. 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 is 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. The characteristics of a population relevant to an assessment will also vary depending on the hazard

proportioned as a failure rate over each phase of flight so that there is some mathematical accounting for the fact that a launch vehicle can only fail once during flight.

at issue. For example, age will play a role in whether a person is harmed by a toxic release: a toxic exposure that fails to injure a healthy adult may seriously injure an infant or the infirm. Age is a much less important parameter for penetration injuries due to flying glass shards. Accordingly, age characteristics may be necessary for one assessment but not another.

In analyzing how a particular hazard may cause an injury, the elements of the risk assessments also diverge. Each hazard causes a different kind and degree of serious injury, so that employing separate methodologies and models to address each is reasonable for purposes of analyzing what harms a person. For example, inert debris causes injuries of penetration, blunt trauma or crushing. Explosive debris may cause knockdown and blast injuries, including, for example, "blast lung," gastrointestinal blast injury, damage to the inner ear, and eardrum rupture. Air blast loading caused by far field blast overpressure may break windows and pose a threat of laceration to building occupants or those nearby. Toxic releases may result in damage to the respiratory system, skin, and eyes.

These different injuries are produced by different causes and the thresholds and measures for serious injury from each hazard will vary. For inert debris, risk assessments tend to account for such characteristics as the mass of the debris, the impact velocity of the debris, debris orientation or the projected area of the debris or a combination of any of these characteristics. The threat posed by a gaseous toxic release is generally characterized by the concentration levels, described in parts per million, and the duration of exposure. An assessment of the far field blast overpressure risk will account for a variety of window characteristics, including window types, fragment sizes, velocities, distances propelled, or impacts per unit area.

The result of this review is that it is reasonable to perform separate risk assessments and employ separate criteria because of the difficulty in normalizing risk across all the different hazards. The current models for estimating risk used at the Air Force ranges represent the state of the art. Nonetheless. current techniques still cannot aggregate the risk across all hazards in a consistent manner without introducing additional uncertainty. This is due to differences in how the hazards are modeled and the nature and quantification of the serious injuries that result from each hazard.

2. Alternatives considered

The Common Standards Working Group explored a number of alternatives before settling on the proposal described above. Those alternatives and their benefits and drawbacks are discussed here. The Common Standards Working Group sought to identify risk assessment procedures that would best protect the general public and reflect current practice without unduly burdening the launch community. In doing so, the working group considered several options both individually and in combination. Chief among the concepts considered were various forms of risk aggregation and risk accumulation. Aggregation requires the risk assessment to combine and limit the total risk associated with the three main hazard categories. Aggregation would ensure that a single risk measure capped the combined risk due to the three main hazard categories. Accumulation combines the risk in the launch area with risk incurred downrange. The group also considered options related to increasing the maximum allowable expected casualty level and imposing different expected casualty limits on new and mature vehicles.

In addition, the Common Standards Working Group considered a third option that would have required the same risk assessment as the original aggregation and accumulation option outlined in the NPRM. The only difference between the two proposals would have been an increase in the maximum allowable E_c value under this option. Aggregating and accumulating with an increased E_c limit could have prevented the risk assessment from becoming overly conservative by adjusting the acceptable risk criterion. However, the main difficulty with this option would have been that choosing a new expected casualty limit would have been difficult to justify in the absence of historical data on which to base it. This difficulty could be mitigated, however, through a focused scientific study dedicated to logically determining an expected casualty limit. In fact, the Department of Defense's Range Commander's Council has previously conducted a similar study that could be used as a baseline for any future research.

A fourth option would have required a launch operator to aggregate risks across the three main categories of hazards without accumulating the flight risks incurred in the launch area with those incurred downrange. The result would have been two separate casualty expectation values for each licensed mission. One value would have represented the aggregate risk in the launch area while the other would have represented the risk downrange. In a departure from the current practice as outlined in EWR 127-1, this option would have imposed individual caps on aggregate risk in both areas but would not have imposed a total hazard cap on any single launch. This option may have had less of an impact on launch operators than the NPRM proposal to aggregate, but would have recognized the different methods used to calculate launch area hazards compared to downrange hazards. These differences include variations in the nature of necessary data and the fidelity of the analyses. Such variations reflect the fact that the ranges typically are not concerned with toxic releases or distant focusing of blast overpressure downrange because most or all of the fuel on board the vehicle would have been consumed en route, or lost on reentry due to the break up and dispersion of liquid fuels. Also, data regarding meteorological conditions tends to be unavailable for most downrange far field blast overpressure concerns. As a result, downrange risk would consist almost entirely of the debris risk, whereas launch area risks would also include overpressures and toxic releases. However, the underlying premise of this option is flawed by the fact that separating launch area risks from downrange risks is contrary to pure risk assessment philosophy in that it considers a launch in discrete parts instead of as a single continuous event. For missions involving multiple distinct periods of population overflight, assessing the risk to each region of overflight separately could result in missions with a very high expected casualty even though the mission met the risk criteria for each overflight area. In other words, such an approach would mask the true risk of the whole mission. Another disadvantage is that, like with other proposals in favor of aggregation, it might be difficult to define and calculate a consistent methodology that normalized the effects of each of the hazards. This particular disadvantage arises from the fact that the same expected casualty value may reflect two different things when applied to two different hazard categories. For example, an E_c of 30×10^{-6} for toxic releases means something different than 30×10^{-6} for debris because, in most cases, more people would have to be exposed to a toxic release to inflict the same number of casualties as a debris impact. Similarly, the potential for fatalities is much higher for a launch with an E_c of 30×10^{-6} for debris than an E_c of 30×10^{-6} for a toxic release due to the nature of the two different hazards. In other words, with debris hazards, a higher percentage of the casualties are fatalities than with toxic hazards. The final and crucial shortcoming of this option is the difficulty in distinguishing between where the launch area ends and the downrange segment begins. This question might not be critical for a coastal range where the physical boundary between land and sea makes for a logical divider. However, no such physical partition exists for an inland launch site.

Under a fifth option, a launch operator would have been required to aggregate overall risks into a single maximum E_c while also capping the maximum allowable risk associated with any one hazard category. Since this option would not have required accumulation, a risk assessment would have required six separate E_c calculations for each licensed launch. Launch operators would have needed to calculate an E_c value for each of the three hazard categories for the launch area and an E_c value for each of the three hazard categories for the downrange portion of the launch resulting in a total of six E_c values. This plan would have required each of the six E_c values to meet the individual cap while requiring the sum of the six values to meet the total allowable aggregate E_c value. The major benefit of this option would have been the ability to recognize the differences between the three main hazard categories while still capping the maximum allowable overall risk level. Unfortunately, not accumulating risks could lead to problems in defining the point in flight where the launch area ends and the downrange segment begins as discussed under the previous option.

The risk assessment proposed under a sixth option would have been very similar to those outlined in the preceding paragraph in that it would have aggregated overall risks into a single maximum E_c, as well as capping the risk of each hazard separately; however, the cap on the maximum allowable risk associated with any one hazard category would have been on the accumulation of launch area and downrange risks for each hazard. This option would have effectively reduced the number of separate expected casualty values from six to three. This option would not have offered any significant benefit over the other options considered and involves the shortcomings associated with aggregation.

Under a seventh option, one set of risk criteria would have been developed for new vehicles while a separate set would have been developed for mature vehicles. This option would have allowed the FAA and the launch operators to recognize the role that operational experience with a particular launch system plays in reducing the level of uncertainty involved in calculating the risk associated with launching a particular vehicle. However, the differences between new and mature vehicles are already addressed under current practice by accounting for the demonstrated reliability of different launch vehicles. Currently, there are no accepted definitions for new and mature launch vehicles.

In summary, the FAA proposes to adopt the Common Standards Working Group determination that, for the reasons discussed above, risk should be limited by hazard. The FAA would limit the risk permitted for debris, far field blast overpressure and toxic release to an E_c of 30×10^{-6} for each hazard rather than an E_c of 30×10^{-6} for a total of all three hazards as proposed in the NPRM.

C. Debris Thresholds for use in Flight Safety Analysis

Based on comments received, the FAA is proposing different thresholds for inert and explosive debris from those proposed in the October NPRM. The October 2000 NPRM would have required that certain probability analyses account for debris with a ballistic coefficient of three or greater. Under 417.107(c) of this SNPRM, the probability analyses would have to account for debris with a kinetic energy of 11 ft-lbs or greater at impact. For explosive debris, such as solid propellant fragments that will explode upon impact, the FAA is changing its proposal from 3.0 psi blast overpressure to blast overpressure of 1.0 psi or greater. The proposed debris thresholds would be applied when demonstrating that a launch satisfies the risk criteria for collective and individual risk of casualties to the public and the criteria for probability of impact for ships and aircraft.

In proposing requirements governing the calculations that are part of a launch operator's demonstration of compliance with the public risk criteria, the FAA's intent is to protect against casualties, the proposed definition in section 417.3 of the NPRM of which is "death or serious injury." Not all pieces of debris have the potential to be lethal or cause a person a serious injury. Accordingly, the FAA does not intend that a probability analysis account for all debris, only that which has the potential to cause serious injury or death.

In proposed sections 417.225 and 417.227 and appendices A and B of the NPRM, the FAA proposed a methodology for conducting a debris risk analysis and analyses for defining hazard areas used to ensure compliance with the individual risk and ship and aircraft impact criteria. See NPRM, 65 FR 64017, 14 CFR 417.225 and 227 and appendixes A and B (proposed). The NPRM proposed that these analyses account for debris with a ballistic coefficient of 3.0 or more, and the analysis would have had to account for a 3.0-psi blast overpressure radius and projected debris effects for all potentially explosive debris. At the time the NPRM was drafted, the FAA believed that these thresholds were consistent with the FAA's definition of casualty, but would not be as conservative as any such thresholds currently used at the federal ranges. However, Air Force members of the Common Standards Working Group raised the concern that any analysis that was limited to these thresholds would not account for significant potential casualties, particularly serious injuries that could result from launch vehicle debris. The FAA has come to agree with the Air Force's concern and has been working with the Air Force as part of the Common Standards Working Group and have identified appropriate thresholds for debris.

The Common Standards Working Group is continuing to explore what measures of concern are most appropriate for distinguishing casualty due to launch vehicle accidents. Improvements in modeling may provide room for better measures of what inert or explosive debris might cause a casualty. Recent models suggest that a change in the proposed measure for inert debris from ballistic coefficient to kinetic energy would be appropriate. Overpressure remains the most appropriate casualty measure for explosive debris; however, a change in the pressure level that presents a hazard would be appropriate. The FAA is proposing new thresholds that reflect the latest thresholds for inert and explosive debris that are being considered by the Common Standards Working Group. The FAA specifically requests comments on the debris thresholds proposed in this SNPRM, including any proposals for alternative approaches to estimating casualties.

The FAA is proposing that a launch operator's demonstration of compliance with the public risk criteria incorporate one of two approaches when applying the proposed thresholds for inert and explosive debris. The more sophisticated of the two approaches, and the one which would result in the more accurate casualty estimate, would require the use of probabilistic human vulnerability models. These models account for the probability of casualty to any person exposed to the threshold levels or greater for inert and explosive debris. The simpler of the two approaches would count all members of the public exposed to the threshold levels or greater as casualties. The simpler approach would result in a relatively conservative casualty estimation, which may be sufficient for a launch operator, depending on the specifics of a proposed launch. Any probabilistic casualty model used for a launch would have to be approved by the FAA during the licensing process or, if the launch is from a federal range, accepted as part of the FAA's baseline assessment of the federal launch range, as is current practice.

Probabilistic human vulnerability models estimate the likelihood of a casualty as a function of specific parameters that describe the contact with the hazard. The parameters may include kinetic energy, kinetic energy per unit area, overpressure, or toxic concentration. Probabilistic human vulnerability models possess greater fidelity than analysis approaches that employ simple conservative assumptions, such as counting every person exposed to the debris thresholds or greater as a casualty. These models possess greater fidelity because they typically account for the variability in how debris may harm different people such as infants, adults or the elderly to account for age, body weight and physical health. Probabilistic human vulnerability models also account for the variability associated with different injury mechanisms such as blunt trauma, crushing and penetration, as well as the variability of response associated with different parts of the body and body positions, such as whether a person is standing, sitting or supine. These models may account for the variability associated with fragment shape, weight and density and the inherent mathematical uncertainties associated with any probabilistic analysis. A human vulnerability model that reasonably accounts for these factors will produce more accurate casualty estimations than would the use of simple conservative assumptions. Accordingly, the use of a probabilistic human vulnerability model may prove to increase launch availability without jeopardizing public safety.

It must be noted that there are expenses associated with employing probabilistic human vulnerability models that can be avoided if the specifics of a proposed launch allow the use of a simple conservative approach. These models may possess significant development costs, including the highly specialized and knowledgeable personnel that would be involved. Such models would typically require more detailed input data. For example, in addition to knowing the number of people in a given area, the input to a probabilistic human vulnerability model could require statistics on the physical characteristics of the people and whether they are expected to be in the open or sheltered, and if sheltered, the characteristics of the shelters. A launch operator would have to weigh the costs associated with developing and using a probabilistic human vulnerability model against the potential for increased launch availability.

Some of the probabilistic human vulnerability models currently used by the Air Force use the Abbreviated Injury Scale (AIS) of the Association for the Advancement of Automotive Medicine to define casualties, and to distinguish between serious injuries and those of lesser severity. 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 1 being a minor injury, 2 moderate, 3 serious, 4 severe, 5 critical, and 6 a non-survivable injury. A scaling committee monitors the AIS evolution. A review of the current Air Force models found that they count an injury that qualifies as AIS Level 3, 4, 5, or 6 as a casualty. The Common Standards Working Group has recommended that any future casualty models used to satisfy Air Force and FAA requirements incorporate AIS Level 3 or greater as the standard for distinguishing casualties from injuries of lessor severity. When using the AIS for the purpose of casualty modeling, any injury that, due to its severity, qualifies as AIS Level 3, 4, 5, or 6 would be counted as a casualty. The FAA agrees that the use of AIS Level 3 or greater is appropriate for describing a medical condition sufficiently to allow modeling of casualties for purposes of determining whether a launch satisfies the public risk criteria.

The FAA recognizes that the 45th Space Wing conducts risk assessment of debris with a kinetic energy of less than 11 ft-lbs for blunt trauma on occasion, but the FAA does not currently plan to codify that practice. The circumstances surrounding that approach currently appear unique to the 45th Space Wing and constitute a response to the crowds of visitors that the Eastern Range must protect for launches. Numerous debris pieces with expected impact kinetic energies of less than 11 ft-lbs may significantly contribute to the risk of a launch when population density is sufficiently high. Also, the criterion of 11 ft-lbs of expected kinetic energy at impact does not ensure protection from serious injuries due to potential penetration wounds. For the time being, however, the FAA will not address this issue. The Common Standards Working Group considered a proposal for a threshold level near 40 ft-lb/in^2 to protect against serious penetration injuries from inert debris impacts. However, the Common Standards Working Group needs more time to evaluate an appropriate debris characteristic to protect against serious penetration injuries. The FAA invites public comments on this subject.

1. Inert debris

This SNPRM reflects two changes to the debris measure proposed in the NPRM: a change of the parameter measured to establish the probability of a casualty due to debris from ballistic coefficient to kinetic energy and a possible increase in conservatism, depending on the characteristics of a debris piece, of the threshold from a ballistic coefficient of three to a kinetic energy of 11 ft-lbs. The FAA proposed, throughout the NPRM, using ballistic coefficient as a metric for human vulnerability to estimate risk from inert debris impacts. Comments received from the Air Force and its contractor, ACTA Inc., as part of the Common Standards Working Group highlighted the pitfalls of relying on that metric. These comments have persuaded the FAA that defining hazardous debris as all pieces with a ballistic coefficient (often referred to as beta) of three or greater may fail to adequately protect the public in some cases. The FAA is now changing its proposal to use kinetic energy as the metric for estimating risk to the public from inert debris at a threshold level of 11 ft-lbs.

Specifying ballistic coefficient as a criterion ignores many important factors. The velocity of a debris piece at impact is an important factor in establishing whether an injury would result, but the terminal velocity of a debris piece at impact can vary significantly depending on the altitude at impact and its ballistic coefficient. Therefore, using ballistic coefficient as a casualty measure for inert debris would not indicate the velocity of impacting debris. Additionally, a debris fragment's ballistic coefficient does not indicate its mass, which is another important factor in establishing injury potential due to impact. A heavy fragment with a large area may be lethal, even though its ballistic coefficient is less than three. Similarly, a light fragment with a small area may be harmless even though its ballistic coefficient is greater than three. For example, consider a 30 pound debris piece, such as a rocket motor case fragment, that behaves like a tumbling plate, with an aerodynamic reference area of 11 square feet and a subsonic drag coefficient of 0.9. This piece has a ballistic coefficient of about three. The terminal velocity for this piece is about 50 feet per second, or 34 miles per hour. This piece would have a kinetic energy of about 1,164 ft-lbs at impact. The NPRM asserts that "a ballistic coefficient of three correlates approximately to a hazardous debris piece possessing 58 ft-lbs of kinetic energy." NPRM, 65 FR 63935. The above example shows, however, that the kinetic energy of debris with a beta of three can be significantly greater than 58 foot-pounds. Accordingly, it is appropriate to consider other factors for determining whether a fragment would produce a casualty.

Inert launch vehicle debris of concern to the FAA typically threatens humans primarily from blunt trauma due to nearly vertical impact. The debris piece's potential to cause a serious injury upon impact with a person depends primarily on the mass and shape of the debris and the velocity at which it impacts. Because kinetic energy on impact accounts for these three factors, the FAA believes it to be the appropriate metric for gauging the potential for blunt trauma.

Recently published human vulnerability model results examined by the Common Standards Working Group suggest that for the general public, a kinetic energy of 11 ft-lbs at impact would be a reasonable threshold level for any analysis intending to account for virtually all serious injuries from blunt trauma. When applied as a threshold, 11 ft-lbs would represent the kinetic energy level for debris that could, depending on the specifics of an impact with a person, cause a casualty. As an example, 11 ft-lbs at impact corresponds to a one-quarter inch thick square aluminum plate with an edge length of about two inches and a weight of about 1.5 ounces impacting at a velocity of approximately 60 mph.

One must note that not every impact of debris at 11 ft-lbs or greater will necessarily result in a casualty. The probability of casualty due to such an impact is further dependent on a number of other factors specific to the debris and the impact scenario. Probabilistic human vulnerability models are often used to account for these other factors, and an analysis that employs these models will produce a more realistic casualty estimate than a deterministic analysis that counts all expected impacts of 11 ft-lbs or greater as casualties.

The choice of 11 ft-lbs as a threshold also has practical benefits. The FAA realizes that there is no standard threshold currently in use, and the human vulnerability models used at the federal ranges today may vary depending on the launch vehicle and other factors. The Air Force members of the Common Standards Working Group have indicated that the models currently used at Air Force ranges satisfy the proposed 11-ft-lb threshold. For example, the debris model used for a Atlas IIAS launch from Cape Canaveral Air Force Station accounts for inert debris with kinetic energy at impact greater than or equal to 7 ft-lbs. A standard threshold would facilitate the development and application of more standardized models with associated efficiencies. For these reasons, the FAA is proposing to use kinetic energy as the metric for estimating the risk of casualties due to blunt trauma from inert debris impacts at a threshold level of 11 ft-lbs.

This SNPRM would require any risk analysis for blunt trauma due to launch vehicle debris to account for all potential debris with 11 ft-lbs or greater of kinetic energy at impact. The analysis would apply the relatively sophisticated approach using probabilistic models to assess the probability of casualty due to any debris with kinetic energy at impact of 11 ft-lbs or greater, or it could apply a more simple approach where each expected impact of a person with kinetic energy of 11 ft-lbs or greater would be counted as a casualty.

2. Explosive debris

In sections 417.225 and 417.227 of the October 2000 NPRM, the FAA proposed that a flight safety analysis, a flight hazard area analysis, and a debris risk analysis had to account for a 3.0-psi blast overpressure radius or greater and projected debris effects for all potentially explosive debris. Explosive debris is debris with the potential to explode upon surface impact. At the time the NPRM was drafted, the FAA believed that this threshold was consistent with the FAA's definition of casualty and would not be more conservative than any such thresholds currently used at the federal ranges. However, comments received from the Air Force and its contractor, ACTA Inc., as part of the Common Standards Working Group indicated that there is a significant potential for casualties at blast pressures below 3.0 psi. The FAA has reviewed this issue with the Common Standards Working Group and now proposes to reduce its threshold for explosive debris to 1.0 psi.

Many factors complicate the determination of threshold blast loads from explosive debris that could cause serious injury. These factors include the substantial difference in vulnerability of people in the open and people in buildings, the substantial variability of protection afforded by various building types, the complex nature of blast wave propagation through groups of buildings or hilly terrain, the potential for far field window breakage due to atmospheric focusing of a blast wave under special conditions, and the general lack of data on casualty-blast load relationships for occupants of various building types. In addition to the direct effect that blast overpressure can have on a person, blast may cause serious injury by breaking glass that may strike a person, by blowing people down, or by collapsing a structure with people in or near it.

People in the open are generally less vulnerable to serious injury from blast loads than occupants of typical buildings, particularly if ear damage is discounted as a serious injury. However, persons standing in the open can be seriously injured as a result of being blown-down by overpressure. Blow-down potential is a function of both blast overpressure and impulse. For an explosive yield of 10,000 pounds TNT, the threshold for serious injury due to blow-down for a 70-kg person is near 1.4 psi.

The FAA recognizes that blast thresholds used currently at federal ranges may vary depending on the analysis being performed and the specifics associated with the people and property being protected. The October 2000 NPRM's proposal to address the risk associated with 3.0-psi overpressure would have addressed risks only to someone standing outside in the open, a typical assumption for overflight risk analysis. The ranges pointed out that this failed to account for risks to persons in or near a building or other structures. Glass can break at 1.0 psi—or even less—which means that a person in a building is at risk from flying glass shards or other secondary hazards and may be more at risk than a person in the open. The current practice at the ranges accounts for such secondary hazards of explosive debris. The Department of Defense Explosive Safety Board (DDESB) approves the siting of buildings that may be subject to approximately 1-psi over pressure level in the event of an accident. Additionally, the Air Force launch ranges use 1.0-psi to determine a hit to ships for probability of impact calculations.

Accordingly, the Common Standards Working Group has reviewed the casualty models and analysis processes used at the Air Force ranges and concluded that the use of 1.0 psi as a threshold for explosive debris would be consistent overall with current practice at those ranges and in the explosive safety community at large.

Although the FAA is proposing overpressure as a threshold parameter, blast effects on humans, especially building occupants, are generally sensitive to the positive phase impulse, as well as the peak overpressure, of a blast load. For example, an explosion with a 50,000-lb TNT equivalent from a launch accident would produce on the order of a 1% probability of serious injury for occupants of typical buildings in the United States located at the 1.0-psi overpressure radius from the source of the blast. However, a more typical explosion (1000-lb TNT equivalent) from a launch accident would produce less than a 0.01% probability of serious injury in the same circumstances. It is important to note that these estimates account for the probability of serious injury due to broken glass shards propelled by the blast and assumes the occupants are equally likely to be anywhere in the building. The difference in the probability of serious injury in the two examples is primarily due to the greater impulse of a large explosion compared to one with a lesser yield. However, the probability of serious injury in both cases at the 1.0-psi overpressure radius is relatively small. Most typical impacts of explosive launch vehicle debris would result in small yields, far below a 50,000 lb TNT equivalent; therefore using a 1.0-psi peak incident overpressure level as a threshold in a simple explosive overpressure vulnerability model would, the FAA believes, capture any overpressure which would cause serious injury while at the same time account for the role played by the impulse of the blast as well.

When applying the 1.0-psi threshold, any probability analysis would have to account for a 1.0-psi blast overpressure radius for all potentially explosive impacting debris. The analysis may apply a relatively sophisticated approach that uses probabilistic models to determine casualty due to any blast overpressures of 1.0-psi or greater or apply a simpler approach that counts all people within the 1.0-psi overpressure radius as a casualty. When using the simple approach, the peak incident overpressure would be computed with the Kingery-Bulmash relationship, without regard to sheltering, reflections, or atmospheric effects. For persons located in buildings, the peak incident overpressure would be computed at the shortest distance between the building and the blast source. A person would be considered a casualty when located anywhere in a building subjected to peak incident overpressure equal to or greater than 1.0 psi.

The FAA anticipates that launch operators launching smaller vehicles, such as Pegasus Taurus, will be able to take advantage of the simple approach. Launch operators conducting launches of larger vehicles would likely resort to use of probabilistic models. The FAA requests comments on the proposed debris thresholds and their application, which allows for both simple and sophisticated analysis methods. Because the FAA considers the proposed debris thresholds and their application to be consistent with current practices at the federal ranges it does not anticipate cost impacts, but requests comments on this point.

IV. Issues of Concern to Commenters

A. Authority and Need for Rulemaking

Some commenters questioned the FAA's authority to conduct this rulemaking, and whether it was consistent with Congressional intent. They also questioned its necessity. The FAA has the authority to conduct this rulemaking ,[7] and codification of the safety requirements is

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[7]. Accord JC Vol. I at iii ("the FAA has the flexibility under the CSLA to develop and issue its own rules"), Lockheed at 2, 5.

necessary. The statute and the legislative history support the proposed codification of launch safety requirements. The rulemaking is necessary to identify genuine and universal safety requirements, which includes identifying and codifying the intent behind existing range safety requirements. Currently, federal requirements consist of a mix of safety and mission requirements. Some are available readily to the public. Others are typically only in the possession of range analysts. This rulemaking identifies those requirements with which a launch operator must comply under current practice. The FAA intends that streamlined performance requirements offer the same high level of safety and the flexibility of current practice. Finally, the FAA is concerned that adopting the suggestion to only apply proposed part 417 to non-federal launch sites could result in confusion regarding safety requirements at the federal ranges. This discussion describes the reasons for the FAA's position that it has the authority to conduct this rulemaking, that the rulemaking is consistent with Congressional intent, and that it is necessary for public safety.

1. **Authority for rulemaking**

The Joint Commenters assert that the FAA's regulation of launch safety is not statutorily mandated, and is inconsistent with the Act's "finding that private sector launch and associated services should be regulated only to the extent necessary to protect, among other things, the public health and safety." JC Vol. I at ii. In support of this argument, the commenters point to the FAA's authority to accept the assistance of other executive agencies in carrying out the Act, the Air Force's comprehensive safety requirements and the safety record achieved at the ranges. JC Vol. I at ii; Lockheed at 6. Lockheed Martin and other commenters suggest that the rulemaking is inconsistent with Congressional intent, as embodied in legislative history, to streamline the licensing process. JC Vol. I at iii; Lockheed at 6.

Congress found that the FAA should "only to the extent necessary, regulate ... launches, reentries and services to ensure compliance with international obligations of the United States and to protect the public health and safety, safety of property, national security and foreign policy interests of the United States." 49 U.S.C. § 70101(a)(7). This rulemaking would identify and codify regulations containing the standards that protect public safety. Congress also found that the provision of launch services would be "facilitated by stable, minimal, and appropriate regulatory guidelines that are fairly and expeditiously applied." 49 U.S.C. § 70101(a)(6).

The commenters acknowledge that the FAA has the authority under 49 U.S.C. §§ 70101-70121 (referred to as "Chapter 701" or "the Act") to issue safety regulations. JC Vol. I at iii; accord Lockheed at 2, 5. Accordingly, the commenters' position that the rulemaking fails to satisfy the Act appears to be based on the belief that the FAA's rulemaking may somehow be inconsistent with Congressional intent. As a preliminary matter, the FAA notes that intent becomes a matter of significance to statutory interpretation only when the statute itself is unclear. The Act is not unclear.

Chapter 701 authorizes the Department of Transportation and thus the FAA, through delegations, to oversee, license and regulate commercial launch and reentry activities and the operation of launch and reentry sites as carried out by U.S. citizens or within the United States. 49 U.S.C. §§ 70103, 70104, 70105. 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. 49 U.S.C. § 70105.

2. Congressional intent

Despite the commenters' claims to the contrary, review of legislative history shows that the FAA's rulemaking would satisfy Congressional intent. Review of the commenters' proposed interpretation of Congressional intent shows that Congress did not attempt to foreclose this rulemaking. Instead, some of the comments take legislative history out of context and argue that observations offered for a different day apply to the current situation. The comments attempt to portray Congressional intent as opposing a rulemaking--such as this--that codifies safety requirements. As explained below, the FAA does not share this interpretation.

Even if intent were an issue, the best expression of Congressional intent is contained in the language of the Act itself. This meaning may be discerned by analyzing the design of the statute as a whole. The Act itself specifically created a civilian regulatory regime for safety. Congress in 1984 neither foresaw nor forbade the conduct of this rulemaking. Instead, Congress gave the FAA responsibility for safety and authority to conduct rulemakings. Where Congress intended to bar duplication of responsibilities in the Act, it did so explicitly. See, e.g., 49 U.S.C. § 70117(b); S. Rep. No. 98-656, 15 (1984)(explaining that because regulatory regimes for communications satellites and land remote sensing satellites already exist, a duplicative process would be unnecessary). The regulatory regime for launch safety is that of the FAA. Had Congress viewed the Air Force's safety oversight as sufficient to require no codification of safety standards, Congress could have done so as explicitly as it ensured against duplication of the roles of the Federal Communications Commission and the National Oceanic and Atmospheric

Administration.[8] Moreover, Congress could have failed to vest safety responsibility in the FAA. Congress did neither of these things.

Lockheed Martin separately urges reliance on a Senate report that accompanied passage of the original Commercial Space Launch Act to support its claim that this rulemaking runs counter to Congressional intent. Lockheed at 6. The cited legislative history does not go as far as Lockheed recommends. Lockheed states, that "Congress stated unambiguously that the Act, and implementation of the Act, should reduce the regulatory burden for commercial launch operators and that the authority of ...the Secretary... to issue additional requirements and regulations must conform with the Congress' expressed desire to streamline the licensing process for commercial launch...." Lockheed at 6. The FAA first notes that what Lockheed cites in support of its assertion is not the language of the statute itself, but the regulatory impact statement of the Senate Report. S. Rep. No. 656, 98th Cong., 2d Sess., 5 (1984), reprinted in 1984 U.S.C.C.A.N. 5328, 5332. More significant, however, is the fact that Lockheed has added a word, the word "must," to the cited language, thereby changing the meaning of the statement from one of description to one of admonition. Accordingly, the Senate report does not have the meaning that Lockheed would ascribe to it. Instead, in discussing the new authority conferred upon the Secretary, the report notes that the Secretary's authority "to issue additional requirements and regulations conforms with the Committee's desire to streamline the commercial launch and launch operations process and to facilitate compliance with the required

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[8] That the FAA may seek the assistance of the head of another executive agency does not accomplish nearly as much as the commenters suggest. Given the FAA's continued reliance on the federal launch ranges, now and for the foreseeable future, it is certainly a statutory provision of which the FAA is aware, but not one that stands in the way of the FAA identifying safety standards through rulemaking.

regulations." Sen. Rep. No. 656 at 5. A better interpretation is that the Committee thought that the new authority streamlined the existing situation.

Indeed, the situation at that time was a difficult one for a launch operator . Prior to passage of the Act, a launch operator, for example, had to obtain an export license under the International Traffic in Arms Regulations. Sen. Rep. No. 656 at 37. This was why the legislation gave the Secretary "exclusive licensing authority" for commercial launch. Sen. Rep. No. 656 at 5, 37. The FAA's interpretation is also more consistent than Lockheed's with the Committee's other statement to the effect that "the legislation would provide for a more stable regulatory environment than that which currently exists...." Sen. Rep. No. 656 at 6. The regulatory environment that existed at the time would have required a launch operator to satisfy the requirements of numerous federal agencies.[9]

Likewise, although Lockheed does accurately describe Congressional encouragement to avoid duplicative and unnecessary regulation, (Lockheed at 6 (citing Sen. Rep. No. 656 at 3, 19)), the FAA's work with the Air Force in achieving common standards is designed to attain that very goal. In summary, the history at the time indicates, and the actual words used by the Committee demonstrate that Congress intended to streamline the existing regulatory process, not to argue against the possible future codification of safety requirements.

3. Necessity for this rulemaking

Although some commenters assert that this rulemaking is not necessary to protect public safety, Chapter 701 directs the FAA to regulate to the extent necessary to protect public safety.

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[9] Contemporaneous and historical accounts describe the regulatory environment with which a launch operator had to comply as consisting of 18 federal agencies and 22 federal statutes. Kay, W.D., "Space Policy Redefined: The Reagan Administration and the Commercialization of Space," Business and Economic History , 237-247 (Fall 1998); "Industry Observer," Av. Week & Space Technology, 15 (Oct. 22, 1984).

The FAA believes that if a launch operator is to be expected to satisfy safety requirements, those requirements must be clear, open and published. In the October 2000 NPRM, the FAA announced that it considered the range safety requirements necessary because they were the requirements with which the ranges had achieved their level of safety. The FAA continues to find that the proposed requirements are necessary to achieving safety. The following discussion provides the reasons for the FAA's position.

Launch operators should achieve the same level of safety, regardless of whether they launch from a federal launch range or a non-federal launch site. Safety standards should be common between the FAA and the ranges. Most significantly, the FAA must identify the standards by which it judges safety; and, having identified those standards, the FAA must provide full disclosure that those standards apply at both federal launch ranges and at non-federal launch sites. Not only has the FAA identified its own proposed standards, in doing so, it has provided the additional benefit of identifying what the federal launch ranges themselves in fact require, and the standards they impose on launch operators through their own internal requirements.

a. Genuine and universal safety requirements

Different federal launch ranges have implemented different approaches to achieving the same safety goals. The FAA proposes to codify the intent behind these different requirements where possible. In the interest of achieving universal applicability, namely, requirements that can apply regardless of differences in geography, mission, meteorological conditions and other factors, the FAA worked with the ranges to identify the underlying intent. Additionally, some of the range requirements documents require a launch operator to provide data that the range, in turn, subjects to standards contained in internal range documents. The internal standards are available upon request and provide greater insight into the intent behind particular information or safety requirements. This rulemaking would codify those as well.

Although, generally, Lockheed Martin maintains that the proposed requirements are new and different from EWR 127-1, Lockheed Martin stated that it would object as well to the proposed requirements, even if it thought that the FAA could succeed in codifying the Air Force requirements, on the grounds that those requirements are not the "real, ultimate requirements" of public safety, which the Air Force is able to accept through "tailoring."[10] Lockheed at 3. The FAA's intent, however, has been to determine what those "real, ultimate requirements" are, so that they may be shared and codified as performance standards.[11] For example, the standards governing the creation of impact limit lines are not contained in EWR 127-1, but may be found instead in a flight safety analysis handbook, Flight Control and Analysis General Reference Handbook, RTI Rep. No. RTI/6762/03-02F (Apr. 24, 1997). This rulemaking attempts to unveil those requirements. Indeed, the Administrative Procedure Act directs that an agency's requirements be public. 5 U.S.C. § 552(a)(1)(D).

The FAA's requirements may appear different from EWR 127-1 because they attempt to capture both the written requirements of EWR 127-1 and how the ranges have implemented those requirements. The FAA, aware of the safety expertise resident at the federal launch ranges,

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[10] "Tailoring," as explained by EWR 127-1, permits the preparation of an individually "tailored" requirements document to ensure that only applicable or alternative equivalent requirements are levied upon a launch vehicle program." EWR 127-1, 1-21, 1.6.3 (Oct. 31, 1997).

[11] An unintended consequence of translating some of the details of EWR 127-1 into performance requirements has been to appear to create new requirements. See, e.g., discussion of surveillance requirements, IV.B. Additionally, as described in the NPRM and elsewhere here, the FAA has proposed more detailed requirements to serve as a roadmap for what the FAA considers demonstrates satisfaction of those performance requirements, and against which alternatives might be measured.

consulted with the ranges and reviewed the ranges' own requirements, as embodied in the EWR 127-1 and in NASA's Range Safety Manual for Goddard Space Flight Center (GSFC)/Wallops Flight Facility (WFF), RSM-93. Range safety personnel advised the FAA that not all of their requirements were enforced in a standardized manner because the ranges had granted waivers, deviations and "meets intent certifications" to launch operators in response to the requests of the launch operators for relief. The ranges have also used "tailoring." Typically, this involves not imposing requirements that do not apply, and rewriting any requirement where the intent of the requirement is satisfied through other means. EWR 127-1, Appendix 1A, 1-23 (Dec. 31, 1997).

The FAA is building in similar flexibility by recognizing where the ranges have been willing to grant relief and incorporating those determinations into the requirements as proposed through this rulemaking so that particular non-compliances would no longer require waivers. For example, the lot acceptance and qualification test requirements for percussion activated device (PAD) primer charges used in a flight termination system that were proposed in the FAA's October 2000 NPRM (proposed 14 CFR E417.31) are relaxed in comparison to the Air Force's current version of EWR 127-1. The NPRM proposes to reduce the number of units to be tested and to reduce the types of tests to be conducted. These proposed changes from current Air Force requirements are based on lessons learned over the past few years and earlier decisions made by Air Force range safety to waive or tailor such requirements for existing launch vehicle systems. One launch operator that currently launches from Air Force ranges, having seen the proposed PAD requirements in the FAA NPRM has since approached the Air Force with a request to apply the FAA requirements to its launch vehicle. These improvements and others identified during the development of the October 2000 NPRM are now being incorporated into the Air Force's new Space Command manual that will replace 127-1. Thus, in many ways, particularly with respect to the particulars of the flight safety system requirements, the FAA believes that this rulemaking may provide a more comprehensive and streamlined version of the ranges' own requirements.

During the discussions between the ranges and the FAA regarding safety requirements for non-federal launch sites, the FAA attempted to identify the common underpinnings of the range requirements to achieve more universal applicability, particularly in the area of flight safety analysis. Flight safety analyses that the Air Force ranges apply on each coast are directed toward each coast's geography, meteorological conditions, and mission profiles. As the FAA worked to make the range requirements more general so that they might apply wherever a launch took place, the question arose as to why the safety requirements for licensed launch operators should differ from site to site. No good reason was evident. Moreover, with the goal of achieving universal applicability of as many of the requirements as possible by identifying the common intent underlying different approaches to similar safety questions, permitting different standards seemed unnecessary.

In the course of these discussions, the ranges and the FAA saw a number of benefits to having common standards. Common standards would provide launch operators certainty in planning. Common standards would permit a body of expertise to support those standards. In the unlikely event that the Air Force ever pulled back from its oversight of commercial activity, a step the Air Force has contemplated within past years, standards will already be in place for FAA licensed launches from a federal range. Also, it might be difficult to justify imposing different standards of safety on licensed launch operators based merely on whether the launch took place from a non-federal launch site or from a federal launch range.

In summary, the applicability of part 417 to all licensed launches, regardless of their launch location is necessary. Universality ensures a single standard of safety. Publication of the requirements currently in place permits a launch operator to know and plan for the requirements with which it must comply. The comments' suggestion that part 417 only apply to non-federal launch sites is based on a misperception that the FAA has proposed "significant changes," in the form of new, more conservative requirements, JC Vol. I at 8, 12, to a proven process, when, to the contrary, this rulemaking only identifies and proposes to codify the intent underlying existing requirements in a performance standard format.[12] This is not to say that there were no problems with the regulations proposed in the October 2000 NPRM. The commenters identified certain areas of the FAA's proposed regulatory text that might be interpreted as more conservative than current practice at the federal ranges. This was not the FAA's intent and the FAA is working to make the appropriate adjustments, some of which are presented in this SNPRM.

b. Identification of standards and resulting application

Commenters' suggestion that the FAA refrain from applying part 417 to launch from a federal launch range does not address the need to identify safety standards, fails to recognize that this exercise has identified those standards, and falls prey to the law of unintended consequences. Having identified its standards, the FAA does not believe that it would be helpful to claim that they do not apply. The logic of how the FAA evaluates the acceptability of the federal launch ranges should alleviate concerns over any seeming duplication between the FAA and the Air

[12] The presence of design requirements shows what the FAA proposes to find acceptable. Launch operators should note that the opportunity to provide a clear and convincing demonstration of an equivalent level of safety is embedded in each design oriented requirement. See also NPRM, 65 FR 63940-41 (discussing reasons for acceptability of Sea Launch's comparable flight safety system).

Force. The Joint Commenters proposed that the FAA apply part 417 only to non-federal launch sites. For the FAA to agree that part 417 would only apply at non-federal launch sites would, however, be confusing at best and misleading at worst.

Part 417 would contain the standards by which the FAA would assess the adequacy of both a licensee and a federal launch range. The FAA assesses a launch operator through the licensing process and a federal launch range through a baseline assessment. Because the FAA obtained the standards in part 417 from the federal launch ranges own standards and practices, the FAA, of course, anticipates that the federal launch ranges will satisfy proposed part 417. Nonetheless, whether through changes in Air Force or NASA policy or because of the failure of a range safety system, it is conceivable that some element of range safety might not satisfy the ranges' own current requirements. In fact, the ranges advise that they may, from time to time, waive requirements for their own equipment, and a launch operator may remain unaware of this waiver.

Even if the FAA acquiesced in the commenters' proposal and declared that part 417 only applied at non-federal launch sites, it would still have to use some set of standards against which to measure the continued adequacy of the federal launch ranges whenever the FAA updated its baseline assessments. Those standards would be found in part 417. Accordingly, to say that part 417 did not "apply" at the federal launch ranges might confuse some into thinking that part 417 had no applicability whatsoever, even in the baseline assessment context. Others might believe that the FAA was misleading them regarding the applicability of part 417 at federal launch ranges given that the FAA would assess the adequacy of the ranges against part 417. The FAA does not consider it advisable to create such confusion. None of the points raised by the comments address this fundamental issue, and the FAA invites the public to take this additional opportunity to present alternatives that take this consideration into account. It is one that the FAA does not believe it can ignore, but recognizes that those with a different perspective may be able to offer insights currently unavailable to the FAA.

Because the range safety requirements are part of how the ranges have achieved their high level of safety, the FAA considers those requirements necessary for continuing to achieve that same level of safety for FAA-licensed launches at both non-federal launch sites and federal launch ranges. The FAA and the commenters take away different lessons from the past safety records. Although the Joint Commenters point to the safety record of the past as justification for not requiring further regulation, the FAA looks to the safety record of the past and attributes that successful record, in some measure, to the launch safety requirements themselves. Accordingly, when the FAA began its own attempt to codify requirements that would govern launch safety at non-federal launch sites, it looked first to the ranges' own requirements and the FAA has continually worked with the Air Force to ensure that in the future the two agencies' requirements are consistent and do not conflict.

c. Implementation

Other comments received in response to the NPRM include concerns about how the FAA would implement the proposed requirements at the federal launch ranges, whether the FAA would grant waivers as readily as the ranges, and whether FAA oversight would result in reduced flexibility, both in meeting the intent rather than the letter of the requirement and in terms of operational flexibility. Because the Act directs the FAA to encourage, facilitate and promote private sector launches, 49 U.S.C. § 70103(b), the Joint Commenters indicate that the FAA should streamline its licensing and regulating regime by continuing to rely on the ranges for the implementation of launch safety requirements. JC Vol. I at ii.

One of the reasons the commenters argue that this rulemaking is not necessary is because they fear that the FAA's identification of the safety standards would constitute duplication of oversight. This is not so much a concern regarding the necessity of having safety standards as a concern with their implementation. The comments recommend that a single entity be responsible for the safety of licensed launches.

A review of what the FAA proposed in the NPRM should allay these concerns. Of first and foremost importance, the commenters should note that the FAA intends no duplication of oversight. The proposed standards themselves, which were derived from range requirements and practices, will apply to all licensed launches, regardless of the location of the launch site. Applicability of standards is different, however, from duplication of oversight. Oversight means inspection, monitoring and otherwise checking whether a licensee is in compliance with the requirements of the Act, the FAA's regulations and its license. As the FAA noted in the October 2000 NPRM, the FAA does not now and does not intend through this rulemaking to duplicate the work, evaluation, inspection and monitoring conducted by the federal launch ranges. NPRM, 65 FR 63924. The FAA relies on its baseline assessments of the ranges, and those baseline assessments have found the ranges safety requirements acceptable. NPRM, 65 FR 63924. Likewise, the FAA has found acceptable the ranges' implementation of those requirements. There are situations, however, where the ranges may, for reasons of their own, change their support for licensed launches. In such a case, the launch operator would likely have to perform its safety work itself. Also, as noted, if "a documented range safety service has changed significantly or has experienced a recent failure" the burden of demonstrating safety at a range shifts to the launch operator. NPRM, 65 FR 63924. The FAA sees little change from current practice in this regard.

The FAA does not agree that this rulemaking will result in loss of flexibility. The NPRM would allow for flexibility through the use of performance requirements, where appropriate. The FAA worked extensively with federal range safety personnel to develop common launch safety requirements that refine and adapt many of the current federal range standards into performance requirements.

For each specific safety issue, the NPRM may contain different levels of performance requirements as needed to respond to the complexity of space launch systems and the potential for negative consequences to public safety. For example, a flight termination system is one of the most critical systems on a launch vehicle for ensuring public safety. Hence, to ensure flight termination system reliability the NPRM contains comprehensive design and test performance requirements for the systems, components and piece parts. Also, the FAA does not attempt to mandate requirements related to achieving the success of the mission, and will permit the launch operator to accept its own risks on that score, where there is no impact on public safety. For example, where safety is ensured by the working of the flight safety system, the NPRM calls for a launch operator to provide for launch vehicle tracking without specifying detailed requirements to ensure reliable tracking. Aside from some general performance requirements, the reliability of the tracking system is left to the launch operator with the understanding that if all tracking data is lost during flight the flight termination system will be used to destroy the vehicle. For a licensed launch from a federal range, the launch operator typically relies on the range to provide reliable launch vehicle tracking. The FAA's proposed requirements do not dictate a change from such practices.

In addition to the use of performance requirements, the FAA proposes to allow flexibility by permitting a license or a license modification applicant to demonstrate an equivalent level of safety for a proposed alternative approach. Although the proposed regulations would provide the requirements with which a licensee must comply, the FAA anticipated that a launch operator might wish to employ alternative means of achieving an equivalent level of safety. In that case, if a launch operator clearly and convincingly demonstrated an equivalent level of safety, the FAA would accept the alternative. Once accepted, an alternative approach would become part of the terms of the license, and the FAA would consider making the substitute available for the benefit of others through the advisory circular process or some other means. The FAA has also demonstrated its flexibility with the licensing of launches such as those of Sea Launch, where there are a number of aspects that do not conform to current practice at U.S. launch ranges. Also, the FAA recognizes that the NPRM represents only a version of current practice: the safety methods used at the U.S. ranges often differ from one another. The FAA has worked with the federal range organizations to develop common launch safety requirements that present a more generalized description of the current practices at the ranges. Where there may be differences between the methodologies defined in the NPRM and those used at a federal range, the current practices at the federal ranges typically do provide an equivalent level of safety to the NPRM.

The Joint Commenters expressed concern that if the NPRM were implemented as drafted, launch operators on federal ranges would have to demonstrate compliance with two sets of requirements overseen and administered by two separate and independent government agencies. The commenters believe that this would be cumbersome and inevitably would lead to costly and duplicative safety efforts with no appreciable increase in public safety. The FAA is continuing to work with the federal ranges to eliminate these concerns . Under current regulations, the FAA issues a license to an applicant proposing to launch from a federal launch range if the applicant satisfies the requirements of part 415, subpart C, of the licensing regulations and has contracted with the federal launch range for the provision of safety-related launch services and property, as long as the safety-related launch services and proposed use of property are within the experience of the federal launch range. The NPRM does not propose to change this overall approach. The FAA does not duplicate analyses performed by the federal launch ranges or routinely review those analyses during the launch safety review. Instead, the FAA relies on its knowledge of the range processes as documented in the FAA's baseline assessments. The FAA's baseline assessments document each federal launch range's capabilities, safety program, standards and policies. The January 16, 2001 Memorandum of Agreement between the FAA and the U.S. Air Force explains the roles and responsibilities of the Air Force and the FAA for overseeing safety of commercial space launch and reentry.

The Joint Commenters expressed doubt that the Air Force and the FAA would be able to work together in an efficient way toward a common goal. The commenters indicated that if the FAA NPRM were implemented, it would result in competing safety requirements at the Air Force ranges. These concerns are unfounded. The Air Force and the FAA remain committed to the partnership outlined in the MOA and to ensuring that competing safety requirements do not exist. The MOA calls for developing common launch safety requirements and for coordinating the common requirements. The Common Standards Working Group is continuing to participate in developing the FAA's final rule and a revised Air Force range safety requirements document. The common standards will be contained in the Code of Federal Regulations and Air Force documents. FAA rules appear in the Code of Federal Regulations. The Air Force range safety requirements, which must address a broader range of issues, will encompass the same common launch safety requirements as well as other issues unrelated to launch safety. When the final Air Force and FAA documents are in place, a licensed launch operator at an Air Force range, in day-to-day practice would only need to work from the Air Force's range safety document so long as the FAA's launch safety requirements are contained there as well. This would be no different from the process in place for licensed launch operators today. The FAA and the Air Force are also working under the MOA to develop processes for implementing the common launch safety requirements together, including coordinated review and disposition of requests for relief from common requirements, as explained in section IV.C of this discussion. Although part 417 would contain the legal requirements with which a licensee must comply, when launching at a federal range, a licensed launch operator's primary day-to-day interface would continue to be the federal range. A unified launch safety community that includes FAA representatives will address any issues that may arise to ensure that all federal launch range and FAA licensing concerns are addressed.

B. Cost Impacts on Licensed Launches from Federal Launch Ranges

Comments in response to the October 2000 NPRM indicate that the launch industry has concerns about how the proposed rule would work, and how the FAA and the Air Force work together. The concerns have led to a perception that this rulemaking will result in significantly increased costs for the launch operators. To address some of these concerns, the FAA is proposing changes to the October 2000 NPRM in this SNPRM, as described earlier in this preamble. The FAA also hopes to clarify some of these issues. Some possible cost impacts identified by the commenters have led the FAA to revisit whether its proposed requirements actually captured current practice. The majority of the concerns underlying the costs the launch operators attribute to this rulemaking are, however, unfounded. The following discussion explains why.

1. Commenters believed some of the proposed requirements were new. Commenters may not be fully familiar with the precise nature of the safety services the ranges provide, and thus believe that some of the proposed requirements in the October 2000 NPRM are new, but, in fact, those requirements are already in place. Similarly, launch operators believe that a number of the more abstract expressions of different range requirements are new. Instead, a number of them are the FAA's proposed attempt to describe the common standards underlying different approaches taken at different federal launch ranges.

2. The launch operators believe that this rulemaking changes their legal responsibility for safety. They are, however, already responsible for safety under the statute and their licenses, and they would not be required to duplicate the work of the federal ranges as a result of this rulemaking.

3. Some of the commenters think that the more onerous requirements governing how to obtain a license apply to federal range launches. The licensing requirements proposed in this rulemaking, however, would apply to an applicant obtaining a license to launch from a non-federal launch site.

4. Commenters expressed concern over a loss of flexibility. These concerns should be allayed by the FAA's proposal to permit a demonstration of an equivalent level of safety, the grandfathering proposal and waiver coordination.

5. Although not a concern raised by the commenters, the FAA requests comment on the neighboring launch operator issue addressed below.

All this is not to say that the comments lack merit. There are a number of instances where the FAA wishes to make changes based upon the comments received. To determine whether it captures current practice, the FAA will revisit the issues raised by such comments.

Some changes have already been proposed through this SNPRM, and the FAA requests views on whether the commenters still assign costs to these matters.[13] As one example, commenters attributed an array of costs to the FAA's original proposal not to grandfather. If the launch operators satisfy the FAA's proposed conditions, these same launch operators may be eligible for the FAA's version of "grandfathering" and need no longer anticipate costs associated with making changes in their operations.

In addressing these cost issues, the FAA found several comments that it does not understand. Because this SNPRM provides an opportunity through its additional comment period to obtain clarity, the FAA urges those commenters who provided the cited comments to assist the FAA in better understanding their differences. [14]

1. "New" requirements

Some launch operators attributed costs to their launches from federal launch ranges in the belief that the FAA proposed new requirements that the launch operators would not be able to satisfy. The confusion appears to stem from several sources, including the FAA's more generalized description of different range practices, and unfamiliar requirements contained in Air Force handbooks. For instance, in the NPRM, the FAA proposed a number of requirements that attempted to reconcile the different approaches of the Eastern and Western Ranges and thus restated the requirements in a more abstract or generalized fashion. Additionally, the comments

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[13] See Boeing Costs at 2, 3, 4 (first and second comments), 9 (first comment), 11 (fifth comment), 12 (first and second comments), 22 (second comment), 23 (fourth comment), 24 (first and sixth comments), 25 (first and second comments), 27 (second comment), 28 (first comment), 29 (first and third comments), 33 (second and third comments), 37 (first and third comments), 40 (all comments); Lockheed Cost Estimates 2, 19 and 26; Orbital Cost Impact Assessment at 6 (item 2 regarding aggregation, items 4, 5 and 7); Sea Launch Costs at 23, 24 (second comment labeled a, b and c).

appear to indicate a lack of familiarity with some of the particulars of the range's analyses requirements and existing FAA requirements. The last category of seemingly new requirements appears to consist, to the best of the FAA's ability to interpret them, of misreadings of the proposal.

Commenters attributed a number of costs to generalized expressions of different range practices. For example, in the NPRM, proposed sections 417.113(b)(2), 417.121(f), 417.225, and appendix C, 417.5(g), (h) and (i) would determine whether downrange surveillance was needed on the day of launch. To protect ship traffic down range of the launch area, the FAA proposed that a launch operator identify where its launch vehicle's stages or other planned ejected debris would impact, determine the corresponding hazard area or areas[15], use statistical ship density data to determine whether the launch operator needed to survey the downrange hazard areas for ships, and if downrange surveillance was necessary, determine whether risks at the time of flight required that the launch operator wait until any ships departed from downrange ship hazard areas before initiating flight. See 14 CFR §§ 417.107(b)(3), 417.121, 417.225, and appendix C, C417.5(g) (proposed), 65 FR 63931 (discussion accompanying proposed regulations). A launch operator would be permitted to initiate flight only if the collective probability of impacting any ship in the downrange hazard areas with planned debris would be

[14] See Boeing at 10 (fifth comment); 23 (second, third and fourth comments); 24 (second comment); 27 (first comment); 28 (second comment); Orbital Cost Impact Assessment at 6 (items 3b, 9 and 13-16); Sea Launch Costs at 2 (first and second comments), 7, 10 (first comment), 11, 18-19, 22, 36.

[15] For both ships and aircraft, the FAA proposed in the NPRM and proposes in appendix A of this SNPRM section A417.23(k) and (l) that an impact hazard area for ships down range of the launch site would consist of an area centered on the planned impact point and defined by the larger of the three-sigma impact dispersion ellipse or an ellipse with the same semi-major and semi-minor axis ratio as the impact dispersion, where, if a ship were located on the boundary of the ellipse, the probability of hitting the ship would be less than or equal to 1×10^{-5}. Each aircraft hazard area downrange of the launch site would encompass an air space region, from an altitude of 60,000 feet to impact on the Earth's surface, that contains the larger of the three-sigma drag impact dispersion or an ellipse with the same semi-major and semi-minor axis ratio as the impact dispersion, where, if an aircraft were located on the boundary of the ellipse the probability of hitting the aircraft would be less than or equal to 1×10^{-8}.

less than or equal to 1×10^{-5}. 65 FR 63931. If a launch operator demonstrated, using statistical ship density data and the formula provided in the NPRM, that the collective ship-hit probability in the downrange flight hazard areas was less than or equal to 1×10^{-5}, the launch operator would not have to survey the downrange hazard areas on the day of flight. Id. In their comments, launch operators expressed concern over this proposed standard.

Commenters claimed that the proposed requirement was new and would mean that launch operators would have to survey downrange impact areas for launches from the Eastern Range. JC Vol. II at 50, 83; see JC Vol. I at 8. The FAA does not agree with either of these assertions. When preparing the NPRM, the FAA consulted extensively with both the Eastern and Western Ranges to ensure that the FAA would capture current requirements. The FAA also considered its own experience with the launches of Sea Launch. As far as the FAA is aware, the overwhelming majority of licensed launches conducted from federal launch ranges today would satisfy the FAA's proposed requirements without having to survey downrange hazard areas located in broad ocean waters.

The Joint Commenters stated that if the FAA considers the surveillance efforts of the federal launch ranges sufficient, then the FAA should not change or add the requirements. JC Vol. II at 50. According to the commenters, surveillance of multiple downrange impact hazard areas for a single launch could require multiple aircraft. JC Vol. II at 50. Mechanical problems on the surveillance craft and weather could require a scrub of the launch with resulting cost impacts.

Currently, a range surveys its launch area (which correlates to the FAA's proposed flight hazard area) for the presence of ships and aircraft prior to launch. The ranges do not typically survey downrange stage impact areas located in broad ocean waters. This does not, however, mean that the proposed requirement is new or that the ranges would not currently survey downrange impact areas if it were determined necessary to protect the public.[16] To the contrary, both the Eastern and Western Ranges have advised the FAA that range analysts have addressed the issue. The ranges have not needed to survey downrange impact areas because of the low density of ship traffic and the nature of the traffic, in broad ocean waters, where spent stages currently land. For example, unlike the recreational craft closer to shore, much of the shipping downrange for a typical launch from Cape Canaveral is commercial in nature and the ranges anticipate that those ships monitor the notices to mariners that advise of the presence of hazard areas. However, if a stage impact area proved to be located near a greater density of ship traffic that did not monitor notices to mariners as closely as commercial shipping pilots do, a range could well require surveillance at that stage impact hazard area. Downrange hazard area surveillance is often performed for launches from Wallops Flight Facility. These launches typically involve small rockets with downrange stage impacts that are relatively close to shore where there are significant numbers of pleasure craft and fishing vessels. The FAA proposes to formalize the analysis process that the ranges have been implementing, and would establish a proposed formula and threshold for determining when surveillance of down range impact areas would be necessary. The FAA believes that typical orbital launches from the federal launch ranges meet the FAA's proposed criteria, and that downrange surveillance would continue not to be required for typical launches from those ranges. The comments to the NPRM indicate that the launch operators believe the contrary. Accordingly, the FAA requests that, through the comment period, the launch operators share the reasoning underlying their conclusion.

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[16] The commenters' assertion, see JC Vol. II at 83, that the ranges do not conduct downrange surveillance for reasons of impracticality is not consistent with what the ranges have advised the FAA. The ranges do not, in most cases, conduct downrange surveillance because a safety analysis shows that it is not currently necessary.

After discussion with some of the launch operators, the FAA believes that the launch operators did not recognize that the FAA, to identify requirements that can be applied to the majority of licensed launch activity, wherever it might occur, was merely articulating a more generalized, abstract version of what the ranges are already doing in order to identify the underlying intent. Accordingly, where some of the commenters attributed costs to this requirement,[17] the FAA does not, either for launches from a federal launch range or from a non-federal launch site. The surveillance issue constitutes one example of the tendency to characterize as new what were, in fact, generalized expressions of different range requirements. The commenters attributed other costs on the basis of this misconception as well.[18]

Additionally, the comments appear to assume that many of the ranges' own internal requirements, when proposed in the NPRM, were new. A range conducts its own flight safety analyses based upon raw data provided by a launch operator. Because the launch operators may only be familiar with the data that they themselves provide the ranges, they worried that the standards that the FAA identified were new.[19] In fact, the federal ranges have been performing the analyses and satisfying these requirements on behalf of the launch operators under current practice.

The FAA has grouped remaining concerns regarding proposed requirements that are only seemingly new into two categories. The one category consists of comments that attribute costs

[17] See, e.g., LM Cost Impact Analysis at 3, 13, 23, 26 (proprietary).
[18] See Lockheed Cost Estimates 5 and 7; Orbital Cost Items 2, 3, 5 and 8; Sea Launch Costs at 15-16, 22.
[19] See Boeing Costs at 14 (first comment), 15, 16, 17 (first comment), 18, 38 (first comment); Lockheed Cost Estimates 11 and 13; Orbital Cost Impact Assessment at 6 (items 1 and 2a).

to existing FAA requirements.[20] The other category consists of comments that attribute costs where the commenter misread the proposed requirement.[21]

2. No change in responsibility

As a separate issue, commenting launch operators stated that this rulemaking would change their responsibility for safety, and thus increase their costs. This was not an issue that the FAA addressed in the NPRM because the FAA already considers a launch operator responsible for safety under the statute, the regulations and its launch license. See 14 CFR 415.71. The FAA recognizes, however, that this comment may arise from a belief that the launch operator must use its own employees, rather than continue to rely on the services provided by a federal launch range.[22] If that is the case, the FAA believes that it can set that concern to rest. Under existing 14 CFR 415.31, the FAA grants a safety approval to a launch operator proposing to launch from a federal launch range if the applicant satisfies the requirements of subpart C and has contracted with the range for the provision of safety related services. The Commercial Space Operations Support Agreement and its annex constitutes such a contract. The FAA is proposing to codify the safety requirements of the range and anticipates that the ranges will continue to satisfy those requirements. Nonetheless, to ensure that there is no remaining confusion on this score, the FAA is revising its current proposal to include a provision in proposed 14 CFR

[20] See Boeing Costs at 6 (first, second and third comments), 12 (third comment), 30 (second comment); Lockheed Cost Estimate 6; Sea Launch Costs at 1 (first and second comments), 4-5 (comments labeled a, j, k, n), 7 (first comment), 8 (first, second and third comments), 10 (first comment), 13 (second comment), 17 (comment labeled a) and 20.

[21] See Boeing Costs at 19 (fourth comment), 29 (fourth comment), 34 (fifth comment), 37 (second comment) and 38 (second comment); Sea Launch Costs at 2 (second comment), 5 (comments labeled l and m), 7 (second comment), 9 (first comment), 21 (first full comment).

[22] See, e.g., Boeing Costs at 1, 20, 30 (first comment), 38 (first comment); Lockheed Martin Estimate 8 (attributing costs to requirement that launch operator conduct flight safety analyses now provided by the range); Orbital Cost

417.203(d) that if a launch operator has contracted with a federal launch range for the provision of any flight safety analysis for a licensed launch, and the FAA has assessed the range and found that the range's analysis methods satisfy the requirements of this subpart, the FAA will treat the federal launch range's analysis as that of the launch operator. For any such analysis, the launch operator need not provide the FAA any further demonstration of compliance. The FAA hopes that this clarifies that licensed launch operators may continue their existing arrangements with the federal launch ranges, and that the primary interface for a launch operator launching from a federal launch range remains the range.

3. Operational or licensing changes

Commenting launch operators raised concerns grounded in the notion that the October 2000 NPRM would result in large changes for licensed launch operators operating at federal launch ranges. Specifically, they feared that the requirements for obtaining and maintaining a license would change. JC Vol. I at 3. The FAA requests that in light of the following discussion, the launch operators revisit whether they should ascribe costs to these perceived changes.

On the basis of information provided by the comments, it appears to the FAA that some commenters assigned costs to what they saw as proposed changes in maintaining license compliance if they launched from a federal launch range.[23] Many of these purported costs arise

Impact Assessment at 6 (Items 2 and 10: attributing costs to dual safety approval submittals and shift to FAA oversight).

[23] Boeing Costs at 1 (second comment), 5 (all comments), 7 (all comments), 8 (all comments), 9 (second, third and fourth comments), 10 (first, second and fourth comments), 11 (first and fourth comments), 12 (second comment), 13 (first, second, third and fourth comment), 14 (second comment), 15, 16, 17 (first second and third comments), 18, 19 (first, second and third comments), 21, 22, 23 (first comment), 26 (second and third comments), 27 (third comment), 28 (first and third comment), 30 (second comment), 31 (first and second comment) and 38 (first comment); Lockheed Cost Estimates 3, 4, 9, 10, 11, 12, 13, 14, 20, 23, 24, and 25(b).

out of the belief that the proposed requirements would subject a launch operator at a range to dual administrative requirements. In the NPRM, however, the FAA proposed that the administrative requirements for submitting material to the FAA contained in part 417 applied in total to all licensed launches from a non-federal launch site. NPRM, 65 FR 63977 (proposed 14 CFR 417.1). Accordingly, unless a range changed its processes, the FAA does not anticipate that this rulemaking would require a launch operator launching from a federal range to demonstrate satisfaction of a part 417 requirement twice. Other costs in this category of concern appear to arise out of the launch operators' fear that the federal ranges will not obtain a satisfactory baseline assessment from the FAA for one requirement or another. Given that the FAA proposes these requirements in coordination with the Air Force through the Common Standards Working Group, the FAA has every reason to expect that the federal ranges will continue to satisfy the requirements.

Similarly, commenters assigned costs to a perceived change in the requirements for obtaining a license to launch from a federal launch range. Commenting launch operators, apparently referring to proposed 14 CFR part 415, subpart F, contended that the new requirements for obtaining a license would be unduly burdensome and unwieldy. JC Vol. I at 10-11. They believe they will be required to demonstrate compliance with two sets of requirements when launching from a federal range. JC Vol. I at 3. The FAA can, however, reassure launch operators who launch from federal launch ranges that proposed subpart F would not apply to them. Existing part 415, subpart C (Safety Review and Approval for Launch from a Federal Launch Range), which governs safety reviews for launch license applications from a federal launch range, will continue to apply. Proposed subpart F, (Safety Review and Approval for Launch of an Expendable Launch Vehicle from a Non-Federal Launch Site), applies to license applications for launch from outside of a federal launch range. See NPRM, 65 FR 63944, 63965 (proposed section 415.101 and accompanying discussion). Indeed, as stated in the NPRM, not only would proposed subpart F not apply to a license governing a launch from a federal launch range, but "the proposed regulations for obtaining a license would not... apply to any launch from a non-federal launch site where a federal launch range performs the safety functions." Id. at 63922.

In the event that the Joint Commenters meant to warn that proposed subpart F would be unduly burdensome for obtaining a license for launch from a non-federal launch site, the FAA notes that, for such launches, it must require the same level of safety at non-federal launch sites as the ranges have achieved in the operation of their federal launch sites. Accordingly, information demonstrating that the current standards, as proposed in part 417, are satisfied is necessary.

4. Flexibility and performance and design requirements

Commenters claimed costs on account of a perceived loss of flexibility.[24] The Joint Commenters stated that the October 2000 NPRM contained additional detailed design and testing requirements that will increase operating costs for all launch programs. Promulgating new requirements is not the FAA's intent, and should not be the effect of the FAA's final rule. Instead, the FAA's provision of a route for a launch operator to demonstrate an equivalent level of safety for a proposed alternative, willingness to grandfather and coordination on a waiver process should demonstrate that the FAA will be flexible.

[24] Boeing Costs at 25 (third comment), 26 (fourth comment), 29 (third and fourth comments), 34 (first comment), 35 (fourth and seventh comments); Lockheed Cost Estimate 21; Orbital Cost Impact Assessment at 6 (items 1, 2a, 5, 6,

The commenters believe that the regulatory language used in the NPRM would reduce flexibility in implementing the requirements and that the FAA has changed standards that are currently goals and presented them as hard requirements. The FAA recognized early in the development of the NPRM that it was not always possible to adopt the range safety standards as written in current federal range safety documents because regulations must contain only that which is actually required. EWR 127-1 contains both guidance and requirements. Recommended FAA approaches may appear in guidance documents, such as FAA advisory circulars. Alternatives may be approved through the licensing process.

When faced with a current standard that was in the form of a goal or preferred approach, the FAA, in coordination with federal range personnel, often had to either rewrite the standard as a performance requirement that described the intent of the original goal or omit it from the NPRM if it was determined to be unnecessary. For example, the federal launch ranges have a reliability goal of a minimum of 0.999 at the 95% confidence level for the flight termination system onboard a launch vehicle. Such a goal does not directly translate into a regulatory requirement for which compliance must be demonstrated. A 0.999 reliability at a 95% confidence level can be demonstrated only through a large number of launches or tests of the complete system while exposed to flight environments. The FAA worked with the federal ranges to understand the intent of the goal and how it has actually been implemented. As a result, the FAA's proposed regulations would require each flight termination system and command control system to have a reliability design of 0.999 at a confidence level of 95% to be demonstrated through an analysis of the design. The FAA is not proposing that this reliability be demonstrated through testing because it is not always practical to require the thousands of system

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11 and 12); Sea Launch Costs at 2 (first and second comments), 5 (comments labeled l and m), 8 (first and second

level tests necessary to demonstrate compliance with the confidence level. Instead, the FAA is proposing an approach that has been developed in close coordination with the federal launch ranges, and that incorporates performance oriented design requirements for components coupled with comprehensive qualification and acceptance testing of components and preflight confidence tests of the entire system. The design and test requirements together with the required reliability analysis should ensure the reliability of the flight termination system.

In their discussion on the highly detailed requirements of the NPRM, the Joint Commenters referenced the FAA's licensing of Sea Launch and stated their belief that if Sea Launch had sought FAA approval under a regulatory regime as set forth in the NPRM, the process would have been far slower and more expensive for the launch operator. JC Vol. I at 7. The FAA disagrees. In licensing Sea Launch, the FAA used the current range safety requirements as the basis for evaluating the safety of the proposed launch vehicle and operations: the same requirements used as the basis for the October 2000 NPRM. It was during the evaluation of Sea Launch that the FAA developed various approaches for allowing flexibility in implementing specific requirements, including demonstrating an equivalent level of safety. These requirements and provisions for flexibility were refined and included in the NPRM. The FAA's conclusion was that Sea Launch could satisfy the requirements in the NPRM with no greater effort than was expended during its initial licensing. In effect, Sea Launch was held to the FAA's current requirements. Published requirements, however, with an appropriate level of detail should provide for a consistent, open and fair licensing process for all launch operators.

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comments), 16 (lightning), 22 (alternate flight safety system), 26-35, 38, 40-42.

5. **Neighboring launch operators**

The FAA has learned that each Air Force launch range treats a portion of the public differently. For a launch conducted by a licensed launch operator, the FAA considers other launch operators at a launch site members of "the public." Historically the Eastern Range and the Western Range did not consider anyone who operated at the range to be a member of the public. For approximately the past five years, however, the Eastern Range has been applying the FAA definition of the public when calculating the public risk associated with a licensed launch. At the Western Range other launch operators are not counted to ascertain their contribution to the collective risk to the general public. Some few personnel of other launch operators, at the request of those launch operators, are subjected to a higher level of risk than the rest of the public, which may include allowing them inside impact limit lines or hazard areas during the flight of a launch vehicle.

For the FAA, this approach has both safety and financial responsibility implications. A launch operator may face issues surrounding launch availability and possible increases in insurance premiums. Although the FAA currently proposes no changes from its current practice, the FAA wishes to bring this issue to the attention of the public to obtain comments regarding the impact of the current approach and possible alternatives. The FAA notes that it is willing to entertain alternatives and implementation proposals. The issue is discussed in greater depth below.

In addition to placing the general public at risk, a launch operator's activities may place its neighbors at risk. Different launch operators are each others' neighbors at a single launch site. When, for example, launch operator A launches from one launch pad, adjacent launch operator B may be located within the impact limit lines or a hazard area created by launch operator A's launch. Nonetheless, for reasons of safety, security, or mission assurance, launch operator B may wish to keep some of its personnel working at the second launch point, even during the hazardous activities, including the flight of launch operator A's launch vehicle. Launch operator B's pressure vessels may require tending. Launch operator B may need to maintain the security of the site. Launch operator B may be interested in meeting a tight schedule. Typically, because the location exposes people to greater risk, the range will require the neighboring launch operator to train, shelter and otherwise attempt to protect its people from the increased risks.

The launch operators in this example are engaged in activities in support of separate launches and do not contract with each other for the launch that is about to take place. For these reasons, the FAA treats them as "the public" with respect to each other.[25] In existing 14 CFR part 420, which governs licensing and safety requirements for the operation of a launch site, the FAA defines the "public" as "people and property that are not involved in supporting a licensed launch, and includes those people and property that may be located within the boundary of a launch site, ..., and any other launch operator and its personnel." 14 CFR § 420.5. In the October 2000 NPRM at § 417.3, the FAA proposed a similar definition for "public safety" as the safety of other launch operators and their personnel.

Likewise, for determining financial responsibility under existing 14 CFR part 440, the FAA treats other launch operators and their personnel as third parties. A licensed launch operator does not sign cross waivers with neighboring launch operators, see generally 14 CFR §

[25] Although the FAA does not regulate or oversee the safety of the workers of a licensee, the workers of a neighboring launch operator are members of the public and the FAA has always intended that they be protected as such.

440.17, and the personnel of neighboring launch operators are treated as third parties in the maximum probable loss analysis that determines the amount of financial responsibility a licensee must shoulder. 14 CFR § 440.3(15). The FAA, when calculating the maximum probable loss that may occur to members of the public, requires that a licensee demonstrate financial responsibility for those members of the public who have a chance of being harmed on the order of 1×10^{-7} or more. See 14 CFR § 440.3(11)(i). This means that if any personnel of launch operator B are within the contours of an area where there is chance of an individual being harmed of 1×10^{-7} or more, the FAA will assess the contribution of those individuals to the final financial responsibility determination.

The 30th Space Wing takes a different approach. At the Western Range, the 30th Space Wing relies on the definitions in EWR 127-1 to treat certain identified personnel of neighboring launch operators as not being members of the public, or, in the parlance of EWR 127-1, as "Wing-essential." EWR 127-1 defines "mission-essential" and "non-essential" personnel, and, by implication, Wing-essential personnel. For the first two categories, different levels of risk, protection and exposure are available. In the portion relevant to this discussion, EWR 127-1 defines mission-essential personnel as "those persons necessary to successfully and safely complete a hazardous or launch operation and whose absence would jeopardize the completion of the operation." EWR 127-1 at 1-vii (Dec. 31, 1999). This category includes, among others, "persons specifically authorized by the Wing Commander to perform scheduled activities." Id. The ranges have a different mission than that of the FAA. Being military installations, they include within their mission not only the successful launch of a given launch vehicle, but the continued operations of other vehicles and programs deemed essential to the mission of the wing by the Wing Commander. These activities include, for example, support of commercial launches, launch of national need payloads, strategic weapons testing, warfighter support, payload processing and other activities that promote the function of the range as a whole.

"Non-essential" personnel, on the other hand, are persons who are not otherwise mission or Wing-essential, and include the general public, visitors, members of the media, and "any persons who can be excluded from Safety Clearance Zones with no effect on the operation or parallel operations." EWR 127-1at 1-viii. EWR 127-1 does not contain a definition for Wing-essential, but the 30th Space Wing interprets the mention of Wing-essential personnel in the two definitions to permit a category of persons to be treated as mission-essential for purposes of calculating risk and requiring sheltering. This category may include personnel of neighboring launch operators who are present to perform safety, security or other tasks necessary to continue that second launch operator's operations at the launch site, but does not include anyone performing routine administrative, maintenance, or janitorial functions. Under the interpretation of the 30th Space Wing, when an employee of launch operator B is present within the impact limit lines or, albeit very infrequently, a hazard area for launch operator A's launch, that employee must be sheltered, and is included in a higher risk threshold. See EWR 127-1 at 1-12, 1.4d (Oct. 31, 1997). In contrast to the permissible E_c of 30×10^{-6} for the general public, the workers of the launch operator conducting the launch may be exposed to a higher risk of 300×10^{-6}. Based on information from the 30th Space Wing, there may be, for a given licensed launch at the Western Range, over 100 people who are members of the public under the FAA's definitions, but who the FAA has not identified as such in its financial responsibility determinations due to the differences in definitions.

At the Eastern Range, the 45th Space Wing treats other launch operators as members of the public when calculating public risk due to a licensed launch. The Eastern Range may permit the personnel of neighboring launch operators to remain within the impact limit lines or the flight hazard area in approved hardened structures for a launch. The Eastern Range, when assessing collective risk to the public, counts the neighboring launch operator's personnel as members of the public. In other words, the presence of too many of such people may produce an E_c in excess of 30×10^{-6}. Accordingly, their numbers are limited for that reason.

The FAA and the Air Force now confront the question of whether to continue the FAA and 45th Space Wing approach, or to adopt a variation on the approach of the 30th Space Wing. The Air Force intends to standardize these approaches at its ranges. The former is current practice for the bulk of licensed launches, but the latter was the practice at both ranges prior to the adoption by the 45th Space Wing of the FAA's definition of "the public," and may provide greater operational flexibility, both for the launch operator conducting the launch and for the neighboring launch operator who wants to continue operations during the hazardous activities of the first launch operator. Greater operational flexibility may come with a price, however. Although the FAA could, through rulemaking, permit some members of the public to be exposed to greater risk than others, especially if they are protected,[26] the FAA must point out that the launch operator conducting the launch would have to demonstrate sufficient financial responsibility under part 440 to protect financially against loss to those members of the public. In other words, where a neighboring launch operator's personnel are exposed to risk sufficient to trigger a requirement for financial responsibility coverage, the insurance premiums of the launch

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[26] The Eastern and Western Ranges advise that risk assessments account for any sheltering of the neighboring launch operator's personnel.

operator who is about to launch may increase. Conversely, that first launch operator may find the increased flexibility in its own operations worth the potential increase in premiums.[27]

The FAA and the Common Standards Working Group intend to explore this issue further so as to ensure a common approach. Before the FAA conducts any rulemaking on this issue, the FAA requests comments on the public's experience with the impacts of the two approaches that have been in practice to date. Are there cost impacts associated with either approach? Do the benefits of one outweigh the advantages of the other? Do concerns for worker safety of the neighboring launch operator suggest that no one other than the participants in that launch be allowed in the areas of greater risk? In other words, even with the benefits of increased operational flexibility, would launch operator B not want its employees exposed to greater risk than the general public? Additionally, implementation raises issues. Were the FAA and the ranges to adopt the Western Range's approach, the ranges could oversee and coordinate the presence of different launch operators and their personnel. At a launch site operated by a licensed launch site operator, the FAA already requires that a launch site operator schedule its customers. 14 CFR § 420.55. However, the launch site operator does not assess risk under current requirements. The FAA requests comments on the advisability of imposing such a requirement on a launch site operator.

[27] The FAA notes that it has not been aware, in the course of conducting its maximum probable loss analyses in accordance with 14 CFR part 440, that some of the personnel identified as mission essential at the ranges were, in fact, what the FAA considers members of the public, and should therefore have been considered at the 10^{-7} threshold instead of the 10^{-5} threshold. Because of this possible confusion, the FAA may not have addressed third parties who should have been considered in financial responsibility determinations for licensed launches from both the Eastern and the Western Range. If the FAA determines that their presence requires an increase in the financial responsibility for which a licensee must prepare, that increase would be mandated by existing requirements and would be a decision that was independent of this rulemaking.

C. FAA and Air Force Process for Relief from Common Launch Safety Requirements

Launch operators commenting on the October 2000 NPRM expressed concern for problems they believe will arise if both the Air Force and the FAA oversee the safety of launches from Air Force ranges. JC Vol. I at 1; Lockheed at 3. In response , the Air Force and the FAA have established a permanent safety working group to develop common launch safety standards and implementation processes. This working group has drafted a process for coordinated review of requests for relief from launch safety requirements as well as tailoring of requirements for future programs. This process is outlined in a draft Memorandum of Understanding (MOU) between Air Force Space Command and the FAA Office of the Associate Administrator for Commercial Space Transportation for Resolving Requests for Relief from Common Launch Safety Requirements. The MOU will provide for Air Force and FAA coordination on issues that may arise for a specific launch. For day-to-day operations at an Air Force range, the Air Force will remain the primary point of contact for the launch operators. For a licensed launch, when a request for relief from a common requirement is made to either agency, each agency will ensure notification of the other, and the two agencies will coordinate activities with the launch operator to ensure an efficient and timely resolution.

The draft coordination process contains provisions to address issues "prior to day of launch," when there is time to coordinate and formally document the resolution of an issue before launch, and "day-of-launch" (flight minus 24 hours, often called "real-time") coordination on issues that arise, albeit infrequently, during a launch countdown prior to flight. The Air Force and the FAA will also jointly participate with launch operators in tailoring of common launch safety requirements during the development of launch vehicle systems to be used for licensed launches from Air Force ranges. The coordination process between the Air Force and the FAA will provide for sharing of data to avoid duplication of effort. This coordination will allow for joint resolution of issues regarding common launch safety requirements while ensuring that both agencies' requirements and concerns are addressed without placing undue burden on launch operators. A copy of the draft Air Force/FAA MOU is available on AST's web site at http://ast.faa.gov.

The agencies will continue to administer their own waiver processes. In conjunction with the Air Force/FAA Common Standards Working Group, the two agencies addressed whether the FAA could baseline the Air Force's waiver process. The group determined that the FAA, once its requirements became final, could not baseline the Air Force's waiver process. The FAA cannot delegate its responsibility for safety. The FAA has the authority to waive its own requirements. 49 U.S.C. § 70105(c)(3). As the January 2001 Safety MOA between the FAA and the Air Force recognized, neither agency may waive the requirements of the other. Although Chapter 701 allows another agency to assist the FAA, and the FAA plans to continue to accept the assistance of the Air Force, Chapter 701 does not permit the FAA to delegate its ultimate statutory responsibility for safety to another agency. Accordingly, although the FAA will continue to rely on the Air Force to ensure compliance with the codified standards so long as the baseline assessments show that the Air Force continues to maintain the common standards, the FAA will not be able to accept the Air Force "non-compliance" process through the FAA's baseline assessment. Non-compliances signify a break from the baseline assessment, and they require the appropriate amount of scrutiny from both agencies. Once the common standards are codified, they will be FAA requirements and require FAA approval of a waiver. The FAA's waiver requirements are contained in 14 C.F.R. part 404.

On a practical level, the FAA and the Air Force perceive benefits in the FAA's involvement in the waiver process. The 45th Space Wing has over the course of the past two years invited FAA participation in the range's waiver decisions. Members of the Common Standards Working Group have suggested that coordination between the agencies would be eased by an FAA presence at the ranges, both so that the FAA has greater familiarity with the different launch programs and so that the FAA will be accessible to range and launch operator personnel. The FAA is considering this option.

Legal considerations surrounding waivers and equivalent level of safety determinations result, in part, in the protection of the launch operator. For the FAA, approval of a request for relief may create precedent: for example, if one launch operator receives a waiver because it satisfies certain conditions, a similarly situated launch operator might also expect, absent relevant differences, to receive the same waiver. The FAA, whether through its log of decisions required by the Freedom of Information Act, 5 U.S.C. 552(a)(2), or through advisory circulars must allow access to its waiver decisions, and, in so doing, permit others interested in obtaining a decision to grant a request for relief to see how one might be obtained, taking into account proprietary considerations as appropriate. Although the FAA recognizes that the federal ranges make every effort to treat range users equally, the FAA, unlike the federal ranges, is required by the APA to treat similarly situated persons in a similar manner. The Air Force advises that it has generally found that circumstances surrounding every waiver are sufficiently different that a waiver applies only to the program requesting it. The FAA must have a rational basis for distinguishing between different waiver applicants requesting similar waivers. There are implications to this. The requirement for a rational basis creates an incentive for the FAA to carefully consider all possible implementations when developing a requirement so that the agency can identify exceptions where possible during the rulemaking process. Additionally, after a rule goes into effect, the FAA must fully scrutinize any waiver request so that granting one waiver does not result in the grant of so many others that the requirement is effectively nullified. This approach should also ensure fair treatment between launch operators. As discussed below, the FAA and the Air Force have developed plans to coordinate their determinations. Although that coordination is a matter internal to the workings of the government, both agencies designed the process to minimize disruption on the launch operator, and a description of it follows.

An area of particular concern to launch operators appears to be how the agencies would handle a request for relief from launch safety requirements. On January 16, 2001, the Department of the Air Force and the Federal Aviation Administration signed a Memorandum of Agreement (MOA) on Safety for Space Transportation and Range Activities. The MOA directs the Air Force and the FAA to work together to achieve common launch safety requirements and to establish a process for communication with respect to interpretations of the common safety requirements as they apply to U.S. Government and FAA-licensed launches. The MOA further directs the two agencies to coordinate on the resolution of requests for relief from any common launch safety requirement.

The FAA understands that the complex nature of launch vehicle system safety causes occasional situations where strict compliance with requirements may be difficult, impossible or impractical. In these situations, the launch operator may seek "relief" from the requirement. Relief from a launch safety requirement at an Air Force range typically takes the form of a waiver, or "meets-intent" certification. The Air Force may permit a waiver when the mission objectives of a launch operator cannot otherwise be achieved. The launch operator must obtain a waiver when proposing an activity that does not satisfy an Air Force requirement or when that activity results in greater risk. For the Wing Commander to make an informed decision, personnel responsible for range safety will typically attempt to describe any increase in risk either quantitatively using formal risk analysis techniques or qualitatively based on the specifics of the launch. In some cases the Air Force may waive the public risk criterion. Typically, this would require a significant effort to mitigate risk, such as by increasing reliability of the launch vehicle, and there would have to be a critical national need for the launch. A "meets intent" certification is used when it can be successfully shown that a launch operator's proposed approach, although non-compliant with a requirement in a literal sense, complies with the overall intent of the requirement. To obtain a "meets intent" certification, a launch operator's proposed approach must provide for an "equivalent level of safety." Tailoring of requirements is typically performed when it can be shown that a requirement is not applicable to a given launch vehicle program. Tailoring also typically includes meets intent approvals that apply to a program on a permanent basis. A "meets intent" certification may also be obtained outside of the tailoring process.

There are many similarities between the way the FAA approaches relief from safety requirements and the Air Force approach. FAA regulations permit waivers to safety requirements; however, the FAA's focus on the public safety aspects of licensed launches restricts consideration of mission objectives, including cost or schedule considerations, as justification for approval. The range safety organizations within the Air Force do this as well. Although cost, schedule, and mission assurance are range safety considerations, they are considered secondary to public safety. For government launches, the Air Force Wing Commander may grant a waiver based on national need. Typically, these decisions do not involve FAA-licensed launches. The FAA may grant a waiver if it decides that the waiver is in the public interest and will not jeopardize the public health and safety, safety of property, and national security and foreign policy interests of the United States. 49 U.S.C. § 70105(c)(3). Preferably, a launch operator subject to FAA regulations would demonstrate an equivalent level of safety to obtain relief from an FAA launch safety requirement. The October 2000 NPRM proposed in each part that a launch operator either meet the launch safety requirements as written or, for any proposed alternative, demonstrate an "equivalent level of safety." For all intents and purposes, a range safety "meets intent" certification constitutes one form of the FAA's equivalent level of safety. The Common Standards Working Group has agreed upon common terminology and definitions of these relief categories to minimize the overall impact on launch operators while maintaining the current flexibility.

Commenting launch operators expressed concern that the process of clearly and convincingly demonstrating to the FAA that an alternative approach provides an equivalent level of safety would prove unduly burdensome, and in some instances, unworkable, compared to the tailoring process with the federal ranges. JC Vol. I at 5. The FAA does not foresee an increase in the level of effort on the part of a launch operator to obtain an equivalent level of safety determination and believes that industry's concerns in this area have been addressed. The Common Standards Working Group does not anticipate that FAA involvement will increase the difficulty or lengthen the tailoring process. The FAA has reviewed a sampling of meets intent certifications and tailoring granted by federal ranges in the past and finds that they would satisfy the FAA equivalent level of safety criterion. In addition, the FAA has demonstrated on numerous occasions its willingness and ability, within the context of its regulations and processes, to be flexible in the implementation of its requirements. The FAA has taken into account the unique aspects of the program of each current licensee as the FAA worked with that licensee to achieve its goals while meeting everyone's mutual public safety responsibilities. For launches from a non-federal launch site, the October 2000 NPRM proposes that the FAA and a launch license applicant use the license application process to identify requirements that are not applicable and to ensure that any alternative approach that provides an equivalent level of safety becomes part of the terms of the license. For future launch vehicle programs that will conduct licensed launches at a federal range, the launch operators will continue to follow the Air Force process with participation from the FAA. The FAA and the Air Force will work in a coordinated effort with the launch operator to tailor the common launch safety requirements and make equivalent level of safety decisions for the launch operator's systems.

V. Section-by-Section Analysis of the SNPRM

Part 415 – Launch Licensee

Subpart F – Safety Review and Approval for Launch of an Expendable Launch Vehicle from a Non-Federal Launch Site

The only changes that this SNPRM proposes to make to subpart F of part 415 involve references made to sections of proposed subpart C of part 417. This SNPRM modifies and reorganizes proposed subpart C of part 417. As a result, a number of references in proposed subpart F of part 415 to sections in subpart C of part 417 must be changed.

Part 417, LAUNCH SAFETY

This SNPRM would revise the table of contents for proposed subpart C of part 417 to reflect the modifications that this SNPRM makes to that subpart.

Subpart A, General

This SNPRM modifies § 417.1 of the October 2000 NPRM to include provisions for existing launch vehicle systems to which some of the safety requirements proposed in part 417 would not apply. These changes represent a form of grandfathering as discussed in section III.A of this SNPRM.

The title of § 417.1 has been changed to "scope and applicability." The NPRM's § 417.1, which provides the scope of part 417, is now paragraph § 417.1(a), General. This paragraph contains the same language as the October 2000 NPRM except for the second, fourth and fifth sentences. The second sentence now reads: "The safety requirements contained in this part apply to all licensed launches of expendable launch vehicles unless paragraph (b) of this section applies." The fourth and fifth sentences now read: "For a licensed launch from a federal launch range, the administrative requirements contained in this part do not apply if the FAA, through its baseline assessment of the range, finds that the range satisfies the requirements of part 417. For a licensed launch from a federal range where the range does not satisfy one or more or the requirements of part 417, the FAA will identify the administrative requirements that apply to the launch during the licensing process." The new proposed fourth and fifth sentences provide clarification for whether the proposed administrative requirements in part 417 would apply for a proposed launch from a federal range. As indicated in the new proposed second sentence, the SNPRM proposes to add paragraph § 417.1(b), which would contain provisions for determining whether a specific requirement would apply to a licensed launch operator at a federal range. Unless one or more of the conditions of paragraph (b)(2) of proposed section 417.1 occurs, if a launch operator has a license from the FAA to launch from a federal launch range as of the effective date of part 417 and, for a specific requirement of this part and launch, if the launch operator employs an alternative to the requirement for which the federal range has granted a written meets intent certification as of the effective date of part 417, the launch operator would not be required to demonstrate to the FAA that its alternative provided an equivalent level of safety. If the launch operator had, as of the effective date of part 417, a written waiver from the federal launch range or a pre-existing noncompliance that satisfied the federal launch range's grandfathering criteria, the requirement would not be applicable to the launch. A discussion on the issue of grandfathering and the FAA's reasons for proposing these changes from the October 2000 NPRM is provided in paragraph III.A of this SNPRM.

Paragraph § 417.1(b)(2) would contain criteria for when a requirement would be applicable to a launch operator even if the launch operator satisfied the provisions of §

417.1(b)(1). Even if a launch operator satisfied paragraph (b)(1) for a specific requirement of part 417, the launch operator would be required to bring its launch and launch vehicle, components, systems, and subsystems into compliance with the requirement, including any demonstration of equivalent level of safety, whenever one or more of the following conditions occurred: (i) the launch operator makes modifications that affect the launch vehicle's operation or safety characteristics; (ii) the launch operator uses the launch vehicle, component, system, or subsystem in a new application; (iii) the FAA or the launch operator determines that a previously unforeseen or newly discovered safety hazard exists that is a source of significant risk to public safety; or (iv) the federal range previously accepted a component, system, or subsystem, but, at that time, a noncompliance to an original federal range requirement was not identified. For all intents and purposes these are the same criteria currently used by the Air Force for determining when range safety grandfathering expires.

The Common Standards Working Group has developed a number of definitions to help ensure common interpretation and implementation of launch safety requirements. For any term with a common definition that the FAA uses in its launch safety regulations, the FAA proposes to include the common definition in § 417.3. The SNPRM proposes to replace or insert the definitions into § 417.3 in alphabetical order as follows:

Equivalent level of safety would mean an "approximately equal" level of safety. "Approximately equal" has mathematical meaning, and is clarified by the fact that an equivalent level of safety determination could involve a change to the level of expected risk that was not statistically or mathematically significant as determined by qualitative or quantitative risk analysis.

Explosive debris would mean solid propellant fragments or other pieces of a launch vehicle or payload that result from break up of the launch vehicle during flight and that explode upon impact with the Earth's surface and cause overpressure.

Meets intent certification would mean a decision by a federal launch range to accept a substitute means of satisfying a safety requirement where the substitute provides an equivalent level of safety to that of the original requirement.

Normal flight would mean the flight of a properly performing launch vehicle whose real-time instantaneous impact point does not deviate from the nominal instantaneous impact point by more than the sum of the wind effects and the three-sigma guidance and performance deviations in the uprange, downrange, left-crossrange, or right-crossrange directions.

Normal trajectory would mean a trajectory that describes normal flight.

Risk would mean a measure that accounts for both the probability of occurrence and the consequence of a hazard to persons or property.

Although the FAA proposed to include its definition of "serious injury" in proposed part 417, it is withdrawing that definition because it is better suited to the reporting requirements for which is was originally intended. See 14 C.F.R. § 415.41(b) (reporting requirements for an accident investigation plan). For purposes of determining whether exposure to a given quantity of a hazard could create a serious injury, the proposed definition was not adequate, and the FAA does intend to employ it in proposed part 417. The reporting definition was not adequate because it does not provide the information necessary for realistic modeling of casualties and is not always consistent with the models currently used to estimate potential casualties due to a proposed launch. The FAA notes that the Abbreviated Injury Scale discussed earlier in this

SNPRM provides a useful means of distinguishing between serious injuries and those of lessor severity.

Waiver would mean a decision that allows a launch operator to continue with a launch despite not satisfying a specific safety requirement where the launch operator is not able to demonstrate an equivalent level of safety. A waiver may apply where a failure to satisfy a safety requirement involves a statistically or mathematically significant increase in expected risk as determined through quantitative or qualitative risk analysis, and where the activity may or may not exceed the public risk criteria.

Part 417, Subpart B, Launch Safety Requirements

§ 417.107 Flight safety.

This SNPRM modifies the FAA's proposed public risk criteria in paragraph § 417.107(b) of the original NPRM to reflect understandings reached in the Common Standards Working Group in consideration of public comments. The primary change being proposed in this SNPRM in the area of risk is that the FAA proposes to limit the risk attributable to each hazard rather than to limit an aggregate of the risk for all hazards as was proposed in the original NPRM. A detailed discussion on the modified public risk criteria proposal is contained in paragraph III.B of this SNPRM.

Paragraph § 417.107(b) of the October 2000 NPRM proposed that a launch operator would be required to conduct all launches in accordance with the proposed public risk criteria. This SNPRM changes the wording of paragraph § 417.107(b) to clarify that a launch operator's flight safety analysis must demonstrate that any proposed launch satisfies the public risk criteria.

This modification is meant as a clarification and does not represent a change to the proposed requirements.

Paragraph § 417.107(b)(1) has been modified and would require that a launch operator initiate the flight of a launch vehicle only if the total risk associated with the flight to all members of the public, excluding those members of the public in waterborne vessels and aircraft, does not exceed an expected average number of 0.00003 casualties ($E_C \leq 30 \times 10^{-6}$) from hazards due to impacting inert and explosive debris, $E_C \leq 30 \times 10^{-6}$ for toxic hazards, and $E_C \leq 30 \times 10^{-6}$ for far field blast overpressure hazards. The FAA proposes in this SNPRM that a launch operator may initiate flight only if the total risk associated with the flight satisfies the criteria. The FAA proposes to add the term "total" to clarify that the risk criteria applies to all phases of flight, including both the uprange and downrange portions. See also 14 CFR 415.35. The FAA proposes to identify both types of impacting debris with specificity because it wants to avoid confusion regarding what kinds of debris a debris risk assessment has always addressed. The FAA proposes to specify both because it is possible that either type of debris or a combination could exceed the expected casualty risk criteria, and the FAA wants to ensure that both are addressed. The FAA proposes here to change the name of the hazard from distant focus overpressure to far field blast overpressure to better reflect that a flight safety analysis must account for any potential source of overpressure due to explosions during launch vehicle flight that may cause window breakage, not just that caused by debris impacts, which is typically described as distant focus overpressure. The FAA proposes to 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 for each hazard would apply 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.

Proposed § 417.107(b)(2) has been modified to change the individual risk criterion from probability of casualty (P_C) $P_C \leq 1 \times 10^{-6}$ to $E_C \leq 1 \times 10^{-6}$, to clarify that the criterion would be applied to each hazard, and would exclude persons in waterborne vessels and aircraft. This proposed change would delete all but the first sentence of § 417.107(b)(2) as proposed in the NPRM. Comments received from the Air Force indicated that the use of P_C as a risk criterion is not consistent with the definition of risk. The changes do not represent any new requirements. They are being proposed to improve clarity and to achieve consistent terminology with the ranges. The proposed addition of the flight safety analysis requirement at the beginning of § 417.107(b) eliminates the need to state anything further in § 417.107(b)(2).

The SNPRM changes the NPRM proposed paragraph § 417.107(b)(3) by deleting all but the first sentence. The addition of the flight safety analysis reference in § 417.107(b) eliminates the need to state anything further in § 417.107(b)(3). A launch operator would initiate flight only if, the probability of debris impact to all water-borne vessels (P_{iv}) that are not operated in direct support of the launch does not exceed 0.00001 ($P_{iv} \leq 1 \times 10^{-5}$) in each debris impact hazard area of § 417.223. To achieve commonality with the Air Force, the SNPRM eliminates the use of the term "collective risk" and states the proposed criterion in terms of probability of debris impact to all water-borne vessels to express the collective risk concept. For example, if there were five vessels in the vicinity of the launch, in order to initiate flight, a launch operator would have to demonstrate that if each vessel's individual probability of impact at the time of flight were calculated and those five probabilities were added together, the total would satisfy the criterion. The reference to the requirements for impact hazard areas has been changed to "each debris impact hazard area of § 417.223" to reflect organizational changes and the performance level flight hazard area analysis requirements proposed in the SNPRM.

Paragraph § 417.107(b)(4) in the SNPRM remains the same, minor editorial changes aside, as proposed in the NPRM. A launch operator would initiate flight only if the probability of debris impact to any individual aircraft (P_{ia}) not operated in direct support of the launch does not exceed 0.00000001 ($P_{ia} \leq 1 \times 10^{-8}$) in each debris impact hazard area of § 417.223. The reference to the requirements for impact hazard areas has been changed to "each debris impact hazard area of § 417.223" to reflect organizational changes and the performance level flight hazard area analysis requirements proposed in the SNPRM.

The FAA is requesting public comment on an alternative requirement to protect individual aircraft not operated in direct support of the launch. The FAA and Air Force Common Standards Working Group is considering a change in the proposed requirements of paragraph § 417.107(b)(4) such that the probability of impact to any individual aircraft (P_{ia}) not operated in direct support of the launch does not exceed 0.0000001 ($P_{ia} \leq 1 \times 10^{-7}$) in each debris impact hazard area. This would relax the FAA's proposed aircraft probability of impact standard from 10^{-8} to 10^{-7}. Such a change would be consistent with the current Range Commander Council Standard 321-00 and the FAA's "Supplemental Application Guidance for Unguided Suborbital Launch Vehicles." Such a change would not affect the currently proposed § 417.107(c)(4) which would require that the aircraft impact analysis account for all debris with the potential to impact an aircraft with 11 ft-lbs of kinetic energy or greater and account for the aircraft velocity.

The SNPRM proposes new paragraph § 417.107(c) that would require a launch operator's flight safety analysis to account for any inert debris impact with a mean expected kinetic energy at impact greater than or equal to 11 ft-lbs and, except for the far field blast overpressure effects analysis of § 417.229, a peak incident overpressure greater than or equal to 1.0 psi due to any explosive debris. The 11 ft-lbs threshold for inert debris would apply when determining expected casualties due to blunt trauma. The 1.0 psi threshold for explosive debris would apply when determining expected casualties due to overpressure effects. The far field blast overpressure effects analysis of proposed § 417.229 would account for overpressure levels below 1.0 psi that could cause window breakage and related casualties due to falling or projected glass shards. The SNPRM also proposes that, when using the debris thresholds to determine potential casualties, a flight safety analysis would use either probabilistic models or a more simple and conservative approach. The FAA and Air Force Common Standards Working Group is considering these debris thresholds as proposed common launch safety requirements. The FAA is requesting public comment on the proposed use of these thresholds. A complete discussion on the proposed thresholds and their applicability is provided in section III.C of this SNPRM.

In addition, § 417.107(c) would clarify that a flight safety analysis would be required to apply the thresholds for inert and explosive debris to demonstrate whether a launch satisfied the probability of impact criterion for water-borne vessels of § 417.107(b)(3) and the probability of impact criterion for aircraft of § 417.107(b)(4). Proposed § 417.107(c)(4) would require the analysis to account for the aircraft velocity. Accounting for the aircraft velocity is important when determining the kinetic energy of a potential debris impact with the aircraft. Accounting for the aircraft's velocity is not a new proposal. It was included in appendix A of the NPRM and is being added to proposed § 417.107(c)(4) to clarify that it is an important part of the criterion.

The SNPRM proposes a new paragraph § 417.107(d), which would require that a probabilistic casualty model used by a launch operator must be based on accurate data and scientific principles and be statistically valid. A launch operator would be required to obtain FAA approval of any probabilistic casualty model that is used in the flight safety analysis. If the launch takes place from a federal launch range, the analysis would be allowed to employ any probabilistic casualty model that is accepted as part of the FAA's baseline assessment of the federal launch range's safety process. The proposed provisions for the use of probabilistic models as part of a launch operator's flight safety analysis are intended to provide greater flexibility in demonstrating that a proposed launch satisfies the public risk criteria and to provide greater consistency with the current practices at federal ranges. A complete discussion on the use of probabilistic models as part of flight safety analysis in provided in conjunction with the discussion on casualty thresholds in paragraph III.C of this SNPRM.

The SNPRM re-letters § 417.107(c), (d), (e) and (f) as proposed in the NPRM to (e), (f), (g), and (h) respectively. The title of proposed § 417.107(e) has been changed from "Conjunction on launch assessment" to "Collision avoidance." This change is being made to reflect common terminology used at the federal ranges. The references to subpart C and appendix A in the last sentence of proposed paragraph § 417.107(e) have been modified to be consistent with the other changes made by this SNPRM.

The second and third sentences of proposed paragraph § 417.107(f) have been replaced with a reference to § 417.203(d) that contains provisions for when a flight safety analysis performed by a federal range for a licensed launch may be treated as the licensed launch operator's analysis. This change is meant to clarify that at a federal range, licensed launch operators need not perform analysis ordinarily performed by the range. This is consistent with the FAA's current practice of accepting the federal range process through its baseline assessments. The public comments on the original NPRM indicated that there was significant misunderstanding with regard to this issue, and this change is intended to clear up that misunderstanding.

This SNPRM changes the title of proposed paragraph 417.121(c) from "Conjunction of launch" to "Collision avoidance" to reflect common terminology used at the federal ranges.

The remaining changes that this SNPRM proposes to make to subpart B of part 417 involve references made to sections of proposed subpart C of part 417. This SNPRM modifies and reorganizes proposed subpart C of part 417. As a result, a number of references made in proposed subpart B of part 417 to sections in subpart C of part 417 must be changed accordingly.

Subpart C, Flight Safety Analysis

Subpart C contains proposed requirements governing performance of flight safety analysis to demonstrate a launch operator's capability to manage risk to the public from normal and malfunctioning launches. As originally proposed, subpart C in the NPRM contained both performance level flight safety analysis requirements and additional detailed requirements regarding how to satisfy the performance standards. Comments received from the public as well as the Common Standards Working Group indicated that subpart C of the original NPRM contained detail beyond the performance level, and not all the detail described flight safety analysis methods used by the ranges. In addition, commenters were concerned that proposed subpart C rigidly mandated an approach to performing some of the flight safety analyses, even though more than one acceptable approach might exist. Accordingly, to reflect the Common Standards Working Group understandings regarding common flight safety analysis performance requirements, the FAA now proposes to separate the performance standards from the more detailed methodology requirements, which are now proposed in appendix A. Although the NPRM provided that the FAA would accept alternate analyses if a launch operator provided a clear and convincing demonstration of an equivalent level of safety, 14 CFR § 417.203(f) (proposed in the October 2000 NPRM), the FAA made this organizational change to promote the understanding that it has the ability to accept alternate approaches. A launch operator who satisfied the subpart C requirements with an alternate analysis would not need to use appendix A. This is the FAA's intent for licensed launches that take place at a federal launch range where the FAA baseline safety assessment of the federal range will document the range's implementation of the subpart C requirements. Appendix A requirements would typically apply for licensed launches from non-federal launch sites. As part of the effort to develop common launch safety requirements, the FAA worked with the federal ranges to develop the performance level requirements for flight safety analysis presented in this SNPRM.

This SNPRM proposes a rewritten subpart C that only contains performance requirements for flight safety analysis developed by the Common Standards Working Group (CSWG). The intent is for each section of subpart C to contain common performance requirements agreed to by the Air Force and the FAA that apply to flight safety analysis, regardless of who performs the analysis, with the understanding that the methodologies implemented to satisfy the performance requirements may vary. The public comments on the original NPRM also indicated that there was significant misunderstanding with regard to the proposed administrative requirements associated with flight safety analysis. The revised subpart C in this SNPRM contains modifications to clarify when a launch operator would be required to perform analyses and submit analysis products to the FAA and when the launch operator would not, depending on whether a launch is from a federal range or a non-federal launch site.

There are criteria that apply to the methodologies used to perform flight safety analysis that are necessary to define the acceptable level of fidelity and, when satisfied, ensure consistent analysis results from one launch to the next. Where the federal ranges typically strive to ensure that their analysis methodologies are the state of the art, the FAA's regulations must include methodology requirements that ensure consistent analysis results for launches from non-federal launch sites. Therefore, the analysis methodology requirements that were in the original subpart C of the October 2000 NPRM have been streamlined and are now contained in appendix A with only a few material changes to better reflect current practice. In addition, the requirements for analysis products that would have to be submitted to the FAA, depending on whether the analysis was performed by a federal range or the launch operator and in accordance with any specific terms of the license, have been revised and moved to appendix A (see discussion on revised appendix A).

The title of § 417.201 is now proposed as "scope and applicability." Subpart C would contain performance requirements for a flight safety analysis to be performed as required by § 417.107(d). As was proposed in the original NPRM, the flight safety analysis requirements of § 417.233 would apply to the flight of any unguided suborbital launch vehicle that uses a wind weighting safety system. All other analyses required by subpart C would apply to the flight of any launch vehicle that is required to use a flight safety system in accordance with § 417.107(a). A major concern raised in the public comments to the original NPRM was that many of the analysis requirements in subpart C may not apply depending on the specifics of an alternative flight safety system. The last sentence of revised § 417.201 would clarify that for any alternative flight safety system approved by the FAA in accordance with 417.107(a)(3), the applicability of the analysis requirements in subpart C would be determined during the licensing process, which is current practice.

Section 417.203 now contains proposed requirements related to how a launch operator would demonstrate compliance with the flight safety analysis requirements. The requirements of § 417.203(a) and (b) were taken from § 417.203(a) of the original NPRM. A new sentence was added to the end of 417.203 (a) to clarify that a launch operator's flight safety analysis may rely on a previously accepted analysis for an identical or similar launch if the analysis still applies to the later launch. This change was made in response to comments expressing concern that a launch operator might be required to unnecessarily repeat analyses, which was not the intent of the FAA original proposal in the NPRM.

Proposed section 417.203(c) reflects the fact that the FAA anticipates that different launch operators will employ different methods for satisfying the requirements of proposed subpart C. In the course of the licensing process the FAA would approve an alternate flight safety analysis if a launch operator provided a clear and convincing demonstration that its proposed analysis provided an equivalent level of safety to that required by proposed subpart C. A launch operator would be required to demonstrate that an alternate flight safety analysis was based on accurate data and scientific principles and was statistically valid. The FAA would not find the launch operator's application for a license or license modification sufficiently complete to begin review until the FAA approved the alternate flight safety analysis. Accordingly, a launch operator may not change its methods for conducting a flight safety analysis without FAA approval. A launch operator would have to submit any change to its flight safety analysis methods to the FAA as a request for license modification prior to proceeding with the proposed launch. § 417.203(c) in the SNPRM was taken from § 417.203(f) of the October 2000 NPRM and provides for flexibility by allowing for alternate flight safety analysis methods.

Proposed § 417.203(d) has been added to address the issue of licensed launches that involve federal ranges. The FAA would accept an alternate flight safety analysis used by a federal launch range for a licensed launch, if the FAA documented and approved the alternate flight safety analysis in the FAA baseline safety assessment of that federal launch range. In this case the FAA would treat the federal launch range's analysis as that of the launch operator and the launch operator would not need to provide any further demonstration of compliance. Licensees are advised to remember that there are different procedures for complying with part 417, depending on whether a launch takes place from a federal launch range or from a non-federal launch site. For a licensee proposing to launch from a federal launch range where an FAA assessment shows that the safety services of that range are acceptable, the licensee would not need to provide the FAA any additional information to comply with subpart C. Only if one of the range safety analysis methods did not satisfy a subpart C requirement would a launch operator have to demonstrate satisfaction to the FAA. Additionally, if an FAA baseline assessment showed that a proposed licensed launch from a federal range was in some way outside the experience of the range, the licensee would also have to address any outstanding issues with the FAA, which is current practice under the FAA's current regulations. Thus, although the part 417 requirements apply to a licensee proposing to launch from a federal launch range, this rulemaking does not require the licensee to change its practices at the range. Only changes in range practice would result in a change for the launch licensee. A licensee proposing to launch from a launch site for which no federal launch range provides safety services would, of course, have to demonstrate compliance with all applicable requirements to the FAA.

Proposed § 417.203(e) would now contain the timing requirements for submitting analysis products to the FAA as were proposed in the original NPRM. § 417.203(e) would further clarify that the requirements for submitting analysis products apply for licensed launches that do not qualify for the provisions of paragraph (d) of this section, that is, the requirements for submitting analysis products would apply to analyses that have not been performed by a federal range. The analysis products that were in the various sections of subpart C of the original NPRM have been streamlined and moved to appendix A as discussed below. The license application analysis submittal requirements in § 417.203(e)(1) are repeated without change from § 417.203(c)(1) of the original NPRM. The six-month submittal requirements of § 417.203(e)(2) are unchanged from § 417.203(c)(2) of the original NPRM; however, paragraph (iii) was added to clarify that if an analysis product has not changed since the launch operator's license application submittal, the launch operator's six-month submittal need not repeat the data. The thirty-day submittal requirements remain unchanged from § 417.203(c)(3) of the original NPRM; however the second sentence was added to clarify that if an analysis product has not changed since the since the six-month analysis submittal, the launch operator's thirty-day submittal need not repeat the data. Proposed § 417.203(e)(4) has been added to provide clarification on how a programmatic flight safety analysis would be treated. A launch operator would not be required to submit the 6-month analysis or 30-day analysis update for a launch if the launch operator submitted complete analysis products during the licensing process and demonstrated that all parts of the analysis applied to each launch to be conducted under the license and that the analysis did not need to be updated to account for launch specific factors.

Proposed § 417.205 would now contain general performance requirements that apply to all the various sub-analyses that make up a flight safety analysis. The first sentence of paragraph

§ 417.205(a) contains the same requirement for controlling risk to the public as the first sentence in § 417.203(a) of the original NPRM, except that the requirements are now placed on the flight safety analysis regardless of who performs the analysis. The FAA intends this editorial change to clarify that the analysis may be performed by the launch operator or a federal range. The remainder of § 417.205(a) of the SNPRM proposes new performance requirements for how an analysis demonstrates control of risk by employing risk assessment or hazard isolation or a combination of both. The ranges have historically preferred the use of hazard isolation over risk assessment as the safer approach to the extent practicable. The FAA does recognize that most launches from the ranges reflect a combination of hazard isolation and risk assessment. The FAA agrees that hazard isolation is preferable; however, because a regulation must identify the acceptable limit for purposes of safety, admonitions to use the safer of two acceptable options are not readily codified. The FAA does, however, expect hazard isolation to be the method of choice whenever practical while permitting a combination or choice of either approach. Hazard isolation not only offers the safer approach, it also tends to be analytically easier to demonstrate satisfaction of the requirements. Risk assessment may, however, while requiring more analysis to prove satisfaction of the requirements, also provide greater operational flexibility on the day of launch.

Proposed paragraph § 417.205(b) contains performance requirements for the input and output of dependent analyses to be compatible to ensure accuracy of the analysis products and is essentially the same as § 417.203(e) of the original NPRM.

Proposed section 417.207 of the SNPRM contains the performance requirements that would apply to any trajectory analysis. § 417.207 does not contain any new requirements as compared to the October 2000 NPRM. § 417.207 combines § 417.205(a) of the October 2000

NPRM with the general requirements that were in other paragraphs of § 417.205 of the NPRM and reflects input from the CSWG to better capture current practice at the Air Force ranges. The remaining trajectory analysis methodology requirements that were proposed by § 417.205 of the October 2000 NPRM have been streamlined and moved to A417.7 of appendix A of part 417. Many of the other analyses, such as those performed to establish flight safety limits and hazard areas, would use the products of the trajectory analysis as input. § 417.207 would require that a trajectory analysis determine, for any time after lift-off, the limits of a launch vehicle's normal flight. Normal flight is defined as proposed in section 417.103 the flight of a properly performing launch vehicle whose real-time instantaneous impact point does not deviate from the nominal instantaneous impact point by more than the sum of the wind effects and the three-sigma performance deviations in the uprange, downrange, left-crossrange, or right-crossrange directions. In § 417.205(f) of the October 2000 NPRM, the FAA proposed that a launch operator use a six-degree-of-freedom trajectory model to generate each required three-sigma trajectory. The FAA now proposes to require that only the final trajectory analysis must employ a six-degree of freedom trajectory model because the CSWG concluded that three-degree of freedom trajectory models may satisfy preliminary trajectory analysis requirements. The FAA proposes to delete the use of instantaneous impact point distance from its nominal location as a reference because specifying the reference might appear to rule out other acceptable alternatives. The FAA is making this change to allow for greater flexibility.

Proposed section 417.209 of the SNPRM contains the performance requirements that would apply to any malfunction turn analysis. Proposed section 417.209 combines § 417.207(a) of the October 2000 NPRM with the more general requirements that were in other paragraphs of § 417.207 of the NPRM and reflects input from the CSWG to better capture current practice at the Air Force ranges. The remaining malfunction turn analysis methodology requirements that were proposed in § 417.207 of the October 2000 NPRM have been streamlined and moved to A417.9 of appendix A of part 417. A malfunction turn analysis would be required to determine a launch vehicle's turning capability using sets of malfunction turn curves, consistent with current practice. The FAA has deleted "greatest turning capability" from the first sentence of § 417.207(a) of the October 2000 NPRM, which is now in § 417.209 of the SNPRM. This change is being made to clarify that the products of a malfunction turn analysis are not limited to just the greatest turning capability. The greatest turning capability of the launch vehicle, which would be defined by the envelope of a set of turn curves, would be used for establishing flight safety limits.

The FAA is now proposing that a malfunction turn analysis account for the relative probability of occurrence of each malfunction turn. Although not proposed in the October 2000 NPRM, this performance requirement is consistent with current practice at the federal ranges and is necessary to facilitate use of risk analysis, which is an option that may provide a launch operator greater flexibility. Malfunction turns are typically described in terms of either their cause or effect. The FAA proposes that a malfunction turn analysis account for the cause in order for probabilities to be assigned, and the effects in order to assess debris impact probabilities. Typical causes of malfunction turns include thrust offset and burn through. Thrust offset may include failures in the gimbals or in the flow of thrust vector control fluid. A nozzle burn through may result in an imbalance in the thrust. If a nozzle breaks off, the loss may produce an imbalance in the thrust of the launch vehicle and consequent changes in its velocity vector. Launch vehicle systems such as the examples discussed above and others that could be the cause of a malfunction turn may fail in many ways. If a flight safety analysis is to make greater use of risk analysis the causes of possible malfunction turns need to be identified and their probabilities determined.

Proposed section 417.211 of the SNPRM contains the performance requirements that would apply to any debris analysis. § 417.211 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the NPRM have been reorganized, and modifications are proposed to better reflect current practice at the federal ranges. § 417.211 combines § 417.209(a) of the October 2000 NPRM with some general requirements from other paragraphs of § 417.209 of the NPRM. The remaining debris analysis methodology requirements that were in § 417.209 of the October 2000 NPRM have been streamlined and moved to A417.11 of appendix A to part 417.

Section 417.211 would require a debris analysis to identify the inert, explosive, and other hazardous launch vehicle debris that results from normal and malfunctioning launch vehicle flight. A debris model would consist of lists of the debris fragments that are planned as part of a launch or that result from breakup of the launch vehicle. The lists would account for and describe all debris fragments and their physical characteristics. These debris lists would be necessary as input to other flight safety analyses such as those performed to establish flight safety limits and hazard areas and to determine if the launch satisfies the public risk criteria.

Proposed section 417.213 of the SNPRM contains the performance requirements that would apply to flight safety limits analysis and would capture current practice at the federal ranges. § 417.213 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the NPRM have been reorganized. § 417.213 combines § 417.213(a) of the October 2000 NPRM with the performance requirements from other paragraphs of § 417.213 of the NPRM. The remaining flight safety limits analysis methodology requirements that were in § 417.213 of the NPRM have been streamlined and moved to A417.13 of appendix A to part 417. § 417.213 also combines specific flight control lines analysis requirements from § 417.211 of the October 2000 NPRM. The SNPRM would eliminate the requirement for a separate flight control line analysis. The flight control lines analysis was proposed in the NPRM to identify the protected areas and account for map and tracking errors. The FAA now proposes to include the identification of protected areas and accounting for map and tracking errors as part of the flight safety limits analysis.

Proposed section 417.213 would require a flight safety limits analysis to identify the location of populated or other protected areas and establish flight safety limits that define when a flight safety official must terminate a launch vehicle's flight to prevent the hazardous effects of the resulting debris impacts from reaching any populated or other protected area and ensure that the launch satisfies the public risk criteria of § 417.107(b). The public risk management requirements of proposed § 417.205(a), in general, allow a flight safety analysis to employ risk assessment or hazard isolation, or a combination of risk assessment and partial isolation of the hazards to demonstrate control of the risk to the public. Because flight safety limits are to be implemented for the specific situation when a malfunctioning launch vehicle is heading for a protected area, the FAA proposes that the flight safety limits should provide for a measure of isolation from impacting debris hazards. Were risk the sole measure used to establish flight safety limits, a low probability of launch vehicle failure might result in flight safety limits that would not represent the boundaries of safe flight in the event of a failure.

Although flight safety limits provide a form of hazard isolation, they must also reflect and support how a launch satisfies the public risk criterion for debris. Current practice provides a good example of how this approach works. At the Eastern Range, the 45th Space Wing establishes destruct lines, which constitute one kind of flight safety limit, to prevent debris with a ballistic coefficient of three[28] or more from reaching protected areas. Nonetheless, debris with a ballistic coefficient of less than three may still reach protected areas and may cause casualties, as discussed previously. A flight safety analysis would assess the "residual risk," risk due to any hazard not isolated from the public, to determine whether the public risk criterion is satisfied. The FAA proposes in this SNPRM to require that the debris risk assessment of proposed section 417.225 account for the risk due to debris with kinetic energy at impact of 11 ft-lbs. With this measure of what may cause a casualty, the risk assessment may show that flight safety limits designed to isolate debris with a ballistic coefficient of three still permit too much risk due to more wind sensitive debris pieces with ballistic coefficients of less than three. For example, a large number of small pieces of debris or large crowds at the edge of the flight safety limits might increase risk to unacceptable levels. In that case, the FAA's proposed requirements would mandate that the flight safety limits be adjusted to ensure that the launch satisfied the public risk criteria of proposed section 417.107(b). If the flight safety limits were designed to isolate debris with a kinetic energy of 11 ft-lbs at impact, there would be no need to assess the residual risk due to debris outside of the flight safety limits. Of course, a flight safety analysis would still need to assess the risk due to the potential for flight termination system failure.

Proposed section 417.215 of the SNPRM contains the performance requirements that would apply to any straight-up time analysis and captures current practice at the federal ranges. § 417.215 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized. Proposed section

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[28] As proposed in appendix A of part 417 of this SNPRM, the FAA proposes to rely on a ballistic coefficient of three to establish flight safety limits.

417.215 combines § 417.215(a) of the October 2000 NPRM with the top-level requirements that were in other paragraphs of § 417.215 of the October 2000 NPRM. The remaining straight-up time analysis methodology requirements that were in § 417.215 of the October 2000 NPRM have been streamlined and moved to A417.15 of appendix A to part 417. A straight-up time analysis would be required to establish the straight-up time as the latest time after liftoff, assuming a launch vehicle malfunctions and flies in a vertical or near vertical direction above the launch point, at which activation of the launch vehicle's flight termination system or breakup of the launch vehicle would not cause hazardous debris or critical overpressure to affect any populated or other protected area. Straight-up time is a special type of flight safety limit used to address this specific type of failure. In the event of such a failure, the flight safety official would terminate flight at the straight-up time to ensure that hazardous debris effects do not extend to populated or other protected areas.

Proposed section 417.217 of the SNPRM contains the performance requirements that would apply to any no longer terminate gate analysis and captures current practice at the federal ranges. § 417.217 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized. Section 417.217 combines § 417.219(a) of the October 2000 NPRM with the performance requirements that were in other paragraphs of § 417.219 of the October 2000 NPRM. The remaining analysis methodology requirements that were in § 417.219 of the October 2000 NPRM have been streamlined and moved to A417.17 of appendix A to part 417.

A no longer terminate gate analysis would be required to determine the portion, referred to as a gate, of a flight safety limit, through which a launch vehicle's tracking icon is allowed to proceed without a launch operator being required to terminate flight. A tracking icon is the representation of a launch vehicle's position in flight available on a flight safety official console during real-time tracking of the launch vehicle's flight. The products of a no longer terminate gate analysis are necessary for establishing flight termination rules for any planned launch vehicle flight over a populated or other protected area. Once a launch vehicle traversed a gate, flight would not be terminated while the vehicle's debris impact dispersion footprint was over the protected area.

Proposed section 417.219 of the SNPRM contains the performance requirements that would apply to any data loss flight time analysis and captures current practice at the federal ranges. § 417.219 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized and some modifications have been made to better reflect current practice at the federal ranges. § 417.219 combines § 417.221(a) of the October 2000 NPRM with the performance requirements that were in other paragraphs of § 417.221 of the October 2000 NPRM. The remaining analysis methodology requirements that were in § 417.221 of the October 2000 NPRM have been streamlined and moved to A417.19 of appendix A to part 417.

Proposed section 417.219 would require a flight safety analysis to establish data loss flight times and a no longer terminate time for use in establishing flight termination rules that apply when launch vehicle tracking data is not available to the flight safety official. A data loss flight time would be the shortest elapsed thrusting time during which a launch vehicle could move from its normal trajectory to a condition where the launch vehicle's hazardous debris impact dispersion extended to any protected area. A flight safety official uses data loss flight times as the longest time he would wait before terminating flight when launch vehicle tracking data became unavailable. Current practice recognizes that loss of tracking data does not necessarily mean that a launch vehicle failure has occurred. The launch may continue in the absence of tracking data, but only for the period of time that the launch vehicle debris impact dispersion could not reach a protected area. The analysis would assume that a malfunction occurred when the tracking data was lost and that the launch vehicle headed for the nearest protected area. If tracking was not restored before the launch vehicle debris impact dispersion could reach the protected area, the flight would have to be terminated. Although the October 2000 NPRM proposed that the time describe the shortest elapsed time in which public endangerment could become possible, because current practice only accounts for debris as a hazard for purposes of determining flight safety limits, the FAA proposes to modify this provision to reflect the true nature of the concern: namely, debris impacts. Because the earliest destruct time is in fact the first data loss flight time, the SNPRM eliminates as redundant all references to the earliest destruct time. A flight safety analysis would also determine the no longer terminate time for a launch, which would replace the term "no longer endanger time." The CSWG recommended that the FAA propose this change in terminology because no longer endanger time has different uses at different ranges and in some cases may be some what of a misnomer. No longer terminate time is a more generally applicable term that better reflects its actual implementation. The SNPRM proposes to provide streamlined definitions and requirements for data loss flight times and the no longer terminate time that are consistent with current practice. The analysis for no longer terminate time would establish the time after liftoff that a launch vehicle's hazardous debris impact dispersion could no longer reach any protected area from that time forward to final impact or orbital insertion as the no longer terminate time for the launch. Different federal ranges use different terminology for data lose flight times and no longer terminate time. The FAA is proposing the use of generic terms and requirements that, for all intents and purposes, are consistent with current practice at the federal ranges.

The SNPRM contains a modification to better reflect current practice at the federal ranges for launches where a gate permits overflight of a protected area and where orbital insertion occurs after reaching the gate. In such cases, the no longer terminate time would be the time after liftoff when the time for the launch vehicle's instantaneous impact point to reach the gate is less than the time for the instantaneous impact point to reach any flight safety limit. Current practice embraces this approach for at least two reasons. If a launch vehicle performs normally until that point in its trajectory, it will almost certainly enter the gate. If flight were terminated after that time, there would be a greater likelihood of debris impacting the protected area than if the flight were allowed to continue.

Proposed section 417.221 of the SNPRM contains the performance requirements that would apply to any time delay analysis and captures current practice at the federal ranges. § 417.221 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized. § 417.221 combines § 417.223(a) of the October 2000 NPRM with the requirements that were in other paragraphs of § 417.223 of the October 2000 NPRM. The remaining analysis methodology requirements that were in § 417.223 of the October 2000 NPRM have been streamlined and moved to A417.21 of appendix A to part 417.

Proposed section 417.221 would require a time delay analysis to determine the mean elapsed time between the violation of a flight termination rule and the time when the flight safety system is capable of terminating flight so that flight termination would occur. A time delay analysis would have to account for all sources of time delay that could have an effect on identifying when a launch vehicle malfunction occurred and how quickly flight could be terminated once a malfunction was identified. Proposed § 417.221 would clarify that a time delay analysis would be required to account for the variance of time delays for each potential failure scenario, including but not limited to, the range of malfunction turn characteristics and the time of flight when the malfunction occurred.

Proposed section 417.223 of the SNPRM contains the performance requirements that would apply to any hazard area analysis and captures current practice at the federal ranges. § 417.223 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized. § 417.223 contains the requirements that were in § 417.225(a) of the October 2000 NPRM. The remaining analysis methodology requirements that were in § 417.225 of the October 2000 NPRM have been streamlined and moved to A417.23 of appendix A to part 417.

The FAA would require a flight hazard area analysis to identify any regions of land, sea, or air that must be monitored, publicized, controlled, or evacuated to control the risk to the public from debris impact hazards. The risk management requirements of § 417.205(a) would apply. Proposed section 417.225(a) of the October 2000 NPRM stated that hazard areas must be implemented to "ensure public safety." The requirements for satisfying the various public risk criteria were spread throughout other paragraphs in § 417.225 of the October 2000 NPRM. In keeping with the intent of defining the performance requirements, the new proposed section 417.223 now states that the risk management requirements of proposed § 417.205(a) would apply. Managing the risk to the public, which involves employing risk assessment or hazard isolation, or a combination of risk assessment and partial isolation of the hazards to demonstrate control of the risk to the public and that the public risk criteria are satisfied as required by proposed § 417.205(a), in effect, provides for the necessary assurance of public safety. Consistent with current practice at the federal ranges, the analysis would account for, but need not be limited to, regions of land potentially exposed to debris resulting from normal flight events and events resulting from any potential malfunction, regions of sea and air potentially exposed to debris from normal flight events, including planned impacts, and in the vicinity of the launch site, any waterborne vessels or aircraft exposed to debris from events resulting from any potential abnormal flight events, including launch vehicle malfunction.

For sea and air regions beyond the vicinity of the launch site, a typical flight hazard area analysis would only account for normal flight events, including planned impacts. Historically, the probability of impacts to aircraft and waterborne vessels due to potential launch vehicle malfunctions has been significant only during the initial stages of flight that take place in the vicinity of the launch site. Typically, once a launch vehicle is beyond the vicinity of the launch site the impact dispersions are large enough and the instantaneous impact point moves fast enough that the probability of impacts to aircraft and waterborne vessels due to potential launch vehicle malfunctions is negligible in comparison to those in the vicinity of the launch site. Furthermore, the probability of a launch vehicle malfunction is typically at its highest during the initial stages of flight, which generally includes the point where the vehicle experiences the maximum dynamic pressure. Once a launch vehicle has completed the initial stages of flight and is beyond the vicinity of the launch site, aerodynamic forces on the launch vehicle are generally small due to the reduced atmospheric density at high altitudes. However, proposed § 417.205(a) would require the analysis to identify any regions of land, sea, or air that must be monitored, publicized, controlled, or evacuated in order to control the risk to the public from debris hazards and would not limit where flight hazard areas may need to be established.

Proposed section 417.225 of the SNPRM contains the performance requirements that would apply to any debris risk analysis and includes requirements for the debris thresholds to be applied when calculating debris risk. The current practice for debris risk analysis may vary from launch site to launch site and from vehicle to vehicle. Proposed section 417.225 of this SNPRM contains proposed common performance requirements that would apply to all launches at federal ranges and non-federal launch sites. Proposed section 417.225 combines § 417.227(a) of the October 2000 NPRM with the requirements from other paragraphs of § 417.227 of the October 2000 NPRM. The remaining analysis methodology requirements that were in § 417.227 of the October 2000 NPRM have been streamlined and moved to A417.25 of appendix A to part 417.

The FAA would require that a debris risk analysis would demonstrate that the risk to the public potentially exposed to inert and explosive debris hazards from any one flight of a launch vehicle satisfied the public risk criterion of proposed § 417.107(b)(1) for debris. A debris risk analysis would account for risk to populations on land, including regions under launch vehicle flight following passage through any gate in a flight safety limit established in accordance with § 417.217. A debris risk analysis would account for any potential casualties to the public in accordance with the debris thresholds and requirements of proposed § 417.107(c). The October 2000 NPRM provided that a debris risk analysis need not account for debris with a ballistic coefficient of less than three. The FAA realizes that ballistic coefficient may not be the best parameter to use as an indication of casualty. A casualty could result from debris with a ballistic coefficient of less than three. The reverse may also be true. An impact of debris with a ballistic coefficient just greater than three might not result in casualty. The FAA in coordination with the Air Force has reviewed the recent human vulnerability modeling results and believes that, for typical space launch vehicle debris masses and shapes, for the purposes of a debris risk analysis, it is reasonable to consider the potential for casualty due to blunt trauma when a human is subjected to any inert debris impact with a mean expected kinetic energy greater than or equal to 11 ft-lbs. Further discussion and results of the research on this issue are provided in paragraph III.C.1 of this notice. Proposed section 417.225 would now reference proposed § 417.107(c), which requires that an analysis account for inert debris impacts with mean expected kinetic energy at impact greater than or equal to 11 ft-lbs.

The October 2000 NPRM proposed that in a debris risk analysis, the effective casualty area of any explosive debris, such as solid propellant fragments that would result from break up of the launch vehicle during flight and that would explode upon impact with the Earth's surface, would account for a 3.0 psi blast overpressure radius. This is typical of current practice for analysis of people in the open. However, using a 3.0-psi blast overpressure radius is generally inappropriate for analysis of people in typical buildings. The FAA in coordination with the Air Force has reviewed the recent human vulnerability modeling results and now proposes that a peak incident overpressure of 1.0 psi or greater due to any explosive debris impact as a practical threshold for explosive debris, excluding window breakage effects treated in the far field blast overpressure analysis. Further discussion and results of the research on this issue are provided in paragraph III.C.2 of this notice. Proposed section 417.225 would now reference proposed § 417.107(c), which requires that the analysis account for any public risk in populated areas potentially subject to peak incident overpressure of 1.0 psi or greater due to any explosive debris impact.

Proposed section 417.227 of the SNPRM contains performance requirements that would apply to any toxic release hazard analysis and captures current practice at the federal ranges. § 417.227 does not contain any new requirements as compared to the October 2000 NPRM;

however, the provisions of the October 2000 NPRM have been reorganized. The requirements of § 417.227 were moved from § 417.229 of the October 2000 NPRM. The proposed analysis methodology requirements continue to be provided in appendix I to part 417, which remains unchanged from the October 2000 NPRM.

A toxic release analysis would be required to establish flight commit criteria that ensure compliance with the public risk criterion of § 417.107(b)(1). The analysis would account for any toxic release that would occur during normal or malfunctioning launch vehicle flight. The analysis would account for any operational constraints and emergency procedures that would provide protection from toxic release. The analysis would account for all members of the public on land and on any waterborne vessels and aircraft not operated in direct support of the launch.

Proposed section 417.229 of the SNPRM contains the performance requirements that would apply to any far-field overpressure blast effects analysis, which was referred to in the NPRM as distant focus overpressure blast effects analysis. Proposed section 417.229 combines § 417.231(a) of the October 2000 NPRM with the other performance requirements from other paragraphs of § 417.231 of the October 2000 NPRM. Section 417.229 of the SNPRM contains modified requirements with substantial streamlining and modifications made for clarity, to provide more flexibility, and to better capture current practice at the federal ranges. Section 417.229(a) combines paragraphs (a) and (c) from § 417.231 of the October 2000 NPRM. Section 417.229(a) now states that a flight safety analysis must establish flight commit criteria that ensure compliance with the public risk criterion. Thus, the SNPRM now proposes the option of performing a risk analysis to assess the potential for casualties due to window breakage consistent with the updated public risk criteria regarding blast risk. To provide greater consistency with current practice, paragraph (a) clarifies that a flight safety analysis must demonstrate that any potential source of far field blast overpressure due to explosions during launch vehicle flight, not just distant focus overpressure from debris impacts, will not cause window breakage. Alternatively, the analysis must demonstrate satisfaction of the risk criteria. The SNPRM emphasizes that the hazard of concern is "far field blast overpressure due to explosions during launch vehicle flight," which excludes consideration of potential sonic boom effects due to normal flight in this analysis. Potential sonic boom effects are typically considered in the environmental review process. Given the proposed 1.0 psi threshold for debris risk analysis, the FAA proposes that the far field blast overpressure analysis must account for any potential source of far field blast overpressure to ensure adequate public protection from potential window breakage hazards and remain consistent with current practice. Past experience at the Eastern and Western Ranges demonstrates that debris impacts are the overwhelmingly dominant source of public risk due to far field blast overpressure (peak incident overpressures below 1.0 psi). However, improperly designed flight termination systems may produce propellant explosions at altitude with the potential to break windows in protected areas.

Section 417.229(b) would provide performance requirements that apply to any far-field blast overpressure analyses, in lieu of the prescriptive requirements proposed in the October 2000 NPRM. Although proposed paragraph (b)(5) would require an analysis to account for the characteristics of potentially affected windows, including size, location, orientation, glazing material, and condition, the FAA does not intend this to require a physical survey of potentially affected public areas. Instead, reasonable assumptions based on the building construction and characteristics typical of the affected public areas may be applied to account for the characteristics of potentially affected windows. For example, as described in A417.29 of appendix A of this SNPRM, the FAA foresees that a launch operator could demonstrate that far field blast overpressure due to potential explosions during launch vehicle flight will not cause windows to break based on the equations and assumptions of the American National Standard "Estimating Air Blast Characteristics for Single Point Explosions in Air, with a Guide to Evaluation of Atmospheric Propagation and Effects," ANSI S2.20-1983. The remaining analysis methodology requirements of § 417.231 of the October 2000 NPRM have been streamlined and moved to A417.29 of appendix A to part 417.

Proposed section 417.231 of the SNPRM contains the performance requirements that would apply to collision avoidance analysis and captures current practice at federal ranges. Proposed section 417.231 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized. Proposed section 417.231 contains the requirements that were in § 417.233(a) of the October 2000 NPRM. The title of § 417.233 in the NPRM was "Conjunction on launch assessment, " which is a term used by United States Space Command. The SNPRM changes the title of the proposed section to "Collision avoidance analysis," to be more consistent with common terminology used at the federal ranges. The analysis methodology requirements that were in § 417.233 of the October 2000 NPRM have been moved to A417.31 of appendix A to part 417.

A federal launch range will typically perform a collision avoidance analysis for any launch from that range. If no federal range is involved in the launch, the launch operator would obtain a collision avoidance analysis from United States Space Command. A launch operator would implement any waits in the launch window, as identified by United States Space Command, during which flight must not be initiated in order to maintain a 200-kilometer separation from any habitable orbiting object.

Proposed section 417.233 of the SNPRM contains the performance requirements that would apply to the flight safety analysis for launch of an unguided suborbital rocket flown with a wind weighting safety system and captures current practice at federal ranges. Proposed section 417.233 does not contain any new requirements as compared to the October 2000 NPRM; however, the provisions of the October 2000 NPRM have been reorganized. Proposed section 417.233 contains the requirements that were in § 417.235(a) of the October 2000 NPRM. The remaining analysis methodology requirements that were in § 417.235 of the October 2000 NPRM have been moved to A417.33 of appendix A to part 417. The analysis would be required to establish the launch commit criteria and other launch safety rules to control the risk to the public due to potential adverse effects resulting from normal and malfunctioning flight and ensure satisfaction of the public risk criteria. The analysis would establish any wind constraints under which launch could occur and include a wind weighting analysis that established the launcher azimuth and elevation settings that corrected for the windcocking and wind-drift effects on the unguided suborbital rocket..

Appendix A – Flight Safety Analyses Methodologies and Products

The SNPRM combines requirements that were in the original appendix A to part 417 of the October 2000 NPRM with requirements moved from part 417, subpart C of the October 2000 NPRM to create a comprehensive flight safety analysis methodologies and products appendix. A417.1 would provide the scope of the appendix. Appendix A would contain requirements for the methods used in performing flight safety analysis as required by § 417.107(d) and subpart C of part 417. The methodologies contained in appendix A would represent acceptable means of satisfying the analysis performance requirements of subpart C and provide a standard against which any proposed alternative analysis approach would be measured. Appendix A would also identify the analysis products that a launch operator would be required to submit to the FAA in accordance with § 417.203(e).

Comments received regarding the October 2000 NPRM indicated that there was confusion as to who had to perform various flight safety analyses and regarding when the various analysis methodology requirements applied, in particular with regard to licensed launches from federal ranges. A417.3 would clarify that the requirements of appendix A would apply to a launch operator and the launch operator's flight safety analysis unless the launch operator demonstrated that an alternative approach provided an equivalent level of safety. If a federal launch range performed the launch operator's analysis, § 417.203(d) would apply. Proposed appendix A section A417.33 would apply to the flight of any unguided suborbital launch vehicle that used a wind weighting safety system. All other sections of appendix A would apply to the flight of any launch vehicle required to use a flight safety system in accordance with proposed § 417.107(a). For any alternative flight safety system approved by the FAA in accordance with 417.107(a)(3), the FAA would determine the applicability of appendix A during the licensing process.

Proposed section A417.5 references important requirements of the new proposed § 417.205 that a launch operator would need to know when satisfying the requirements of appendix A. These requirements are the general performance requirements for public risk management and the requirements for the compatibility of the input and output of dependent analyses.

The remaining sections of appendix A do not contain any new requirements as compared to the October 2000 NPRM and current practice; however, the provisions of the October 2000

NPRM have been reorganized and in a number of cases, the requirements have been significantly streamlined in response to comments received on the NPRM and to provide greater consistency with current practice. Comments will be addressed in the final rule. Requirements that were in subpart C of part 417 of the October 2000 NPRM were streamlined where possible and moved to appendix A. For example, paragraph A417.7(a) references the new top level performance requirement, now in section 417.207. The rest of the material in A417.7 comes from section 417.205 of the original NPRM. The other sections in appendix A now follow this same approach. For each new performance requirement section in the revised part 417 subpart C, there is a section in appendix A. As another example, performance malfunction turn analysis requirements would now appear in § 417.211. The methodology requirements for calculating malfunction turn data and the requirements for analysis products that would apply to a launch operator's demonstration of compliance would now appear in A417.11. The flight hazard area analysis requirements that were in the original appendix A, have now been combined with the flight hazard area requirements that were in § 417.225 of the October 2000 NPRM and the combined requirements are now in A417.23. The FAA's goal is to have a single, all inclusive flight safety analysis appendix that contains detailed requirements necessary to demonstrate compliance with the flight safety analysis performance requirements that are now in subpart C of part 417.

Proposed section A417.7 contains trajectory analysis methodology requirements that were in § 417.205 of the October 2000 NPRM with some significant modifications. The NPRM would have allowed the use of annual or monthly composite wind profiles in a launch operator's trajectory analysis. Proposed A417.7(b) changes the proposed requirement to composite wind profiles for the month that a proposed launch will take place or winds that are as severe or more severe than the winds for the month that a proposed launch will take place. Annual winds may or may not represent worst case conditions. Use of annual winds in some cases can result in significant launch restrictions and in other cases may result in unsafe analysis results. Use of monthly wind profiles is current practice at both Air Force ranges and does not represent any increase in analysis effort. A launch operator would still be allowed to use "worst case winds" in a trajectory analysis.

The October 2000 NPRM would have required that the three-sigma trajectories be determined assuming a normal bivariate Gaussian distribution. The SNPRM contains changes that recognize that the distribution may in fact be something else. Paragraph A417.7(d) now proposes only that the trajectory analysis describe the distribution. The original requirements for a Gaussian distribution in the following paragraphs have been deleted and the paragraphs have been reworded to reflect the possibility of different distributions. These changes provide for greater flexibility and broader applicability of the requirements.

The proposed requirements for a fuel-exhaustion trajectory in SNPRM paragraph A417.7(d)(3) have been streamlined as compared to § 417.205(d)(3) of the October 2000 NPRM. As indicated by comments received on the NPRM the subparagraphs under § 417.205(d)(3) of the NPRM were in some ways repetitive. The SNPRM contains no new fuel-exhaustion trajectory requirements. Proposed paragraph A417.7(d)(3) in the SNPRM has been reworded and the subparagraphs have been deleted to eliminate repetitiveness. The SNPRM clarifies that the requirements for a fuel-exhaustion trajectory only apply to launch vehicles with a last suborbital stage that will terminate thrust nominally without burning to fuel exhaustion.

Proposed A417.7(e) of the SNPRM contains requirements for a straight-up trajectory that remain unchanged from § 417.205(e) of the October 2000 NPRM.

Proposed A417.7(f) of the SNPRM contains significantly streamlined requirements from § 417.205(f) of the October 2000 NPRM. The NPRM would have directed the use of a root-sum-square analysis method or equivalent and provided some detailed requirements that would apply only to the root-sum-square method. The revised proposed requirements of A417.7(f) of the SNPRM provide a more performance oriented approach that recognizes that there is more than one acceptable analysis approach. A417.7(f) would still require the use of a six degree of freedom trajectory model; however, the paragraph would now contain performance requirements for how the model was used. The root-sum-square and Monte Carlo methods are now only referred to as examples of approaches that would satisfy the performance requirements. The detailed requirements proposed in the NPRM for performing a root-sum-square analysis have been deleted. Proposed section A417.7(e)(1) now requires that the analysis identify the distribution of each performance parameter rather than its standard deviation in recognition that the distribution may be other than normal.

A417.7(g) of the SNPRM contains requirements for trajectory analysis products from § 417.205(g) of the October 2000 NPRM with some streamlining and modifications to remain consistent with changes made to other paragraphs in section A417.7. Paragraph (g)(2) now requires a description of the distribution of each performance error as discussed earlier. Consistent with current practice, the proposed altitude intervals for the required wind profiles in paragraph (g)(3) have been changed from 1000 feet to 5000 feet, which results in fewer data points without any negative effect on the analysis. The last sentence in paragraph (g)(3) has been deleted in the SNPRM as redundant. Paragraph (g)(7) was modified in the SNPRM to combine the original paragraph § 417.205(g)(7) with paragraphs § 417.205 (g)(8) and (9) of the October 2000 NPRM. The SNPRM clarifies the proposed requirement for total thrust paragraph (g)(7)(xi) is total vacuum thrust. The requirements for dynamic pressure and Coriolis displacement proposed in paragraph § 417.205(g)(7)(xiii) and (xiv) of the NPRM have been deleted in the SNPRM as redundant because they can be determined from, or are incorporated into, other data that would be submitted.

Proposed A417.9 of the SNPRM contains requirements for malfunction turn analysis from § 417.207 of the October 2000 NPRM with some streamlining and modifications made for clarity, flexibility, and consistency with current practice. Paragraph (b)(1) now clarifies that malfunction turn data must be provided for a duration of no less than 12 seconds or the product of 1.2 times the three-sigma upper bound time delay determined in accordance with A417.21, whichever is greater. New text in paragraph (b)(1) clarifies that these duration limits apply regardless of whether or not the vehicle would break up before the prescribed duration for the turn data. New text in paragraph (b)(2) states that the analysis must produce malfunction turn data for malfunctions initiated at intervals of no more than four seconds over the flight, instead of every trajectory time as proposed previously. The new text in paragraph (b)(2) is consistent with current 127-1 requirements. The definitions of the different types of malfunction turns that were in paragraph (b)(3) have been moved to paragraph (d). This change is purely an organizational change made to improve readability. Paragraph (b)(4) is revised to clarify that the first malfunction turn start time must correspond to lift-off. Paragraph (b)(4) is also revised to clarify that subsequent malfunction turns must be initiated at regular nominal trajectory time intervals not to exceed the greater of the three-sigma lower bound delay time or four seconds. Consistent with current Air Force requirements in EWR127-1, paragraph (b)(7) is modified to prescribe that gravity effect must be omitted from all malfunction turn data.

Proposed (d)(7)(ii) would require that if flying a trim turn is not possible even for a period of only a few seconds, the malfunction turn analysis would need only establish tumble turns. Otherwise, the malfunction turn analysis would be required to establish a series of trim turns, including the maximum-rate trim turn, and the family of tumble turns. During the part of launch vehicle flight where the maximum trim angle of attack is small, tumble turns may result in the greatest malfunction turn angles. If the maximum trim angle of attack is large, trim turns may lead to higher malfunction turn angles than tumble turns.

In proposed (d)(7)(iii), where a launch operator would be required to establish the maximum turning capability of the launch vehicle, a launch operator would have to account for a launch vehicle that was unstable at low angles attack but stable at some higher angles of attack. If both large and small constant engine deflections of the launch vehicle resulted in tumbling, regardless of how small the deflection might be, the analysis would have to use the malfunction turn capabilities achieved at the stability angle of attack, assuming no upsetting thrust moment, in addition to the turns achieved by a tumbling vehicle. This situation arises because the stability at high angles of attack is insufficient to arrest the angular velocity, which is built up during the initial part of a tumble turn where the launch vehicle is unstable. Although the launch vehicle cannot arrive at this stability angle of attack as a result of the constant engine deflection, there is some deflection behavior, such as the nozzle's rate of deflection, that will produce this result. If a launch operator did not elect to employ such a deflection program, the launch operator could simplify the analysis by assuming that the launch vehicle instantaneously rotated to the trim angle of attack and stabilized at this point. In such a case, tumble turn angles could be used during that part of launch vehicle flight for which the tumble turn envelope curve maintained a positive slope throughout the duration of the computation.

The phrase, "if thrust augmenting rocket motors are used on a launch vehicle," is deleted from paragraph (e)(4)(iii) because the launch operator would be required to submit vehicle orientation data in all cases. This modification is consistent with current EWR 127-1 requirements and necessary because the potential for non-symmetric induced velocities exists irrespective of the presence of thrust augmenting rocket motors.

Proposed section A417.11 of the SNPRM contains requirements for debris analysis taken from § 417.227 of the October 2000 NPRM with some streamlining and modifications made for clarity, to provide more flexibility, and to remain consistent with current practice. This section streamlines the October 2000 NPRM in that the same debris analysis requirements now apply to both intentionally jettisoned debris and debris resulting from launch vehicle break-up. Paragraph (c)(1) clarifies that a debris model must provide debris fragment data for the number of temporal segments sufficient to meet the requirements for smooth and continuous contours used to define hazard areas as required by A417.23. Paragraph (c)(8) and sub-paragraphs to (c)(3) are now consistent with the current Air Force requirements of EWR 127-1. Debris analysis requirements proposed by the October 2000 NPRM in paragraph (c)(9) were moved to the debris risk analysis section (A417.25) because computation of the effective casualty area for inert fragments depends on the path angle of the fragment trajectory at impact. Consistent with current Air Force requirements in EWR 127-1, paragraph (c)(10)(ii) now allows grouping of fragments with sub-sonic ballistic coefficients less than or equal to three within a class. Paragraph (c)(10)(iii) also proposes greater consistency with current Air Force requirements in EWR 127-1. Minor non-material changes were made to paragraph (d) and elsewhere to provide more clarity.

Section A417.13 of the SNPRM contains requirements for flight safety limits analysis from § 417.211 and § 417.213 of the October 2000 NPRM with some streamlining and modifications made for clarity, to provide more flexibility, and to remain consistent with current practice. As previously mentioned, the SNPRM eliminates the requirement for a separate flight control line analysis. The pertinent requirements to account for map and tracking errors that were part of the flight control lines analysis in the October 2000 NPRM are now included as part of the flight safety limits analysis. The October 2000 NPRM proposed that the flight safety limits "must ensure that the launch vehicle's debris impact dispersion does not extend beyond the flight control lines." In keeping with current practice at the federal ranges, paragraph (b) of the SNPRM expands and clarifies that for a flight termination at any time during launch vehicle flight, the flight safety limits would: (1) represent, but need to be limited to, the extent of the debris impact dispersion for all debris fragments with ballistic coefficient greater than or equal to three; and (2) ensure that the debris impact area on the Earth's surface that is bounded by the debris impact dispersion in the uprange, downrange and crossrange directions; does not extend to any populated or other protected area. Using flight safety limits to protect the public from debris with ballistic coefficient greater than or equal to three is consistent with current practice at the federal ranges. Any risk due to more wind sensitive debris with ballistic coefficients less than three are typically addressed using risk assessment. Paragraph (c) of the SNPRM presents the risk management options of employing flight safety limits that provide hazard isolation or defining flight safety limits that generally contain hazardous debris together with debris risk assessment to ensure the public risk criteria are satisfied.

Section A417.15 of the SNPRM contains requirements for straight-up time analysis from § 417.215 of the October 2000 NPRM with some streamlining. The SNPRM references sources of debris impact dispersion of A417.13(b)(4)(ii) through (xiii) instead of re-listing those. In addition, the SNPRM eliminates the requirement for a sample set of straight-up time calculations because a description of the methodology used will suffice.

The SNPRM does not contain a section dedicated to wind analysis requirements such as § 417.217 of the October 2000 NPRM. Instead, wind analysis elements have been incorporated into those sections that involve wind analysis products.

Section A417.17 of the SNPRM contains requirements for a no-longer terminate gate analysis from §417.219 of the October 2000 NPRM with some streamlining. Paragraph (b)(4) was modified to clarify that the width of the gate must restrict a launch vehicle's normal trajectory ground trace. Because a "normal trajectory" means a trajectory within three-sigma of nominal with wind effects, the remainder of the (b)(4) was eliminated as redundant. Similarly, the definition of tracking representation was eliminated from (c)(1) since the SNPRM provides this definition in §417.217.

Section A417.19 of the SNPRM contains requirements for the data loss flight time and no-longer terminate time analyses taken from § 417.221 of the October 2000 NPRM, with some streamlining and modifications made for clarity and to remain consistent with current practice. Paragraph (b) of the October 2000 NPRM was eliminated as redundant because the earliest destruct time is, in fact, the first data loss flight time. Paragraph A417.19(b) of the SNPRM modifies paragraph (c) of the October 2000 NPRM to provide requirements for the no-longer terminate time that are consistent with current practice. The SNPRM effectively replaces the term the no-longer endanger time in proposed section A417.19 with the more generic term "no-longer terminate time" to be consistent with the performance requirements of proposed § 417.219. Proposed paragraph (b) adds the clarification that when determining the no-longer terminate time the analysis would account for a launch vehicle malfunction that would direct the vehicle toward the nearest flight safety limit or protected area following the same requirements proposed for determining the data loss flight times. Proposed paragraph (c) of the SNPRM modifies paragraph (d) of the October 2000 NPRM to provide the streamlined definition and requirements for data loss flight times that are consistent with current practice.

Section A417.21 of the SNPRM contains requirements for the time delay analysis from §417.223 of the October 2000 NPRM with some streamlining and modifications made for clarity and to remain consistent with current practice.

Section A417.23 of the SNPRM contains requirements for flight hazard area analysis from §417.225 of the October 2000 NPRM with streamlining and substantial modifications made to enhance clarity, to provide greater flexibility, and to remain consistent with current practice. The SNPRM eliminates the reference to "safety clear zones" in paragraph (b) because no definition or requirements for such existed in the October 2000 NPRM with regard to flight safety analysis. However, the term was used in the proposed ground safety requirements of subpart E of the NPRM. In keeping with current practice, paragraph (b) was modified to present the options of employing a launch site flight hazard area that encompasses the flight safety limits when the hazard isolation option is employed in accordance A417.13(c) or encompasses all hazard areas established in accordance with paragraphs (d) through (i).

Proposed paragraph (d) of section A417.23 would now require that a debris impact hazard area account for the effects of impacting debris resulting from normal and malfunctioning launch vehicle flight, excluding toxic effects, and accounts for potential impact locations of all debris fragments. The October 2000 NPRM had required the debris hazard area to account for any toxic effects of debris, which is not consistent with current practice at the Easter n Range or Western Range. Paragraph (d)(1) and its sub-paragraphs would provide requirements that are consistent with current practice at the Eastern Range and Western Range for determination of an individual casualty contour. Specifically, the SNPRM clarifies that a debris hazard area must be bounded by an individual casualty contour that defines where the risk to an individual would exceed an expected casualty (E_C) criterion of 1×10^{-6} if one person were assumed to be in the open and inside the contour during launch vehicle flight. The SNPRM clarifies that an individual casualty contour would be determined using the blunt trauma and overpressure effects thresholds common to the Air Force and the FAA. Elements of the sub-paragraphs to (d) in the October 2000 NPRM are re-organized for greater clarity. Also, the sub-paragraphs to (d) are revised to provide greater flexibility by specifying performance level requirements. In sub-paragraph (d)(5), the SNPRM now requires only that the analysis must account for the type of vehicle breakup, either by the flight termination system or by aerodynamic forces, eliminating the excess conservatism associated with the phrase "whichever results in the greater debris dispersion" that appeared in sub-paragraph (d)(4) of the October 2000 NPRM. In sub-paragraph (d)(6), the SNPRM now requires that the analysis use a probability of occurrence equal to one for the planned debris fragments produced by normal separation events during flight, consistent with current practice. This correction to the October 2000 NPRM provides positive public protection from planned jettison debris regardless of the probability of mission success.

Proposed paragraph (e) in section A417.23 of the SNPRM contains modified requirements for the near-pad blast hazard area that are more consistent with current practice than those in the October 2000 NPRM. The paragraph (e) would require a hazard area analysis to define a blast overpressure hazard area as a circle centered at the launch point with a radius equal to the 1.0-psi overpressure distance produced by the equivalent TNT commensurate with the explosive capability of the vehicle, in lieu of the 3.0 psi overpressure level specified in the October 2000 NPRM. This modification is generally consistent with current practice, although overpressure levels used to define near-pad blast hazard areas for flight vary significantly between ranges. The Eastern Range uses an overpressure level that is more conservative than 1.0 psi. Also consistent with current practice, the paragraph would require the establishment of a minimum near-pad blast hazard area to provide protection from hazardous fragments potentially generated and propelled by an explosion. These modifications to paragraph (e) are not expected to produce more restrictive hazard areas because the overall flight hazard area must envelope the near-pad blast hazard area, the individual casualty contour, any ship-hit contours, and any aircraft-hit contour. Typically, a near-pad blast hazard area established to meet the proposed requirements would not extend beyond the individual casualty contour.

Proposed paragraph (g) in section A417.23 of the SNPRM contains modified requirements for the flight hazard area ship-hit contours that are more consistent with current practice and provide greater flexibility by specifying performance level requirements. Whereas the NPRM of October 2000 specified that the ship-hit contour need not account for debris with a ballistic coefficient less than three, the SNPRM requires that the ship hit use the blunt trauma and overpressure effects thresholds common to the Air Force and the FAA. As previously discussed, these thresholds provide a level of protection commensurate with current practice.

Proposed section A417.25 of the SNPRM contains requirements for debris risk requirements from §417.227 of the October 2000 NPRM with some streamlining and modifications made for clarity, to provide more flexibility, and to remain consistent with current practice. Paragraph (b)(3) would be streamlined by replacing "planned launch vehicle events and breakup of a launch vehicle due to activation of a flight termination system or spontaneous breakup due to a launch vehicle failure during launch vehicle flight" with "normal and malfunctioning launch vehicle flight." Whereas the NPRM of October 2000 indicated that the debris risk analysis would not need to account for debris with a ballistic coefficient less than three, the SNPRM specifies the that the debris risk analysis must use the blunt trauma and overpressure effects thresholds common to the Air Force and the FAA.

New text in paragraph (b)(4)(i) of section A417.25 clarifies the portion of trajectory time for which a debris risk analysis must account. The text, "planned flight events and from launch vehicle failure" is replaced with "normal and malfunctioning launch vehicle flight" in accordance with discussions with the Common Standards Working Group. Modifications in paragraph (b)(4)(ii) clarify that the factors accounted for in the dispersion for each debris class include the variance produced by break-up imparted velocities and the variance produced by aerodynamic properties for each debris class. Variance in the impact dispersion due to aerodynamic properties includes the effects of lift and drag, whereas the NPRM inadvertently omitted the influence of lift. Paragraph (b)(4)(iii) is streamlined to delete redundant text. The phrase, "performs a survivability analysis and" is deleted from the second sentence of this paragraph to allow an assumption of 100% survivability to substitute for a survivability analysis.

Paragraph (b)(8) of section A417.25 is modified to require the use the blunt trauma and overpressure effects thresholds common to the Air Force and the FAA. New text is added as (b)(8)(i) and (b)(8)(ii) to provide more flexibility in casualty area analysis for inert debris fragments. The SNPRM proposes a two-tier approach to the casualty area estimates that allows a simple and conservative estimate (that the effective casualty area equals seven times the maximum projected area of the fragment) to substitute for an analysis of the effective casualty area for each inert debris fragment that accounts for bounce, skip, slide, and splatter effects based on the path angle of the fragment trajectory at impact among other influences.

The first sentence of paragraph (b)(9) clarifies that "traditional" population growth rate equations are exponential in nature. The second sentence in this paragraph is deleted as unnecessarily prescriptive and inflexible. The population model requirements are streamlined and clarified to define population centers that are similar enough to be described and treated as a single average set of characteristics without degrading the accuracy of the debris risk estimate.

The second sentence in paragraph (b)(10)(iii) of section A417.25 is modified for clarity by deleting the word "census." Population density information may come from other sources. Paragraph (c)(3) was reorganized and modified for clarity to include subparagraphs (i), (ii), and (iii). Paragraph (c)(3)(i) states, "Flies within normal limits until some malfunction causes spontaneous breakup or results in a commanded flight termination." Paragraph (c)(3)(ii) is modified to read, "Experiences malfunction turns." This new failure scenario text is consistent with current EWR 127-1 requirements. Paragraph (c)(3)(iii) is added to read, "Flight safety system fails to function." The word "cell" in Paragraph (c)(4) is replaced with "center" to reflect current practice. New text is added to account for a population model containing a description of the shelter characteristics within the population center. The new text in paragraph (c)(4) identifies a population characteristic currently used in Range Safety population models.

The SNPRM proposes minor modifications to paragraph (c) form completeness, to enhance clarity, and to require that the debris risk analysis products are consistent with current practice as well as the proposed requirements. In sub-paragraph (7)(i), the SNPRM clarifies that the debris analysis products must describe the propellant composition, instead of its ingredients. This correction indicates that the relevant information is the product of propellant formulation analysis and probabilistic far-field blast overpressure analyses, in lieu of the prescriptive requirements put forth in the October 2000 NPRM.

Section A417.31 of the SNPRM contains requirements for collision avoidance analysis taken from §417.233 of the October 2000 NPRM with some streamlining and modifications made for clarity. The terms "licensee" and "license applicant" in A417.31 are now renamed "launch operator" to reflect similar terminology used throughout other sections. The second sentence in paragraph (b)(3) now states, "If an updated conjunction on launch assessment is needed due to a launch delay, a launch operator must submit the request to United States Space Command at least 12 hours prior to the beginning of the new launch window." This clarifies the agency responsible for receiving collision avoidance analysis requests and the lead-time for such requests. The launch assessment worksheet, figure A417.31 1., in paragraph (c) is no longer necessary. All data requirements are described in the following text. Removal of the figure streamlines this section and eliminates the requirement to revise this section when the assessment worksheet format changes. The second sentence in paragraph (c)(5) originally read, "The term 'vector at injection' is used to identify the position and velocity vectors after the thrust for a segment has ended." This is now changed to read, "The term 'vector at injection' is used to identify the position and velocity of all orbital or suborbital segments after the thrust for a segment has ended." This is more technically correct. Paragraph (c)(5) is streamlined by deleting the third sentence. This sentence is unnecessary since it provides a previous definition to a term that is no longer used. Position and velocity information in paragraph (c)(5)(ii) is modified for the purposes of clarity to read, "The position coordinates in the EFG coordinate system measured in kilometers and the EFG components measured in kilometers per second, of each launch vehicle stage or payload after any burnout, jettison, or deployment."

Appendixes B through I of part 417

The only changes that this SNPRM makes to appendixes B though I of part 417 involve references made to sections of proposed subpart C of part 417. This SNPRM modifies and reorganizes proposed subpart C of part 417. As a result a number of references made in proposed appendixes B through I of part 417 to sections in subpart C of part 417 must be changed accordingly. The necessary reference changes are identified in this SNPRM.

VI. Procedural Matters

Paperwork Reduction Act

As required by the Paperwork Reduction Act of 1995, 44 U.S.C. 3501 et seq., the Federal Aviation Administration has reviewed the information collection requirements of this supplemental notice of proposed rulemaking. The FAA has determined that this supplemental notice of proposed rulemaking does not alter the information collection requirements of the notice of proposed rulemaking issued October 25, 2000. With that notice of proposed rulemaking, the FAA determined that there would be no additional burden to respondents over and above that which the Office of Management and Budget has already approved under the existing rule titled, "Commercial Space Transportation Licensing Regulations" (OMB control number 2120-0608). Under the existing rule, the FAA considers license applications to launch from non-federal sites on a case-by-case basis. In conducting a case-by-case review, the FAA gives due consideration to current practices in space transportation, generally involving launches from federal sites. Accordingly, the FAA believes that, under the proposals of the NPRM and this SNPRM, there would be no additional information collection not already included in the previously approved information collection activity. This rule would eliminate the case-by-case review, thereby streamlining the licensing process, and would not place any additional burden on the respondent.

Regulatory Evaluation Summary

Introduction

Proposed and final rule changes to federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each federal agency 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 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. 2531-2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, the Trade Agreements Act also requires agencies to consider international standards and, where appropriate, use them as the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 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 annually (adjusted for inflation).

In conducting these analyses, the Federal Aviation Administration (FAA) has determined that the Supplement to the Notice of Proposed Rulemaking (SNPRM): (1) is "a significant regulatory action" as defined in the Executive Order, and is "significant" as defined in the Department of Transportation's Regulatory Policies and Procedures; (2) will not have a significant impact on a substantial number of small entities; (3) will not reduce barriers to international trade; and (4) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector. These analyses are available in the docket, and are summarized below.

Regulatory Background

The FAA's Associate Administrator for Commercial Space Transportation, on October 25, 2000, issued a Notice of Proposed Rulemaking (NPRM) that proposed to amend the commercial space transportation regulations by codifying the license application process for launches from non-federal launch-sites. The NPRM was also intended to codify the current safety requirements for launch operators regarding license requirements, criteria, and responsibilities in order to protect the public from hazards of launches from federal and non-federal sites. Comments received on the NPRM resulted in the development of the SNPRM, which offers clarifications and proposed changes to the NPRM based on certain comments to the NPRM. The SNPRM, together with the NPRM, would codify the Federal Aviation Administration's license application process for launch from non-federal launch sites, and would codify the safety requirements for licensed launch operators in order to protect the public from the hazards of launch from either a federal range or non-federal launch site.

Identification of Current Practice

Whether launching from a federal range, a launch site located on a federal range, or a non-federal launch site, a launch operator is responsible for ground and flight safety under its FAA license. At a federal launch range a launch operator is currently required to comply with the rules and procedures of the federal range. It is current practice for the FAA to accept federal range safety requirements for licensed launches from federal ranges, as current federal range procedures and practices satisfy the majority of the FAA's safety concerns. In the absence of federal launch range oversight, each launch operator would be required to demonstrate the adequacy of its ground and flight safety programs to the FAA in order to satisfy the FAA's statutory responsibility. Current practice for licensed launches from non-federal launch sites is for operators to achieve a level of safety equivalent to that at the federal ranges.

Regulatory Requirements

Two revisions to the NPRM — section 417.107(b), public risk criteria, and section 417.203, compliance — as presented in the SNPRM, would result in economic impacts. These two sections are the principal focus of this regulatory evaluation of the SNPRM. They contain the following regulatory proposals that have changed relative to the NPRM: (1) applying the risk criteria of $Ec \leq 30 \times 10^{-6}$ to each hazard individually rather than aggregating the risk over all hazards as was proposed in the NPRM, and (2) requiring the FAA to perform more intensive and timely baseline assessments of federal range flight safety analyses in order to verify launch operator compliance with range safety.

Costs of the Supplement to the Notice of Proposed Rulemaking

The SNPRM would impose a total estimated cost of approximately $700,000 ($530,000 discounted), in 2001 dollars, on the commercial space transportation industry over the 5-year period from 2003 through 2007. The FAA would incur some costs to administer the SNPRM but there is insufficient information to quantify and develop an estimate at this time.

Commercial Space Transportation Industry Costs

Commercial space transportation launch operators would incur additional costs to comply with the requirements contained in Section 417.107(b) of the SNPRM only. This requirement proposes that the risk criteria be applied to each hazard individually, rather than aggregating the risk, as was proposed in the NPRM. The proposed limits and method of applying risk on a per hazard basis are less stringent than that of aggregating the risk for all hazards. Existing FAA regulations establish a risk criteria of $E_c \leq 30 \times 10^{-6}$ for the debris hazard. It is current practice for the FAA to accept the federal range requirements for launches from federal ranges, in accordance with an assessment performed by the FAA. The majority of licensed launches to date have taken place primarily from the Air Force's Eastern Range, which calculates risk and applies risk criteria on a per hazard basis without considering the aggregate risk. The Air Force's Western Range also calculates the risk due to each hazard; however, the Western Range does consider the aggregate risk in its decision-making process. Therefore, current practice could be either approach, depending on from which range the launch takes place.

The Eastern Range has allowed a launch when the toxic risk was 233×10^{-6} for expected casualty, which is less stringent than the 30×10^{-6} per hazard proposed in the SNPRM. While it is mainly government launches that rely on this risk ceiling for toxic hazards in excess of 30×10^{-6}, there have been few licensed launches that have exceeded this level. The regulatory evaluation associated with the NPRM did not address the probability that licensed launches from the Eastern Range would exceed 30×10^{-6} for toxic risk. Further evaluation and a better understanding of current range practice indicates that Eastern Range launches have proceeded with a significantly higher toxic risk criteria (i.e., up to 114×10^{-6} for a licensed launch) than that being proposed. Therefore, the FAA is now prepared to assume that there may be some future launches that would be delayed due to the proposed requirement.

There were 39 launches of commercial launch vehicles from the Eastern Range from the years 1997 to August 2001. Two of these 39 launches exceeded the toxic risk ceiling proposed by the SNPRM due to meteorological conditions, but were launched anyway because they fell within the acceptable range of the Eastern Range. If these precise meteorological launch conditions existed under the SNPRM, then the two launches, which took place under the current practice at the Eastern Range, would not have launched. Therefore, the proposed requirement, under the same meteorological launch conditions, would cause a commercial launch operator to delay a planned launch from the Eastern Range until more favorable weather prevailed. Launch delays from the Eastern Range would cause a launch operator to incur additional costs.

The FAA estimates that the average cost of a one-day delay to commercial space launch operators would be $380,000. Using the Air Force Eastern Range experience mentioned above — that two out of 39 launches might have to be delayed under the SNPRM — the FAA estimates the probability of a launch delay in any given year during the 2003 to 2007 period would be five percent (calculated as $2 \div 39 = .051282$). Accordingly, due to the proposed toxic risk ceiling requirement, as many as two of the 36 expected Eastern Range launches from 2003 through 2007 could be delayed (calculated as $.051282 \times 36 = 1.85$). It is important to note that the estimate of two delays attributable to this proposed requirement over the five-year period may be an overstatement. The likelihood of launch delays resulting from toxicity limits is expected to decrease, as future launch vehicle toxicity is expected to be reduced significantly, and future launches are likely to be conducted from launch complexes that are farther away from populated areas. Collectively, these launch characteristics will result in E_c values significantly lower than that experienced historically as well as the proposed ceiling.

Because it is not possible to ascertain with certainty when during the 2003 through 2007 period there will be a launch delay at the Eastern Range as a result of the toxic standard in the SNPRM, the probability of a delay based on past experience is multiplied by all projected launches per annum, yielding the expected number of launch delays. The average cost to a commercial space launch operator of a one-day delay (i.e., $380,000) is multiplied by the expected number of launch delays over the five year period, resulting in a cost of approximately $700,000 ($530,000 discounted) to commercial space transportation industry launch operators to comply with the proposed requirement at the Eastern Range.

This proposed amendment would codify and standardize this requirement for all launches regardless of launch site, and would not differ from current practice for launch operators seeking licenses to perform launches from non-federal launch sites. Accordingly, commercial launch operators would not incur additional costs to comply with this requirement as it pertains to non-federal launch sites.

Federal Aviation Administration Costs

The FAA would incur additional costs to administer the requirements contained in Section 417.203 of the SNPRM. It is a current, customary, and standard operating practice of the FAA to perform baseline assessments of federal range flight safety analyses. However, this proposed requirement creates some urgency in the frequency with which these assessments are performed (i.e., it is imperative that the baseline assessments be updated so as to be consistent with current federal range flight safety analyses, thereby permitting application of this proposed requirement). Further, the FAA believes that more extensive reviews of federal range flight safety programs would be required in order to keep abreast of the increasing number, diversity, and complexity of commercial launches from federal ranges and associated flight safety analyses. As a result of this proposed amendment, the FAA would expend additional effort and incur associated incremental costs to perform more rigorous and timely baseline assessments. Although the FAA believes that these incremental costs would not be substantial, there is insufficient information currently available to provide a supportable estimate of these costs at this time.

Additionally, federal organizations other than the FAA, such as DOD and NASA (i.e., federal personnel that are range operators), may be required to expend additional effort and incur incremental costs preparing for more rigorous, extensive, and frequent baseline assessments and cooperating with the FAA during their conduct. Additionally, federal range operating contractors may also be similarly affected by these activities. The FAA solicits comments and detailed information to help better address this subject in this regulatory evaluation.

Total Cost Impact of Supplement to Notice of Proposed Rulemaking

The FAA estimates that the total costs of the SNPRM would be approximately $700,000; these would be incurred entirely by the commercial space transportation launch operators to comply with the proposed requirements contained in the SNPRM. The incremental costs to the FAA to administer the SNPRM would not be substantial and there is insufficient information currently available to develop a supportable estimate.

Safety Benefits from the Supplement to the Notice of Proposed Rulemaking

The SNPRM would result in some additional safety benefits associated with licensed commercial launches from the Eastern Range only. This is due to the proposed requirement associated with section 417.107(b), public risk criteria. The positive safety benefits would be the accident costs avoided (i.e., the dollar value of fatalities, injuries, and property damage) due to applying the toxic risk criteria of 30×10^{-6} (which is less than the 114×10^{-6} that was the highest toxic risk allowed for a licensed launch at the Eastern Range in the past five years). Although the FAA has not quantified the accident prevention or damage limiting effects the proposed requirement would have on Eastern Range launches, it does believe that section 417.107(b) would yield some incremental safety benefits.

Qualitative Benefits from the Supplement to the Notice of Proposed Rulemaking

The proposed SNPRM offers a variety of impacts that would benefit both the commercial space transportation industry and the FAA that are not readily quantified. Formalizing and identifying licensing responsibilities by establishing a specific regulation would emphasize commercial launch operator responsibilities and FAA expectations, and would enhance launch operators' understanding of such. Consequently, the proposed requirement may yield some operating efficiencies and associated cost savings that the FAA has not quantified or estimated.

Further, as the number of applications for launch licensing increases, formality (in the way of a regulation) would also help ensure consistency in implementing the licensing process. This could lead to cost savings to the FAA as a result of economies of scale from repetitive operations. These cost savings would spill over to commercial space transportation entities by reducing the turnaround time between application submittal and licensing approval. Additionally, consistent application of the licensing process would help commercial space transportation entities gain familiarity with its requirements, leading to proficiency in their ability to interact with the process and the FAA. This in turn would lead to industry cost savings, possibly due to less rework or paperwork avoided.

Initial Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) requires agencies to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions. Agencies are required to determine whether a proposed or final rule would have a significant economic impact on a substantial number of small entities. If the determination is that it will, then the agency must prepare a regulatory flexibility analysis. If an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, then the head of the agency may so certify and a regulatory flexibility analysis is not required.

The FAA conducted the required review of the SNPRM and determined that it would not have a significant economic impact on a substantial number of small entities. To make this determination, the FAA has identified the commercial space transportation industry launch operators that would be affected by the SNPRM and found that only a small number of businesses that would be affected by the SNPRM could be considered a small entity. For manufacturers, a small entity is one with 1,500 or fewer employees.

The FAA has identified two companies, Astrotech Space Operations and Interorbital Systems, that have fewer than 1,500 employees. Astrotech Space Operations is a wholly owned subsidiary of Spacehab, which has average annual revenues of approximately $100 million. The total cost of the SNPRM to industry would be $700,000. This total cost for the industry is less than one percent of Spacehab's annual revenue. Hence, the cost of the SNPRM would not constitute a significant economic impact on a firm with revenues of this magnitude. The cost of a delayed launch might have a significant impact on Interorbital Systems. Even if delay costs are significant for this entity, one impacted entity is not considered a substantial number of small entities. Accordingly, on this basis and pursuant to the Regulatory Flexibility Act, 5 U.S.C. 605(b), the FAA certifies that the SNPRM 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.

International Trade Impact Assessment

The Trade Agreement Act of 1979 prohibits Federal agencies from promulgating any standards or engaging in any related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and where appropriate, that they be the basis for U.S. standards.

In accordance with the above statute and policy, the FAA has assessed the potential effect of the SNPRM and has determined that it would impose the same costs on domestic and international entities, and thus has a neutral trade impact.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. The FAA has determined that this action will not have a substantial direct effect on the states, on the relationship between the national U.S. Government and the states, or on the distribution of power and responsibilities among the various levels of government. Therefore, the FAA has determined that this final rule does not have federalism implications.

Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), enacted as Pub. L. 104-4 on March 22, 1995, is intended among other things, to curb the practice of imposing unfunded federal mandates on state, local, and tribal governments.

Title II of the Act requires each federal agency to prepare a written statement assessing the effects of any federal mandate in a proposed or final agency rule that may result in the expenditure of $100 million or more (adjusted annually for inflation) 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 SNPRM does not contain such a mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

Environmental Assessment

The FAA has determined that the proposed amendments to the commercial space transportation licensing and safety rules are categorically excluded from environmental review under 102(2)(C) of the National Environmental Policy Act (NEPA). The proposed rules, which address obtaining and maintaining a license, are administrative and procedural in nature and are therefore categorically excluded under FAA Order 1050.1D, appendix 4, paragraph 4(i). In addition, part 415 already requires an applicant to submit sufficient environmental information for the FAA to comply with NEPA and other applicable environmental laws and regulations during the processing of each license application, thereby ensuring that any significant adverse environmental impacts from licensing commercial launches will be considered during the application process. Accordingly, the FAA has determined that this rule is categorically excluded because no significant impacts to the human environment will result from finalization or implementation of its administrative and procedural provisions for licensing commercial launches.

Energy Impact

The energy impact of the rulemaking action has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) and Public Law 94-163, as amended (42 U.S.C. 6362). It has been determined that it is not a major regulatory action under the provisions of the EPCA.

List of Subjects

14 CFR 415

Rockets, Space transportation and exploration.

14 CFR 417

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 parts 415 and 417 of Chapter III Title 14, Code of Federal Regulations (as proposed to be revised at 65 FR 63922, Oct. 25, 2000) as follows:

Part 415 – Launch Licensee

Subpart F – Safety Review and Approval for Launch of an Expendable Launch Vehicle from a Non-Federal Launch Site

1. In § 415.109(g) as proposed to be revised at 65 FR 63966, revise "§ 417.205" to read "§ 417.207".

2. In § 415.115(b) as proposed to be revised at 65 FR 63967, revise "§ 417.233" to read "§ 417.231".

3. In § 415.115(d)(5) as proposed to be revised at 65 FR 63967, revise "§ 417.225" to read "§ 417.223".

4. In § 415.115(f) as proposed to be revised at 65 FR 63967, revise "§ 417.235" to read "§ 417.233".

5. In § 415.115(f)(2) as proposed to be revised at 65 FR 63967, revise "§ 417.235" to read "§ 417.233".

6. In § 415.117(c)(2)(ii) as proposed to be revised at 65 FR ~~63968~~ 63969, revise "§ 417.229" to read "§ 417.227".

7. In § 415.119(h) as proposed to be revised at 65 FR ~~63969~~ 63970, revise "§ 417.225" to read "§ 417.223".

Part 417 – Launch Safety

8. Revise § 417.1 as proposed to be revised at 65 FR 63977 to read as follows:

Subpart A—General

§ 417.1 Scope and Applicability.

(a) General. This part prescribes the responsibilities of a launch operator conducting a licensed launch of an expendable launch vehicle and the requirements with which a licensed launch operator must comply to maintain a license and conduct a launch.

(1) The safety requirements of this part apply to all licensed launches of expendable launch vehicles, except for a launch from a federal launch site that meets one of the conditions of paragraph (b). of this section.

(2) All the administrative requirements of this part for submitting material to the FAA apply to all licensed launches from a non-federal launch site. For a licensed launch from a federal launch range, an administrative requirement of this part does not apply if the FAA, through its baseline assessment of the range, finds that the range satisfies the requirement. For a licensed launch from a federal range where the range does not satisfy one or more of the requirements of part 417, the FAA will identify, during the licensing process, the administrative requirements that the launch operator must meet.

(3) Requirements for preparing a license application to conduct a launch, including all related policy, safety and environmental reviews and payload determinations, are contained in parts 413 and 415.

(b) Federal launch range meets intent certifications, waivers, and noncompliances due to grandfathering.

(1) If a launch operator has a license from the FAA to launch from a federal launch range as of the effective date of this part and, for a specific requirement of this part and launch:

(i) If the launch operator employs an alternative to the requirement for which the federal range has granted a written meets intent certification on or before the [EFFECTIVE DATE OF] this part, the launch operator need not demonstrate to the FAA that its alternative provides an equivalent level of safety; or

(ii) If the launch operator has, on or before the [EFFECTIVE DATE OF] this part, a written waiver from the federal launch range or a noncompliance that satisfies the federal launch range's grandfathering criteria, the requirement of this part does not apply to the launch.

(2) Even if a launch operator satisfies paragraph (b)(1) of this section for a specific requirement of this part, the launch operator must bring its launch and launch vehicle, including components, systems, and subsystems, into compliance with the requirement, whenever one or more of the following conditions occurs:

(i) The launch operator makes modifications that affect the launch vehicle's operation or safety characteristics;

(ii) The launch operator uses the launch vehicle, component, system, or subsystem in a new application;

(iii) The FAA or the launch operator determines that a previously unforeseen or newly discovered safety hazard exists that is a source of significant risk to public safety; or

(iv) The federal range previously accepted a component, system, or subsystem, but, at that time, did not identify a noncompliance to a federal range requirement.

9. Amend proposed § 417.3 as proposed to be revised at 65 FR 63977 by removing the definition of serious injury; and adding the following definitions in alphabetical order:

§ 417.3 Definitions.

Equivalent level of safety means an "approximately equal" level of safety. An equivalent level of safety may involve a change to the level of expected risk that is not statistically or mathematically significant as determined by qualitative or quantitative risk analysis.

Explosive debris means solid propellant fragments or other pieces of a launch vehicle or payload that result from breakup of the launch vehicle during flight and that explode upon impact with the Earth's surface and cause overpressure.

Meets intent certification means a decision by a federal launch range to accept a substitute means of satisfying a safety requirement where the substitute provides an equivalent level of safety to that of the original requirement.

Normal flight means the flight of a properly performing launch vehicle whose real-time instantaneous impact point does not deviate from the nominal instantaneous impact point by more than the sum of the wind effects and the three-sigma guidance and performance deviations in the uprange, downrange, left-crossrange, or right-crossrange directions.

Normal trajectory means a trajectory that describes normal flight.

Risk means a measure that accounts for both the probability of occurrence of a hazardous event and the consequence of that event to persons or property.

Waiver means a decision that allows a launch operator to continue with a launch despite not satisfying a specific safety requirement and where the launch operator is not able to demonstrate an equivalent level of safety. A waiver may apply where a failure to satisfy a safety requirement involves a statistically or mathematically significant increase in expected risk as determined through qualitative or quantitative risk analysis, and where the activity may or may not exceed the public risk criteria.

10. Amend § 417.107 as proposed to be revised at 65 FR 63981 by revising paragraph (b); redesignating paragraphs (c) through (f) as paragraphs (e) through (h), respectively; adding new paragraphs (c) and (d); and revising newly redesignated paragraphs (e) and (f) to read as follows:

Subpart B – Launch Safety Requirements

§ 417.107 Flight safety.

* * * * *

(b) Public risk criteria. A launch operator may initiate the flight of a launch vehicle only if flight safety analysis performed under paragraph (f) of this section demonstrates that any risk to the public satisfies the following public risk criteria:

(1) A launch operator may initiate the flight of a launch vehicle only if the risk associated with the total flight to all members of the public, excluding persons in waterborne vessels and aircraft, does not exceed an expected average number of 0.00003 casualties ($E_C \leq 30 \times 10^{-6}$) from impacting inert and impacting explosive debris, $E_C \leq 30 \times 10^{-6}$ for toxic release, and $E_C \leq 30 \times 10^{-6}$ for 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 for each hazard 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.

(2) A launch operator may initiate flight only if the risk to any individual member of the public does not exceed a casualty expectation (E_C) of 0.000001 per launch ($E_C \leq 1 \times 10^{-6}$) for each hazard, excluding persons in waterborne vessels and aircraft.

(3) A launch operator may initiate flight only if the probability of debris impact to all water-borne vessels (P_{iv}) that are not operated in direct support of the launch does not exceed 0.00001 ($P_{iv} \leq 1 \times 10^{-5}$) in each debris impact hazard area of § 417.223.

(4) A launch operator may initiate flight only if the probability of debris impact to any individual aircraft (P_{ia}) not operated in direct support of the launch does not exceed 0.00000001 ($P_{ia} \leq 1 \times 10^{-8}$) in each debris impact hazard area of § 417.223.

(c) Debris thresholds. A launch operator's flight safety analysis, performed as required by paragraph (f) of this section, must account for any inert debris impact with a mean expected kinetic energy at impact greater than or equal to 11 ft-lbs and, except for the far field blast overpressure effects analysis of § 417.229, a peak incident overpressure greater than or equal to 1.0 psi due to any explosive debris impact.

(1) When using the 11ft-lb threshold to determine potential casualties due to blunt trauma from inert debris impacts, the analysis must:

(i) Incorporate a probabilistic model that accounts for the probability of casualty due to any debris expected to impact with kinetic energy of 11 ft-lbs or greater and satisfies paragraph (d) of this section; or

(ii) Count each expected impact with kinetic energy of 11 ft-lbs or greater to a person as a casualty.

(2) When applying the 1.0-psi threshold to determine potential casualties due to overpressure effects, the analysis must:

(i) Incorporate a probabilistic model that accounts for the probability of casualty due to any blast overpressures of 1.0-psi or greater and satisfies paragraph (d) of this section; or

(ii) Count each person within the 1.0-psi overpressure radius of the source explosion as a casualty. When using this approach, the analysis must compute the peak incident overpressure using the Kingery-Bulmash relationship and may not take into account sheltering, reflections, or atmospheric effects. For persons located in buildings, the analysis must compute the peak incident overpressure for the shortest distance between the building and the blast source. The analysis must count each person located anywhere in a building subjected to peak incident overpressure equal to or greater than 1.0 psi as a casualty.

(3) The analysis must account for any inert debris impact with a mean expected kinetic energy at impact greater than or equal to 11 ft-lbs and a peak incident overpressure greater than or equal to 1.0 psi due to any explosive debris impact when demonstrating that a launch satisfies the probability of impact criterion for waterborne vessels of § 417.107(b)(3).

(4) The analysis must account for any inert or explosive debris impact with a mean expected kinetic energy at impact greater than or equal to 11 ft-lbs when demonstrating whether a launch satisfies the probability of impact criterion for aircraft of § 417.107(b)(4). The analysis must account for the aircraft velocity.

(d) Casualty modeling. A probabilistic casualty model must be based on accurate data and scientific principles and must be statistically valid. A launch operator must obtain FAA approval of any probabilistic casualty model that is used in the flight safety analysis. If the launch takes place from a federal launch range, the analysis may employ any probabilistic casualty model that is accepted as part of the FAA's baseline assessment of the federal launch range's safety process..

(e) Collision avoidance.

(1) A launch operator must ensure that a launch vehicle, any jettisoned components, and its payload do not pass closer than 200 kilometers to a habitable orbital object

(i) Throughout a sub-orbital launch; and

(ii) During ascent to initial orbital insertion through at least one complete orbit for an orbital launch.

(2) A launch operator must obtain a collision avoidance analysis for each launch from United States Space Command. United States Space Command also calls this analysis a conjunction on launch assessment. Sections 417.231 and A417.31 of appendix A of this part contain the requirements for obtaining a collision avoidance analysis. A launch operator must use the results of the collision avoidance analysis to develop flight commit criteria for collision avoidance as required by § 417.113(b).

(f) Flight safety analysis. A launch operator must perform and document a flight a safety analysis as required by subpart C of this part. A launch operator must not initiate flight unless the flight safety analysis demonstrates that any risk to the public satisfies the public risk criteria of paragraph (b) of this section. For a licensed launch that involves a federal launch range, the FAA may treat an analysis performed and documented by the federal range as that of the launch operator as provided in § 417.203(d) of subpart C. A launch operator must use the flight safety analysis products to develop flight safety rules that govern a launch. Section 417.113 contains the requirements for flight safety rules.

11. In § 417.113(b)(1) as proposed to be revised at 65 FR 63982, revise "§ 417.233" to read "§ 417.231".

12. In § 417.113(b)(2) as proposed to be revised at 65 FR 63982, revise "§ 417.225" to read "§ 417.223".

13. In § 417.113(c)(4) as proposed to be revised at 65 FR 63983, revise "§ 417.221" to read "§ 417.219".

14. In § 417.113(c)(5) as proposed to be revised at 65 FR 63983, revise "§ 417.219" to read "§ 417.217".

15. In § 417.117(h) as proposed to be revised at 65 FR 63984, revise the fourth sentence to read as follows: A post launch report must contain the results of any monitoring of flight environments and any measured wind profiles used for the launch. Section 417.307(b) contains requirements for monitoring flight environments.

16. Revise § 417.121(c) as proposed to be revised at 65 FR 63985 to read as follows:

§ 417.121 Safety critical preflight operations.

* * * * *

(c) Collision avoidance. A launch operator must coordinate with United States Space Command to obtain a collision avoidance analysis, also referred to as a conjunction on launch assessment. Sections 417.107(e), 417.231, and A417.31 of appendix A of this part contain requirements for collision avoidance analysis. A launch operator must develop and incorporate flight commit criteria for collision avoidance as required by § 417.113(b).

* * * * *

17. In § 417.121(e)(3) as proposed to be revised at 65 FR 63985, revise "§ 417.225" and "§ 417.235" to read "§ 417.223" and "§ 417.233" respectively.

18. In § 417.121(e)(4) as proposed to be revised at 65 FR 63985, revise "§ 417.225" and "§ 417.235" to read "§ 417.223" and "§ 417.233" respectively.

19. In § 417.121(f) as proposed to be revised at 65 FR 63985, revise "§ 417.225" and "§ 417.235" to read "§ 417.223" and "§ 417.233" respectively.

20. In § 417.121(i) as proposed to be revised at 65 FR 63985, revise "§ 417.235" to read "§ 417.233".

21. In § 417.125(c)(2) as proposed to be revised at 65 FR 63986, revise "§ 417.235" to read "§ 417.233".

22. In § 417.125(f) as proposed to be revised at 65 FR 63986, revise "§ 417.235" to read "§ 417.233".

23. In § 417.125(g)(2) as proposed to be revised at 65 FR 63986, revise "§ 417.235"to read "§ 417.233".

24. In § 417.323(c) as proposed to be revised at 65 FR 64030, revise "§ 417.221(c) with § 417.219(c).

25. In § 417.327(g)(10) as proposed to be revised at 65 FR 64033, revise "§ 417.221" to read "§ 417.219".

26. Revise subpart C of part 417 as proposed to be revised at 65 FR 63987 to read as follows:

Subpart C—Flight Safety Analysis

417.201 Scope and applicability.

417.203 Compliance

417.205 General.

417.207 Trajectory analysis.

417.209 Malfunction turn analysis.

417.211 Debris analysis.

417.213 Flight safety limits analysis.

417.215 Straight-up time analysis.

417.217 No-longer-terminate gate analysis.

417.219 Data loss flight time and no longer terminate time analyses.

417.221 Time delay analysis.

417.223 Flight hazard area analysis.

417.225 Debris risk analysis.

417.227 Toxic release hazard analysis.

417.229 Far-Field overpressure blast effects analysis.

417.231 Collision avoidance analysis.

417.233 Analysis for launch of an unguided suborbital rocket flown with a wind weighting safety system.

417.234-417.300 [Reserved]

Subpart C - Flight Safety Analysis

§ 417.201 Scope and applicability.

(a) This subpart contains performance requirements for performing the flight safety analysis required by § 417.107(f).

(b) Except as permitted by paragraphs (c) and (d) of this section, the flight safety analysis requirements of this subpart apply to the flight of any launch vehicle that must use a flight safety system as required by § 417.107(a).

(c) The flight safety analysis requirements of § 417.233 apply to the flight of any unguided suborbital launch vehicle that uses a wind weighting safety system.

(d) For any alternative flight safety system approved by the FAA under § 417.107(a)(3), the FAA will determine during the licensing process which of the analyses required by this subpart apply.

§ 417.203 Compliance.

(a) General. A launch operator's flight safety analysis must satisfy the performance requirements of this subpart. The flight safety analysis must also meet the requirements for methods of analysis contained in appendices A and B for an orbital launch and appendices B and C for a suborbital launch except as otherwise permitted by this section. A flight safety analysis for a launch may rely on an earlier analysis from an identical or similar launch if the analysis still applies to the later launch.

(b) Method of analysis. For each launch, a launch operator's flight safety analysis must use methods approved during the licensing process by the FAA, as a license modification, or, if the launch takes place from a federal launch range, approved as part of the FAA's baseline assessment of the federal range's processes. Appendix A to this part contains requirements that apply to flight safety methods of analysis. A licensee must submit any change to the methods to the FAA as a request for license modification before the launch to which the proposed change would apply. Section 415.73 contains requirements governing a license modification.

(c) Alternate analysis. The FAA will approve an alternate flight safety analysis if a launch operator provides a clear and convincing demonstration that its proposed analysis provides an equivalent level of safety to that required by this subpart. A launch operator must demonstrate that an alternate flight safety analysis is based on accurate data and scientific principles and is statistically valid. The FAA will not find the launch operator's application for a license or license modification sufficiently complete to begin review under § 413.11 of this chapter until the FAA approves the alternate flight safety analysis.

(d) Analyses performed by a federal range. The FAA will accept a flight safety analysis used by a federal launch range for a licensed launch, if the launch operator has contracted with a federal launch range for the provision of flight safety analysis for a licensed launch, and the FAA has assessed the range and found that the range's analysis methods satisfy the requirements of this subpart. In this case, the FAA will treat the federal launch range's analysis as that of the launch operator and the launch operator need not provide any further demonstration of compliance.

(e) Analysis products. For a licensed launch that does not satisfy paragraph (d) of this section, the launch operator must demonstrate to the FAA compliance with the requirements of this subpart, and must include in its demonstration the analysis products required by appendices A, B, and C, depending on whether the launch vehicle uses a flight safety system or

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a wind weighting safety system. A launch operator must submit analysis products to the FAA as follows:

(1) License application flight safety analysis. At the time of license application, a launch operator must submit the required analysis products as part of the launch operator's safety review document in accordance with § 415.115. The FAA will evaluate the analysis to determine whether the methods of analysis for each launch comply with the requirements of this subpart.

(2) Six-month analysis. A launch operator must submit launch specific analysis products to the FAA no later than six months before each planned flight. The launch operator:

(i) Must account for vehicle and mission specific input data.

(ii) May reference previously submitted analysis products and data that are applicable to the launch or data that is applicable to a series of launches.

(iii) May state that an analysis product has not changed since the launch operator's license application submittal. In this case, the six-month submittal need not repeat the data.

(iv) Must identify any analysis product that may change as a flight date approaches and describe what needs to be done to finalize the product and when it will be finalized.

(v) Must submit the analysis products using the same format and organization used during the license application process.

(vi) Must, if requested by the FAA, present the six-month flight safety analysis products in a technical meeting at the FAA.

(3) Thirty-day flight safety analysis update. A launch operator must submit updated analysis products no later than 30 days before flight. If an analysis product has not changed

since the six-month analysis submittal, the launch operator's thirty-day submittal need not repeat the data. The launch operator:

(i) Must account for potential variations in input data that may affect the analysis products within the final 30 days prior to flight.

(ii) May submit the analysis products using the same format and organization used in its license application.

(iii) May not change an analysis product within the final 30 days before flight unless the launch operator identified a process for making a change in that period as part of the launch operator's flight safety analysis process and the FAA approved the process through the licensing process.

(4) Programmatic flight safety analysis. A launch operator need not submit the 6-month or 30-day analysis if the launch operator:

(i) Submits complete analysis products during the licensing process;

(ii) Demonstrates that the analysis satisfies all the requirements of this subpart; and

(iii) Demonstrates the analysis does not need to be updated to account for launch specific factors.

§ 417.205 General.

(a) Public risk management. A flight safety analysis must demonstrate that the launch operator will, for each launch, control the risk to the public from hazards associated with normal and malfunctioning launch vehicle flight. The analysis must employ risk assessment or hazard isolation, or a combination of risk assessment and partial isolation of the hazards to demonstrate control of the risk to the public.

(1) Risk assessment. When demonstrating control of risk through risk assessment, the analysis must demonstrate that any risk to the public satisfies the public risk criteria of § 417.107(b) of this part. The analysis must account for, but need not be limited to, the variability associated with:

(i) Each source of a hazard during flight,

(ii) Normal flight and each failure response mode of the launch vehicle,

(iii) Each external and launch vehicle flight environment,

(iv) Populations potentially exposed to the flight, and

(v) The performance of any flight safety system, including time delays associated with the system.

(2) Hazard isolation. When demonstrating control of risk through hazard isolation, the analysis must establish the geographical areas from which the public must be excluded during flight and any operational controls needed to isolate all hazards from the public.

(3) Combination of risk assessment and partial isolation of hazards. When demonstrating control of risk through a combination of risk assessment and partial isolation of the hazards from the public, the analysis must demonstrate that the residual public risk due to any hazard not isolated from the public under paragraph (a)(2) of this section satisfies the public risk criteria.

(b) Dependent analyses. Because some analyses required by this subpart are inherently dependent on one another, the data output of any one analysis must be compatible in form and content with the data input requirements of any other analysis that depends on that output. Figure 417.203-1 illustrates the flight safety analyses that might be performed for a launch that uses a flight safety system and the typical dependencies that exist among the analyses.

Data Source Analyses (These analyses provide data to the dependent analyses indicated with an X.)	**Dependent Analyses** (These analyses use data from the data source analyses indicated as input.)									
	Malfunction Turn	Flight Safety Limits	Straight Up Time	No-Longer Terminate Gate	Data Loss Flight Time	Flight Hazard Areas	Debris Risk Analysis	Toxic Release Hazard Analysis	Far Field Overpressure Blast Effects Analysis	Collision Avoidance Analysis
Trajectory Analysis	X	X	X	X	X	X	X	X	X	X
Malfunction Turn Analysis		X	X		X	X	X	X	X	
Debris Analysis		X	X	X	X	X	X	X	X	X
Flight Safety Limits			X	X	X	X	X	X	X	
Straight-Up Time								X	X	
No-Longer Terminate Gate					X		X	X	X	
Data Loss Flight Time	X									
Time-Delay Analysis	X	X	X	X	X	X	X	X	X	X

Figure 417.203-1, Illustration of dependent flight safety analyses that might performed for a launch that uses a flight safety system

§ 417.207 Trajectory analysis.

(a) General. A flight safety analysis must include a trajectory analysis that establishes:

(1) For any time after lift-off, the limits of a launch vehicle's normal flight, as defined by the nominal trajectory and potential three-sigma trajectory dispersions about the nominal trajectory.

(2) A fuel exhaustion trajectory that produces instantaneous impact points with the greatest range for any given time-after-liftoff.

(3) A straight-up trajectory that would result if the launch vehicle malfunctioned and flew in a vertical or near vertical direction above the launch point.

(b) Trajectory model. A final trajectory analysis must use a six-degree of freedom trajectory model to satisfy the requirements of paragraph (a) of this section.

(c) Wind effects. A trajectory analysis must account for wind effects, including profiles of winds that are no less severe than the worst wind conditions under which flight might be attempted, and must account for uncertainty in the wind conditions.

§ 417.209 Malfunction turn analysis.

(a) General. A flight safety analysis must include a malfunction turn analysis that establishes the launch vehicle's turning capability in the event of a malfunction during flight. A malfunction turn analysis must account for each cause of a malfunction turn, such as thrust vector offsets or nozzle burn-through. For each cause, the analysis must establish the launch vehicle's turning capability using a set of turn curves. The analysis must account for:

(1) All trajectory times during the thrusting phases of flight.

(2) When a malfunction begins to cause each turn throughout the thrusting phases of flight. The analysis must use trajectory time intervals between malfunction turn start times that are short enough to establish smooth and continuous flight safety limits and hazard areas.

(3) The relative probability of occurrence of each malfunction turn of which the launch vehicle is capable.

(4) When each malfunction turn will terminate expressed as a single value or a probability time distribution.

(5) What terminates each malfunction turn, such as, aerodynamic or inertial breakup.

(6) The launch vehicle's turning behavior from the time when a malfunction begins to cause a turn until aerodynamic breakup, inertial breakup, or ground impact. The analysis must use trajectory time intervals during the malfunction turn that are short enough to establish turn curves that are smooth and continuous.

(7) For each malfunction turn, the launch vehicle velocity vector turn angle as a function of time from the start of the turn and measured relative to the nominal launch vehicle velocity vector at the start of the turn.

(8) For each malfunction turn, the launch vehicle velocity turn magnitude as a function of time from the start of the turn and measured relative to the nominal velocity magnitude that corresponds to the velocity vector turn angle.

(9) For each malfunction turn, the orientation of the launch vehicle longitudinal axis as a function of time from the start of the turn and measured relative to the nominal launch vehicle velocity vector at the start of the turn.

(b) Set of turn curves for each malfunction turn cause. For each cause of a malfunction turn, the analysis must establish a set of turn curves that satisfies paragraph (a) of this section and must establish the associated envelope of the set of turn curves. Each set of turn curves must describe the variation in the malfunction turn characteristics for each cause of the turn. The envelope of each set of curves must define the limits of the launch vehicle's malfunction turn behavior for each cause of a malfunction turn. For each malfunction turn envelope, the analysis must establish the launch vehicle velocity vector turn angle deviation from the nominal launch vehicle velocity vector. For each malfunction turn envelope, the analysis must establish the vehicle velocity turn magnitude deviation from the nominal velocity magnitude that corresponds to the velocity vector turn angle envelope.

§ 417.211 Debris analysis.

(a) General. A flight safety analysis must include a debris analysis. For an orbital or suborbital launch, a debris analysis must identify the inert, explosive and other hazardous launch vehicle debris that results from normal and malfunctioning launch vehicle flight.

(b) Launch vehicle breakup. A debris analysis must account for each cause of launch vehicle breakup, such as:

(1) Any flight termination system activation,

(2) Launch vehicle explosion,

(3) Aerodynamic loads,

(4) Inertial loads,

(5) Atmospheric reentry heating, and

(6) Impact of intact vehicle.

(c) Debris fragment lists. A debris analysis must produce lists of debris fragments for each cause of breakup and any planned jettison of debris, launch vehicle components, or payload. The lists must account for all launch vehicle debris fragments, individually or in groupings of fragments whose characteristics are similar enough to be described by a single set of characteristics. The debris lists must describe the physical, aerodynamic, and harmful characteristics of each debris fragment, such as:

(1) Origin on the vehicle;

(2) Whether it is inert or explosive;

(3) Weight, dimensions, and shape;

(4) Lift and drag characteristics;

(5) Properties of the incremental velocity distribution imparted by breakup; and

(6) Axial, transverse, and tumbling area.

§ 417.213 Flight safety limits analysis.

(a) General. A flight safety analysis must identify the location of populated or other protected areas. The analysis must also establish flight safety limits that define when a flight safety official must terminate a launch vehicle's flight to prevent the hazardous effects of the resulting debris impacts from reaching any populated or other protected area and ensure that the launch satisfies the public risk criteria of § 417.107(b).

(b) Flight safety limits. The analysis must establish flight safety limits for use in establishing **flight termination rules**. Section 417.113(c) contains requirements for flight termination rules. The flight safety limits must account for the temporal and geometric extents on the Earth's surface of a launch vehicle's hazardous debris impact dispersion resulting from any planned or unplanned event for all times during flight. Flight safety limits must account for potential contributions to the debris impact dispersions, such as:

(1) Time delays, as established by the time delay analysis of § 417.221,

(2) Residual thrust remaining after flight termination implementation,

(3) Wind effects,

(4) Velocity imparted to vehicle fragments by breakup,

(5) Lift and drag forces on the malfunctioning vehicle and falling debris,

(6) Vehicle guidance and performance errors,

(7) Launch vehicle malfunction turn capabilities, and

(8) Any uncertainty due to map errors and launch vehicle tracking errors.

(c) Gates. If a launch involves flight over any populated or other protected area, the flight safety analysis must establish a gate through a flight safety limit. Section 417.217 contains requirements for establishing a gate.

§ 417.215 Straight-up time analysis.

A flight safety analysis must establish the straight-up time for a launch for use as a flight termination rule. Section 417.113(c) contains requirements for flight termination rules. The analysis must establish the straight-up time as the latest time after liftoff, assuming a launch vehicle malfunctioned and flew in a vertical or near vertical direction above the launch point, at which activation of the launch vehicle's flight termination system or breakup of the launch vehicle would not cause hazardous debris or critical overpressure to affect any populated or other protected area.

§ 417.217 No longer terminate gate analysis.

For a launch that involves flight over a populated or other protected area, the flight safety analysis must include a no longer terminate gate analysis. The analysis must establish the portion, referred to as a gate, of a flight safety limit through which a launch vehicle's tracking representation will be allowed to proceed without requiring the flight to be terminated. A tracking representation is a launch vehicle's present position, instantaneous impact point position, debris impact footprint, or other vehicle performance icon or symbol displayed on a flight safety official console during real-time tracking of the launch vehicle's flight. When establishing a gate in a flight safety limit, the analysis must demonstrate that the launch vehicle flight satisfies the public risk criteria of § 417.107(b).

§ 417.219 Data loss flight time and no longer terminate time analyses.

(a) General. For each launch, a flight safety analysis must establish data loss flight times, as identified in paragraph (b) of this section, and a no longer terminate time to establish flight termination rules that apply when launch vehicle tracking data is not available to the flight safety official. Section 417.113(c) contains requirements for flight termination rules.

(b) Data loss flight times. A flight safety analysis must establish the shortest elapsed thrusting time during which a launch vehicle can move from normal flight to a condition where the launch vehicle's hazardous debris impact dispersion extends to any protected area as a data loss flight time. The analysis must establish a data loss flight time for all times along the nominal trajectory from liftoff through the no longer-terminate time established under paragraph (c) of this section.

(c) No longer terminate time. The analysis must establish a no-longer-terminate time as follows:

(1) For a suborbital launch, the analysis must establish the no longer terminate time as the time after liftoff that a launch vehicle's hazardous debris impact dispersion can no longer reach any protected area.

(2) For an orbital launch where the launch vehicle's instantaneous impact point does not overfly a protected area before reaching orbit, the analysis must establish the no-longer terminate time as the time after liftoff that the launch vehicle's hazardous debris impact dispersion can no longer reach any protected area or orbital insertion, whichever occurs first.

(3) For an orbital launch where a gate permits overflight of a protected area and where orbital insertion occurs after reaching the gate, the analysis must establish the no longer terminate time as the time after liftoff when the time for the launch vehicle's instantaneous impact point to reach the gate is less than the time for the instantaneous impact point to reach any flight safety limit.

§ 417.221 Time delay analysis.

(a) General. A flight safety analysis must include a time delay analysis that establishes the mean elapsed time between the violation of a flight termination rule and the time when a flight safety system is capable of terminating flight for use in establishing the flight safety limits of § 417.213.

(b) Analysis constraints. A time delay analysis must determine a time delay distribution that accounts for the following:

(1) The variance of time delays for each potential failure scenario, including but not limited to the range of malfunction turn characteristics and the time of flight when the malfunction occurs;

(2) A flight safety official's decision and reaction time, including variation in human response time, and

(3) Flight termination hardware and software delays including those delays inherent in:

(i) Tracking systems;

(ii) Data processing systems, including filter delays;

(iii) Display systems;

(iv) Command control systems; and

(v) Flight termination systems.

§ 417.223 Flight hazard area analysis.

(a) General. A flight safety analysis must include a flight hazard area analysis that identifies any regions of land, sea, or air that must be monitored, publicized, controlled, or evacuated in order to control the risk to the public from debris impact hazards. The risk management requirements of § 417.205(a) apply. The analysis must account for, but need not be limited to:

(1) Trajectory times from liftoff to the no longer terminate time of § 417.219(c).

(2) Regions of land potentially exposed to debris resulting from normal flight events and events resulting from any potential malfunction.

(3) Regions of sea and air potentially exposed to debris from normal flight events, including planned impacts.

(4) In the vicinity of the launch site, any waterborne vessels or aircraft exposed to debris from events resulting from any potential abnormal flight events, including launch vehicle malfunction.

(5) Any operational controls implemented to control risk to the public from debris hazards.

(6) Debris identified by the debris analysis of § 417.211.

(7) All launch vehicle trajectory dispersion effects in the surface impact domain.

(b) Public notices. A flight hazard areas analysis must establish the ship and aircraft hazard areas for notices to mariners and notices to airmen. Section 417.121(e) requires notices to mariners and airmen.

§ 417.225 Debris risk analysis.

A flight safety analysis must demonstrate that the risk to the public potentially exposed to inert and explosive debris hazards from any one flight of a launch vehicle satisfies the public risk criterion for debris of § 417.107(b)(1). A debris risk analysis must account for risk to populations on land, including regions of launch vehicle flight following passage through any gate in a flight safety limit established under § 417.217. A debris risk analysis must account for any potential casualties to the public using the debris thresholds and as required by § 417.107(c).

§ 417.227 Toxic release hazard analysis.

A flight safety analysis must establish flight commit criteria that ensure compliance with the public risk criterion for toxic release of § 417.107(b)(1). The analysis must account for any toxic release that will occur during the proposed flight of a launch vehicle or that would occur in the event of a flight mishap. The analysis must account for any operational constraints and emergency procedures that provide protection from toxic release. The analysis must account for all members of the public who may be exposed to the toxic release, including all members of the public on land and on any waterborne vessels and aircraft except those operated in direct support of the launch.

§ 417.229 Far-field blast overpressure effects analysis.

(a) General. A flight safety analysis must establish flight commit criteria that ensure compliance with the public risk criterion for far field blast overpressure of § 417.107(b)(1). The analysis must demonstrate that any far field blast overpressure due to potential explosions during launch vehicle flight will not cause windows to break or that any risk to the public due to potential far field overpressure complies with the public risk criteria.

(b) Analysis constraints. The analysis must account for:

(1) The potential for distant focus overpressure or overpressure enhancement given current meteorological conditions and terrain characteristics;

(2) The potential for broken windows due to peak incident overpressures below 1.0 psi and related casualties;

(3) The explosive capability of the launch vehicle at impact and at altitude and potential explosions resulting from debris impacts, including the potential for mixing of liquid propellants;

(4) Characteristics of the launch vehicle flight and the surroundings that would affect the population's susceptibility to injury, such as, shelter types and time of day of the proposed launch;

(5) Characteristics of the potentially affected windows, including their size, location, orientation, glazing material, and condition; and

(6) The hazard characteristics of the potential glass shards, such as falling from upper building stories or being propelled into or out of a shelter toward potentially occupied spaces.

§ 417.231 Collision avoidance analysis.

(a) General. A flight safety analysis must include a collision avoidance analysis that establishes any launch waits in a planned launch window during which a launch operator must not initiate flight, in order to maintain a 200-kilometer separation from any habitable orbiting object. The launch operator must apply any launch waits as flight commit criteria.

(b) Orbital launch. For an orbital launch, the analysis must establish any launch waits needed to ensure that the launch vehicle, any jettisoned components, and its payload do not pass closer than 200 kilometers to a habitable orbiting object during ascent to initial orbital insertion through at least one complete orbit.

(c) Suborbital launch. For a suborbital launch, the analysis must establish any launch waits needed to ensure that the launch vehicle, any jettisoned components, and any payload do not pass closer than 200 kilometers to a habitable orbital object throughout the flight.

§ 417.233 Analysis for an unguided suborbital rocket flown with a wind weighting safety system.

For launch of an unguided suborbital rocket flown with a wind weighting safety system, the flight safety analysis must establish the launch commit criteria and other launch safety rules that the launch operator must implement to control the risk to the public from potential adverse effects resulting from normal and malfunctioning flight. The risk management requirements of § 417.205(a) apply. The analysis must include a trajectory analysis, flight hazard area analysis, debris risk analysis, and collision avoidance analysis that satisfy § 417.207, § 417.223, § 417.225, and § 417.231, respectively. In addition, for each launch, the analysis must establish any wind constraints under which launch may occur and include a wind weighting analysis that establishes the launcher azimuth and elevation settings that correct for the windcocking and wind-drift effects on the unguided suborbital rocket.

27. Revise appendix A to part 417 as proposed to be revised at 65 FR 64041 to read as follows:

APPENDIX A TO PART 417—FLIGHT SAFETY ANALYSIS METHODOLOGIES AND PRODUCTS

A417.1 Scope.

This appendix contains requirements that apply to the methods for performing the flight safety analysis required by § 417.107(f) and subpart C of part 417. The methodologies contained in this appendix provide an acceptable means of satisfying the requirements of subpart C and provide a standard and a measure of fidelity against which the FAA will measure any proposed alternative analysis approach. This appendix also identifies the analysis products that a launch operator must submit to the FAA as required by § 417.203(e).

A417.3 Applicability.

The requirements contained in this appendix apply to a launch operator and the launch operator's flight safety analysis unless the launch operator clearly and convincingly demonstrates that an alternative approach provides an equivalent level of safety. If a federal launch range performs the launch operator's analysis, § 417.203(d) applies. Section A417.33 applies to the flight of any unguided suborbital launch vehicle that uses a wind weighting safety system. All other sections of this appendix apply to the flight of any launch vehicle required to use a flight safety system in accordance with § 417.107(a). For any alternative flight safety system approved by the FAA in accordance with § 417.107(a)(3), the FAA will determine the applicability of this appendix during the licensing process.

A417.5 General.

A launch operator's flight safety analysis must satisfy the requirements for public risk management and the requirements for the compatibility of the input and output of dependent analyses of § 417.205.

A417.7 Trajectory.

(a) General. A flight safety analysis must include a trajectory analysis that satisfies the requirements of § 417.207. The requirements of this section apply to the computation of the trajectories required by § 417.207 and to the trajectory analysis products that a launch operator must submit to the FAA as required by § 417.203(e).

(b) Wind standards. A trajectory analysis must incorporate wind data in accordance with the following:

(1) For each launch, a trajectory analysis must produce "with-wind" launch vehicle trajectories pursuant to paragraph (f)(6) of this section and do so using composite wind profiles for the month that the launch will take place or composite wind profiles that are as severe or more severe than the winds for the month that the launch will take place.

(2) A composite wind profile used for the trajectory analysis must have a cumulative percentile frequency that represents wind conditions that are at least as severe as the worst wind conditions under which flight would be attempted for purposes of achieving the launch operator's mission. These worst wind conditions must account for the launch vehicle's ability to operate normally in the presence of wind and accommodate any flight safety limit constraints.

(c) Nominal trajectory. A trajectory analysis must produce a nominal trajectory that describes a launch vehicle's flight path, position and velocity, where all vehicle aerodynamic parameters are as expected, all vehicle internal and external systems perform exactly as planned, and no external perturbing influences other than atmospheric drag and gravity affect the launch vehicle.

(d) Dispersed trajectories. A trajectory analysis must produce the following dispersed trajectories and describe the distribution of a launch vehicle's position and velocity as a function of winds and performance error parameters in the uprange, downrange, left-crossrange and right-crossrange directions.

(1) Three-sigma maximum and minimum performance trajectories. A trajectory analysis must produce a three-sigma maximum performance trajectory that provides the maximum downrange distance of the instantaneous impact point for any given time after lift-off. A trajectory analysis must produce a three-sigma minimum performance trajectory that provides the minimum downrange distance of the instantaneous impact point for any given time after lift-off. For any time after lift-off, the instantaneous impact point dispersion of a normally performing launch vehicle must lie between the extremes achieved at that time after lift-off by the three-sigma maximum and three-sigma minimum performance trajectories. The three-sigma maximum and minimum performance trajectories must account for wind and performance error parameter distributions in accordance with the following:

(i) For each three-sigma maximum and minimum performance trajectory, the analysis must use composite head wind and composite tail wind profiles that represent the worst wind conditions under which a launch would be attempted in accordance with paragraph (b) of this section.

(ii) Each three-sigma maximum and minimum performance trajectory must account for all launch vehicle performance error parameters identified in accordance with paragraph (f)(1) of this section that have an effect upon instantaneous impact point range.

(2) Three-sigma left and right lateral trajectories. A trajectory analysis must produce a three-sigma left lateral trajectory that provides the maximum left crossrange distance of the instantaneous impact point for any time after lift-off. A trajectory analysis must produce a three-sigma right lateral trajectory that provides the maximum right crossrange distance of the

instantaneous impact point for any time after lift-off. For any time after lift-off, the instantaneous impact point dispersion of a normally performing launch vehicle must lie between the extremes achieved at that time after lift-off by the three-sigma left lateral and three-sigma right lateral performance trajectories. The three-sigma lateral performance trajectories must account for wind and performance error parameter distributions in accordance with the following:

(i) In producing each left and right lateral trajectory, the analysis must use composite left and composite right lateral-wind profiles that represent the worst wind conditions under which a launch would be attempted in accordance with paragraph (b) of this section.

(ii) The three-sigma left and right lateral trajectories must account for all launch vehicle performance error parameters identified in accordance with paragraph (f)(1) of this section that have an effect on the lateral deviation of the instantaneous impact point.

(3) Fuel-exhaustion trajectory. A trajectory analysis must produce a fuel-exhaustion trajectory for the launch of any launch vehicle with a final suborbital stage that will terminate thrust nominally without burning to fuel exhaustion. The analysis must produce the trajectory that would occur if the planned thrust termination of the final suborbital stage did not occur. The analysis must produce a fuel-exhaustion trajectory that extends either the nominal trajectory taken through fuel exhaustion of the last suborbital stage or the three-sigma maximum trajectory taken through fuel exhaustion of the last suborbital stage, whichever produces instantaneous impact points with the greatest range for any time after liftoff.

(e) Straight-up trajectory. A trajectory analysis must produce a straight-up trajectory that begins at the planned time of ignition, and that simulates a malfunction that causes the launch vehicle to fly in a vertical or near vertical direction above the launch point. A straight-up trajectory must last no less than the sum of the straight-up time determined in accordance with A417.15 plus the duration of a potential malfunction turn determined in accordance with A417.9(b)(2).

(f) Analysis process and computations. A trajectory analysis must produce each three-sigma trajectory required by this appendix using a six-degree-of freedom trajectory model and an analysis method, such as root-sum-square or Monte Carlo, that accounts for all individual launch vehicle performance error parameters that contribute to the dispersion of the launch vehicle's instantaneous impact point.

(1) A trajectory analysis must identify all launch vehicle performance error parameters and each parameter's distribution to account for all launch vehicle performance variations and any external forces that can cause offsets from the nominal trajectory during normal flight. A trajectory analysis must account for, but need not be limited to, the following performance error parameters:

(i) Thrust;

(ii) Thrust misalignment;

(iii) Specific impulse;

(iv) Weight;

(v) Variation in firing times of the stages;

(vi) Fuel flow rates;

(vii) Contributions from the guidance, navigation, and control systems;

(ix) Steering misalignment; and

(x) Winds.

(2) Each three-sigma trajectory must account for the effects of wind from liftoff through the point in flight where the launch vehicle attains an altitude where wind no longer affects the launch vehicle.

(g) Trajectory analysis products. The products of a trajectory analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include the following:

(1) Assumptions and procedures. A description of all assumptions, procedures and models, including the six-degrees-of-freedom model, used in deriving each trajectory.

(2) Three-sigma launch vehicle performance error parameters. A description of each three-sigma performance error parameter accounted for by the trajectory analysis and a description of each parameter's distribution determined in accordance with paragraph (f)(1) of this section.

(3) Wind profile. A graph and tabular listing of each wind profile used in performing the trajectory analysis as required by paragraph (b)(1) of this section and the worst case winds required by paragraph (b)(2) of this section. The graph and tabular wind data must provide wind magnitude and direction as a function of altitude for the air space regions from the Earth's surface to 100,000 feet in altitude for the area intersected by the launch vehicle trajectory. Altitude intervals must not exceed 5000 feet.

(4) Launch azimuth. The azimuthal direction of the trajectory's "X-axis" at liftoff measured clockwise in degrees from true north.

(5) Launch point. Identification and location of the proposed launch point, including its name, geodetic latitude (+N), longitude (+E), and geodetic height.

(6) Reference ellipsoid. The name of the reference ellipsoid used by the trajectory analysis to approximate the average curvature of the Earth and the following information about the model:

(i) Length of semi-major axis,

(ii) Length of semi-minor axis,

(iii) Flattening parameter,

(iv) Eccentricity,

(v) Gravitational parameter,

(vi) Angular velocity of the Earth at the equator, and

(vii) If the reference ellipsoid is not a WGS-84 ellipsoidal Earth model, the equations that convert the submitted ellipsoid information to the WGS-84 ellipsoid.

(7) Temporal trajectory items. A launch operator must provide the following temporal trajectory data for time intervals not in excess of one second and for the discrete time points that correspond to each jettison, ignition, burnout, and thrust termination of each stage. If any stage burn time lasts less than four seconds, the time intervals must not exceed 0.2 seconds. The launch operator must provide the temporal trajectory data from launch up to a point in flight when effective thrust of the final stage terminates, or to thrust termination of the stage or burn that places the vehicle in orbit. For an unguided sub-orbital launch vehicle flown with a flight safety system, the launch operator must provide these data for each nominal quadrant launcher elevation angle and payload weight. The launch operator must provide these data on paper in text format and electronically in ASCII text, space delimited format. The launch operator must provide an electronic "readme" file that identifies the data and their units of measure in the individual disk files.

(i) Trajectory time-after-liftoff. A launch operator must provide trajectory time-after-liftoff measured from first motion of the first thrusting stage of the launch vehicle. The tabulated data must identify the first motion time as T-0 and as the "0.0" time point on the trajectory.

(ii) Launch vehicle direction cosines. A launch operator must provide the direction cosines of the roll axis, pitch axis, and yaw axis of the launch vehicle. The roll axis is a line identical to the launch vehicle's longitudinal axis with its origin at the nominal center of gravity positive towards the vehicle nose. The roll plane is normal to the roll axis at the vehicle's nominal center of gravity. The yaw axis and the pitch axis are any two orthogonal axes lying in the roll plane. The launch operator must provide roll, pitch and yaw axes of right-handed systems so that, when looking along the roll axis toward the nose, a clockwise rotation around the roll axis will send the pitch axis toward the yaw axis. The right-handed system must be oriented so that the yaw axis is positive in the downrange direction while in the vertical position (roll axis upward from surface) or positive at an angle of 180 degrees to the downrange direction. The axis may be related to the vehicle's normal orientation with respect to the vehicle's trajectory but, once defined, remain fixed with respect to the vehicle's body. The launch operator must indicate the positive direction of the yaw axis chosen. The analysis products must present the direction cosines using the EFG reference system described in paragraph (g)(7)(iv) of this section.

(iii) X, Y, Z, XD, YD, ZD trajectory coordinates. A launch operator must provide the launch vehicle position coordinates (X, Y, Z) and velocity magnitudes (XD, YD, ZD) referenced to an orthogonal, Earth-fixed, right-handed coordinate system. The XY-plane must be tangent to the ellipsoidal Earth at the origin, which must coincide with the launch point. The positive X-axis must coincide with the launch azimuth. The positive Z-axis must be directed away from the ellipsoidal Earth. The Y-axis must be positive to the left looking downrange.

(iv) E, F, G, ED, FD, GD trajectory coordinates. A launch operator must provide the launch vehicle position coordinates (E, F, G) and velocity magnitudes (ED, FD, GD) referenced to an orthogonal, Earth fixed, Earth centered, right-handed coordinate system. The origin of the EFG system must be at the center of the reference ellipsoid. The E and F axes must lie in the plane of the equator and the G-axis coincides with the rotational axis of the Earth. The E-axis must be positive through 0° East longitude (Greenwich Meridian), the F-axis positive through 90° East longitude, and the G-axis positive through the North Pole. This system must be non-inertial and rotate with the Earth.

(v) Resultant Earth-fixed velocity. A launch operator must provide the square root of the sum of the squares of the XD, YD, and ZD components of the trajectory state vector.

(vi) Path angle of velocity vector. A launch operator must provide the angle between the local horizontal plane and the velocity vector measured positive upward from the local horizontal. The local horizontal must be a plane tangent to the ellipsoidal Earth at the sub-vehicle point.

(vii) Sub-vehicle point. A launch operator must provide sub–vehicle point coordinates that include present position geodetic latitude (+N) and present position longitude (+E). These coordinates must be at each trajectory time on the surface of the ellipsoidal Earth model and located at the intersection of the line normal to the ellipsoid and passing through the launch vehicle center of gravity.

(viii) Altitude. A launch operator must provide the distance from the sub-vehicle point to the launch vehicle's center of gravity.

(ix) Present position arc-range. A launch operator must provide the distance measured along the surface of the reference ellipsoid, from the launch point to the sub-vehicle point.

(x) Total weight. A launch operator must provide the sum of the inert and propellant weights for each time point on the trajectory.

(xi) Total vacuum thrust. A launch operator must provide the total vacuum thrust for each time point on the trajectory.

(xii) Instantaneous impact point data. A launch operator must provide instantaneous impact point geodetic latitude (+N), instantaneous impact point longitude (+E), instantaneous impact point arc-range, and time to instantaneous impact. The instantaneous impact point arc-range must consist of the distance, measured along the surface of the reference ellipsoid, from the launch point to the instantaneous impact point. For each point on the trajectory, the time to instantaneous impact must consist of the vacuum flight time remaining until impact if all thrust were terminated at the time point on the trajectory.

(xiii) Normal trajectory distribution. A launch operator must provide a description of the distribution of the dispersed trajectories required under (d), such as the elements of covariance matrices for the launch vehicle position coordinates and velocity magnitudes.

A417.9 Malfunction turn.

(a) General. A flight safety analysis must include a malfunction turn analysis that satisfies the requirements of § 417.209. The requirements of this section apply to the computation of the malfunction turns and the production of turn data required by § 417.209 and to the malfunction turn analysis products that a launch operator must submit to the FAA as required by § 417.203(e).

(b) Malfunction turn analysis constraints. The following constraints apply to a malfunction turn analysis:

(1) The analysis must produce malfunction turns that start at a given malfunction start time. The turn must last no less than 12 seconds. These duration limits apply regardless of whether or not the vehicle would breakup or tumble before the prescribed duration of the turn.

(2) A malfunction turn analysis must account for the thrusting periods of flight along a nominal trajectory beginning at first motion until thrust termination of the final thrusting stage or until the launch vehicle achieves orbit, whichever occurs first.

(3) A malfunction turn must consist of a 90-degree turn or a turn in both the pitch and yaw planes that would produce the largest deviation from the nominal instantaneous impact point of which the launch vehicle is capable at any time during the malfunction turn in accordance with paragraph (d) of this section.

(4) The first malfunction turn must start at liftoff. The analysis must account for subsequent malfunction turns initiated at regular nominal trajectory time intervals not to exceed four seconds.

(5) A malfunction turn analysis must produce malfunction turn data for time intervals of no less than one second over the duration of each malfunction turn.

(6) The analysis must assume that the launch vehicle performance is nominal up to the point of the malfunction that produces the turn.

(7) A malfunction turn analysis must not account for the effects of gravity.

(8) A malfunction turn analysis must ensure the tumble turn envelope curve maintains a positive slope throughout the malfunction turn duration as illustrated in figure A417.9-1. When calculating tumble turns for an aerodynamically unstable launch vehicle, in the

high aerodynamic region it often turns out that no matter how small the initial deflection of the rocket engine, the airframe tumbles through 180 degrees, or one-half cycle, in less time than the required turn duration period. In such a case, the analysis must use a 90-degree turn as the malfunction turn.

(c) Failure modes. A malfunction turn analysis must account for the significant failure modes that result in a thrust vector offset from the nominal state. If a malfunction turn at a malfunction start time can occur as a function of more than one failure mode, the analysis must account for the failure mode that causes the most rapid and largest launch vehicle instantaneous impact point deviation.

(d) Type of malfunction turn. A malfunction turn analysis must establish the maximum turning capability of a launch vehicle's velocity vector during each malfunction turn by accounting for a 90-degree turn to estimate the vehicle's turning capability or by accounting for trim turns and tumble turns in both the pitch and yaw planes to establish the vehicle's turning capability. When establishing the turning capability of a launch vehicle's velocity vector, the analysis must account for each turn in accordance with the following:

(1) 90-degree turn. A 90-degree turn must constitute a turn produced at the malfunction start time by instantaneously re-directing and maintaining the vehicle's thrust at 90 degrees to the velocity vector, without regard for how this situation can be brought about.

(2) Pitch turn. A pitch turn must constitute the angle turned by the launch vehicle's total velocity vector in the pitch-plane. The velocity vector's pitch-plane must be the two dimensional surface that includes the launch vehicle's yaw-axis and the launch vehicle's roll-axis.

(3) Yaw turn. A yaw turn must constitute the angle turned by the launch vehicle's total velocity vector in the lateral plane. The velocity vector's lateral plane must be the two dimensional surface that includes the launch vehicle's pitch axis and the launch vehicle's total velocity.

(4) Trim turn. A trim turn must constitute a turn where a launch vehicle's thrust moment balances the aerodynamic moment while a constant rotation rate is imparted to the launch vehicle's longitudinal axis. The analysis must account for a maximum-rate trim turn made at or near the greatest angle of attack that can be maintained while the aerodynamic moment is balanced by the thrust moment, whether the vehicle is stable or unstable.

(5) Tumble turn. A tumble turn must constitute a turn that results if the launch vehicle's airframe rotates in an uncontrolled fashion, at an angular rate that is brought about by a thrust vector offset angle, and if the offset angle is held constant throughout the turn. The analysis must account for a series of tumble turns, each turn with a different thrust vector offset angle, that are plotted on the same graph for each malfunction start time.

(6) Turn envelope. A turn envelope must constitute a curve on a tumble turn graph that has tangent points to each individual tumble turn curve computed for each malfunction start time. The curve must envelope the actual tumble turn curves to predict tumble turn angles for each area between the calculated turn curves. Figure A417.9-1 depicts a series of tumble turn curves and the tumble turn envelope curve.

(7) Malfunction turn capabilities. When not using a 90-degree turn, a malfunction turn analysis must establish the launch vehicle maximum turning capability in accordance with the following malfunction turn constraints:

(i) Launch vehicle stable at all angles of attack. If a launch vehicle is so stable that the maximum thrust moment that the vehicle could experience cannot produce tumbling, but produces a maximum-rate trim turn at some angle of attack less than 90 degrees, the analysis must produce a series of trim turns, including the maximum-rate trim turn, by varying the initial thrust vector offset at the beginning of the turn. If the maximum thrust moment results in a maximum-rate trim turn at some angle of attack greater than 90 degrees, the analysis must produce a series of trim turns for angles of attack up to and including 90 degrees.

(ii) Launch vehicle aerodynamically unstable at all angles of attack. If flying a trim turn is not possible even for a period of only a few seconds, the malfunction turn analysis need only establish tumble turns. Otherwise, the malfunction turn analysis must establish a series of trim turns, including the maximum-rate trim turn, and the family of tumble turns.

(iii) Launch vehicle unstable at low angles of attack but stable at some higher angles of attack. If large engine deflections result in tumbling, and small engine deflections do not, the analysis must produce a series of trim and tumble turns as required by paragraph (d)(7)(ii) of this section for launch vehicles aerodynamically unstable at all angles of attack. If both large and small constant engine deflections result in tumbling, regardless of how small the deflection might be, the analysis must account for the malfunction turn capabilities achieved at the stability angle of attack, assuming no upsetting thrust moment, and must account for the turns achieved by a tumbling vehicle.

(e) Malfunction turn analysis products. The products of a malfunction turn analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) A description of the assumptions, techniques, and equations used in deriving the malfunction turns.

(2) A set of sample calculations for at least one flight hazard area malfunction start time and one downrange malfunction start time. The sample computation for the downrange malfunction must start at a time at least 50 seconds after the flight hazard area malfunction start time or at the time of nominal thrust termination of the final stage minus the malfunction turn duration.

(3) A launch operator must submit malfunction turn data in electronic tabular and graphic formats. The graphs must use scale factors such that the plotting and reading accuracy do not degrade the accuracy of the data. For each malfunction turn start time, a graph must use the same time scales for the malfunction velocity vector turn angle and malfunction velocity magnitude plot pairs. A launch operator must provide tabular listings of the data used to generate the graphs in digital ASCII file format. A launch operator must submit the data items required in this paragraph for each malfunction start time and for time intervals that do not exceed one second for the duration of each malfunction turn.

(i) Velocity turn angle graphs. A launch operator must submit a velocity turn angle graph for each malfunction start time. For each velocity turn angle graph, the ordinate axis must represent the total angle turned by the velocity vector, and the abscissa axis must represent the time duration of the turn and must show increments not to exceed one second. The series of tumble turns must include the envelope of all tumble turn curves. The tumble turn envelope must represent the tumble turn capability for all possible constant thrust vector offset angles. Each tumble turn curve selected to define the envelope must appear on the same graph as the envelope. A launch operator must submit a series of trim turn curves for representative values of thrust vector offset. The series of trim turn curves must include the maximum-rate trim turn.

Figure A417.9-1 depicts an example family of tumble turn curves and the tumble turn velocity vector envelope.

(ii) Velocity magnitude graphs. A launch operator must submit a velocity magnitude graph for each malfunction start time. For each malfunction velocity magnitude graph, the ordinate axis must represent the magnitude of the velocity vector and the abscissa axis must represent the time duration of the turn. Each graph must show the abscissa divided into increments not to exceed one second. Each graph must show the total velocity magnitude plotted as a function of time starting with the malfunction start time for each thrust vector offset used to define the corresponding velocity turn-angle curve. A launch operator must provide a corresponding velocity magnitude curve for each velocity tumble-turn angle curve and each velocity trim-turn angle curve. For each individual tumble turn curve selected to define the tumble turn envelope, the corresponding velocity magnitude graph must show the individual tumble turn curve's point of tangency to the envelope. The point of tangency must consist of the point where the tumble turn envelope is tangent to an individual tumble turn curve produced with a discrete thrust vector offset angle. A launch operator must transpose the points of tangency to the velocity magnitude curves by plotting a point on the velocity magnitude curve at the same time point where tangency occurs on the corresponding velocity tumble-turn angle curve. Figure A417.9-2 depicts an example tumble turn velocity magnitude curve.

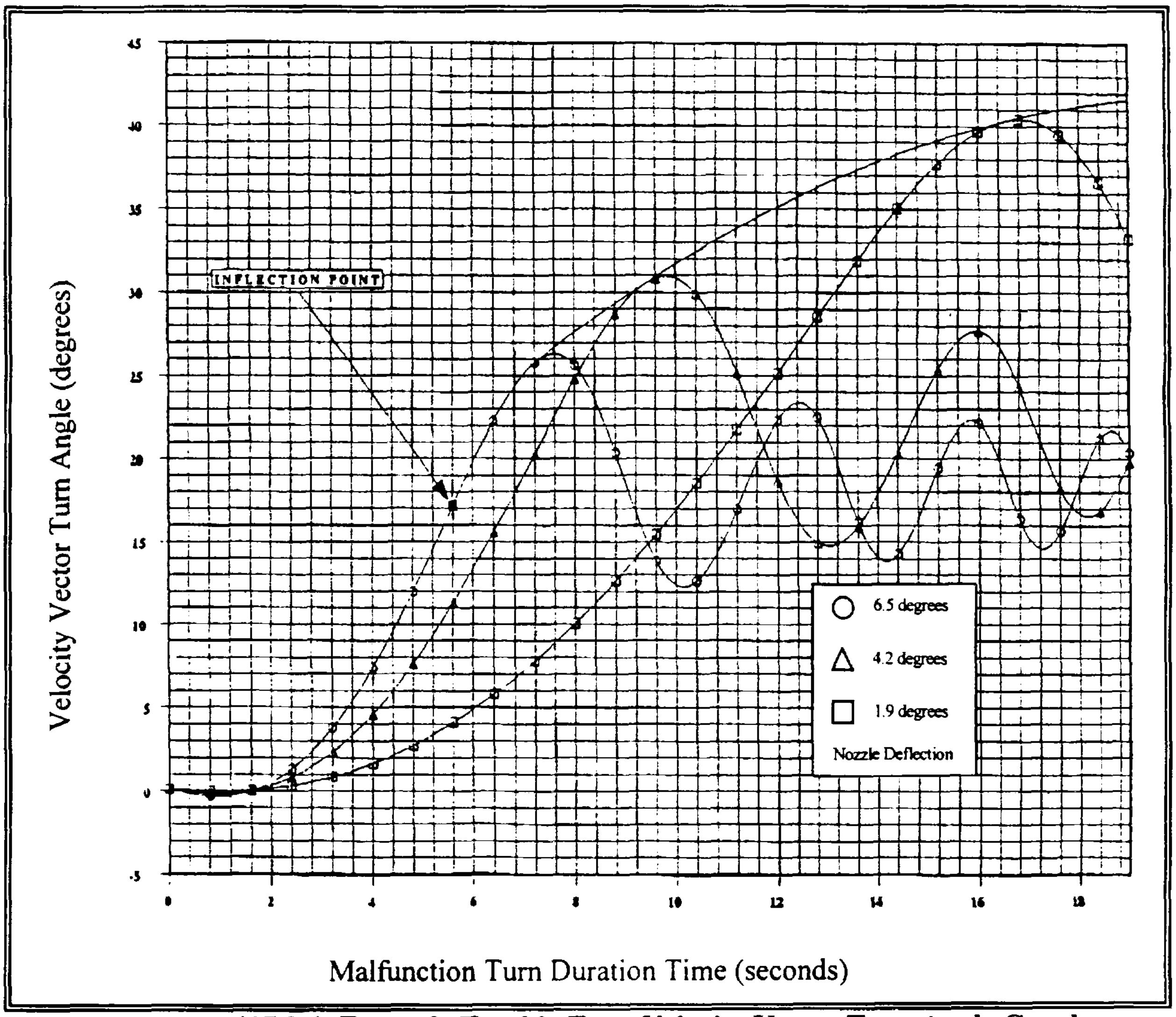

Figure A417.9-1, Example Tumble Turn Velocity Vector Turn Angle Graph.

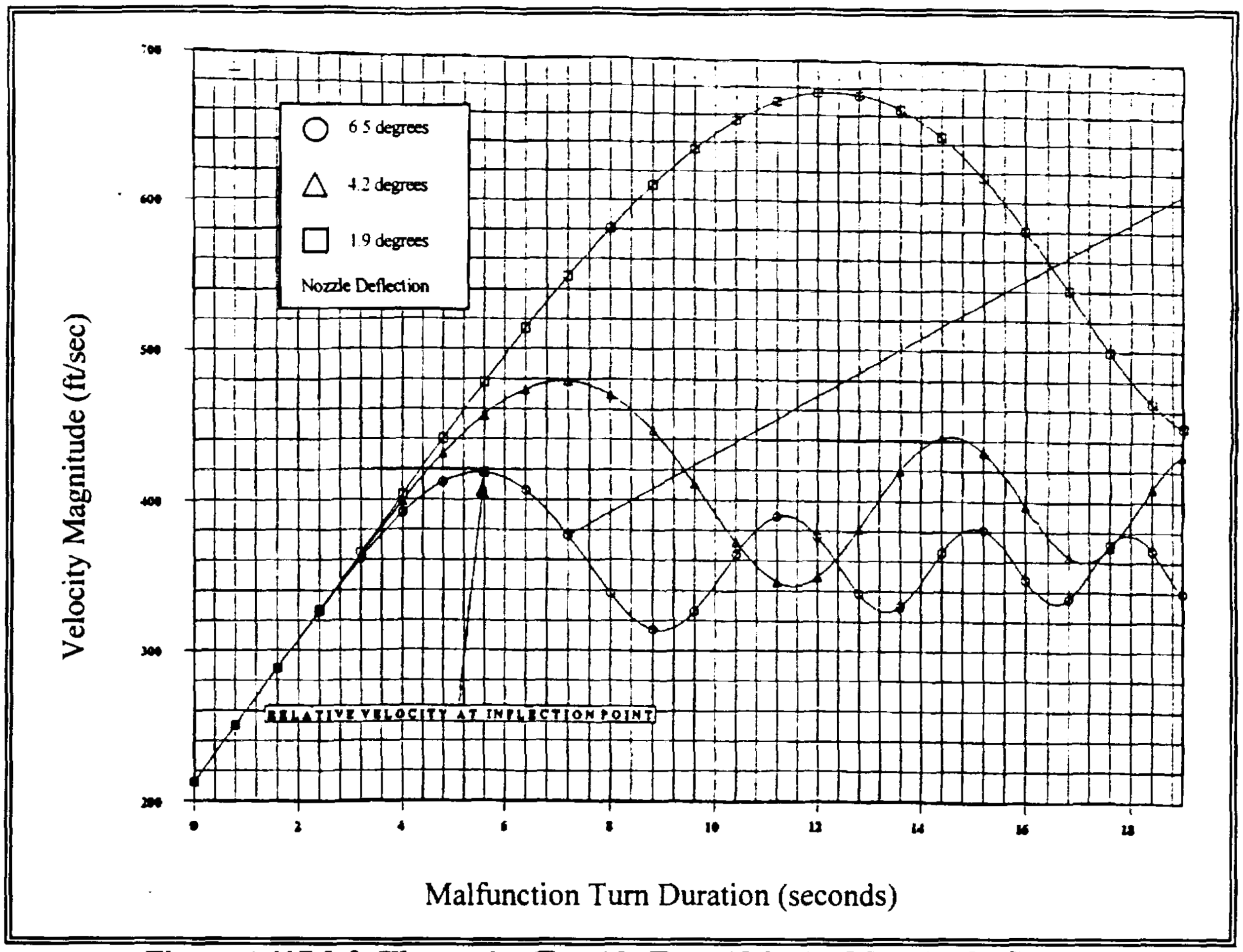

Figure A417.9-2, Illustrative Tumble Turn Velocity Magnitude Graph.

(iii) Vehicle orientation. The launch operator must submit tabular or graphical data for the vehicle orientation in the form of roll, pitch, and yaw angular orientation of the vehicle longitudinal axis as a function of time into the turn for each turn initiation time. Angular orientation of a launch vehicle's longitudinal axis is illustrated in figures A417.9-3 and A417.9-4.

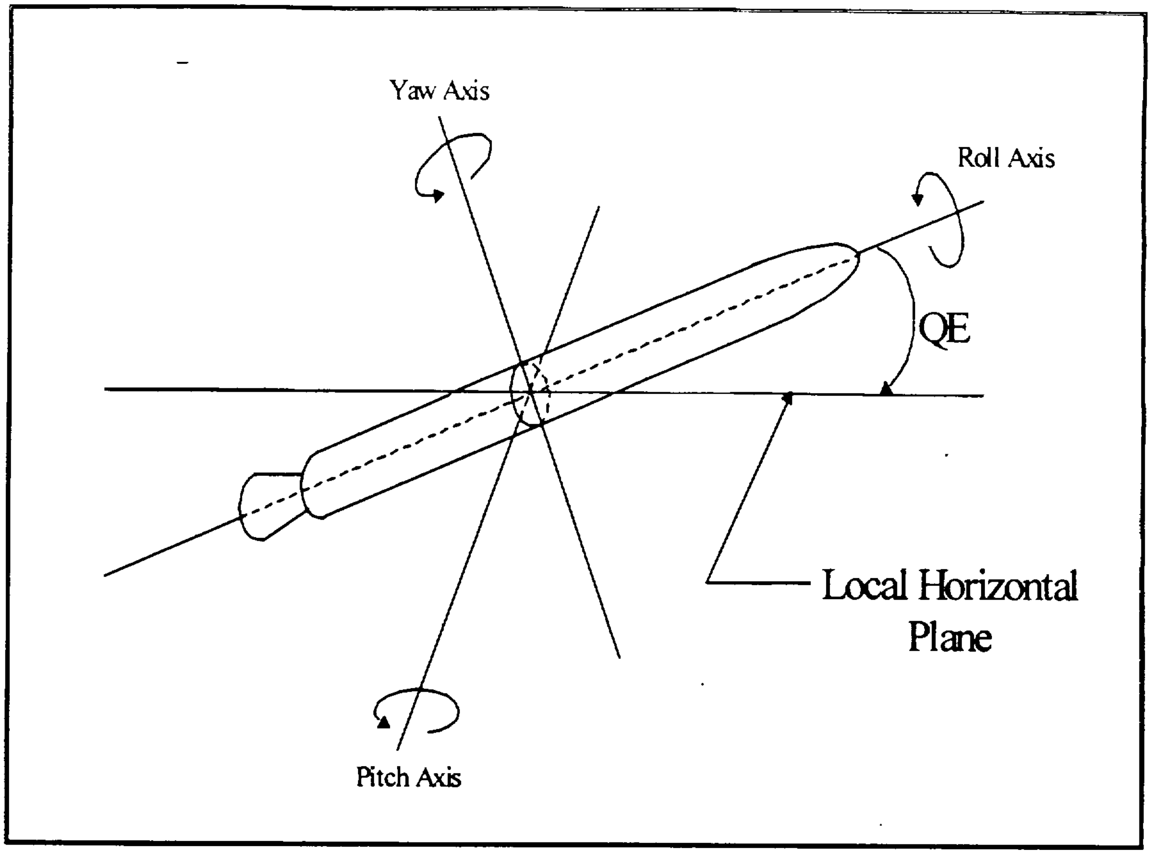

Figure A417.9-3, Illustrative Longitudinal Axis Quadrant Elevation (QE)

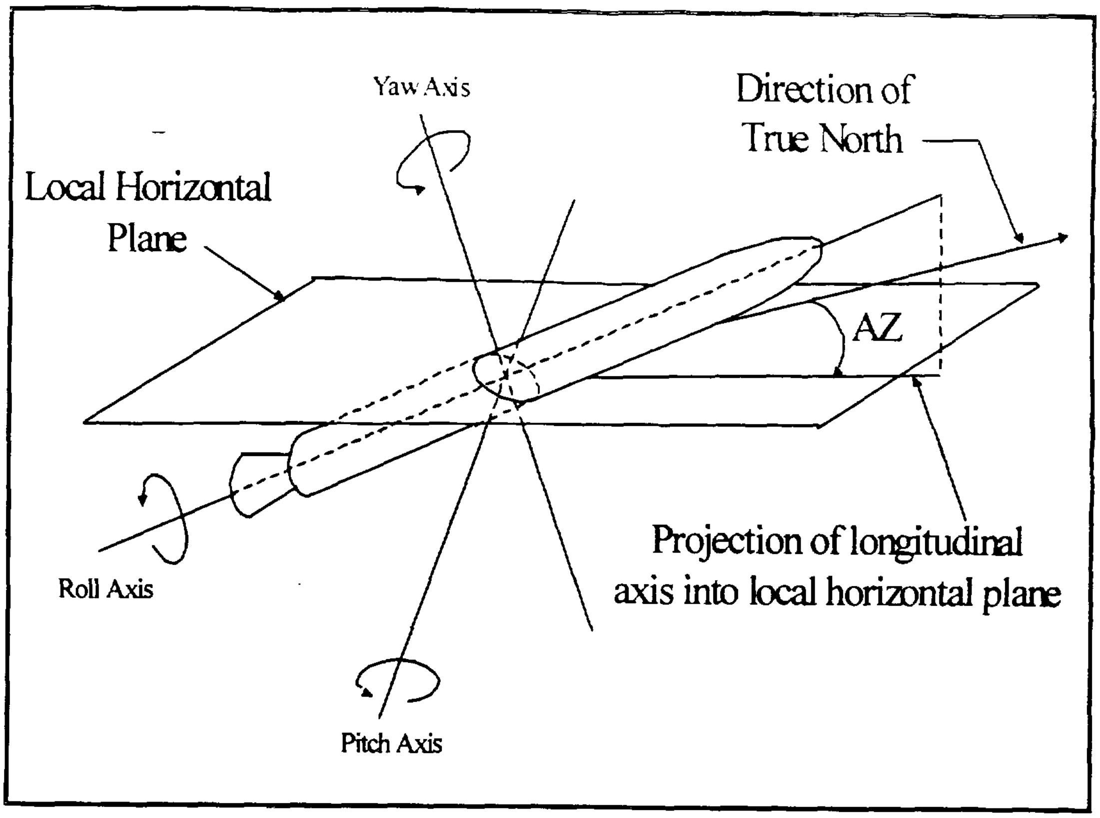

Figure A417.9-4, Illustrative Longitudinal Axis Azimuth (AZ)

(iv) Onset conditions. A launch operator must provide launch vehicle state information for each malfunction start time. This state data must include the launch vehicle thrust, weight, velocity magnitude and pad-centered topocentric X, Y, Z, XD, YD, ZD state vector.

(v) Breakup information. A launch operator must specify whether its launch vehicle will remain intact throughout each malfunction turn. If the launch vehicle will breakup during a turn, the launch operator must identify the time for launch vehicle breakup on each velocity magnitude graph. The launch operator must show the time into the turn at which vehicle breakup would occur as either a specific value or a probability distribution for time until breakup.

(vi) Inflection point. A launch operator must identify the inflection point on each tumble turn envelope curve and maximum rate trim turn curve for each malfunction start time as illustrated in figure A417.9-1. The inflection point marks the point in time during the turn where the slope of the curve stops increasing and begins to decrease or, in other words, the point were the concavity of the curve changes from concave up to concave down. The inflection point on a malfunction turn curve must identify the time in the malfunction turn that the launch vehicle body achieves a 90-degree rotation from the nominal position. On a tumble turn curve the inflection point must represent the start of the launch vehicle tumble.

A417.11 Debris.

(a) General. A flight safety analysis must include a debris analysis that satisfies the requirements of § 417.211. The requirements of this section apply to the debris data required by § 417.211 and the debris analysis products that a launch operator must submit to the FAA as required by § 417.203(e).

(b) Debris analysis constraints. A debris analysis must produce the debris model described in paragraph (c) of this section. The analysis must account for all launch vehicle debris fragments, individually or in groupings of fragments called classes. The characteristics of each debris fragment represented by a class must be similar enough to the characteristics of all the other debris fragments represented by that class that all the debris fragments of the class can be described by a single set of characteristics. Paragraph (c)(10) of this section applies when establishing a debris class. A debris model must describe the physical, aerodynamic, and harmful characteristics of each debris fragment either individually or as a member of a class. A debris model must consist of lists of individual debris or debris classes for each cause of breakup and any planned jettison of debris, launch vehicle components, or payload. A debris analysis must account for:

(1) Launch vehicle breakup caused by the activation of any flight termination system. The analysis must account for:

(i) The effects of debris produced when flight termination system activation destroys an intact malfunctioning vehicle.

(ii) Spontaneous breakup of the launch vehicle, if the breakup is assisted by the action of any inadvertent separation destruct system.

(iii) The effects of debris produced by the activation of any flight termination system after inadvertent breakup of the launch vehicle.

(2) Debris due to any malfunction where forces on the launch vehicle may exceed the launch vehicle's structural integrity limits.

(3) The immediate post-breakup or jettison environment of the launch vehicle debris, and any change in debris characteristics over time from launch vehicle breakup or jettison until debris impact.

(4) The impact overpressure, fragmentation, and secondary debris effects of any confined or unconfined solid propellant chunks and fueled components containing either liquid or solid propellants that could survive to impact, as a function of vehicle malfunction time.

(5) The effects of impact of the intact vehicle as a function of failure time. The intact impact debris analysis must identify the trinitrotoluene (TNT) yield of impact explosions, and the numbers of fragments projected from all such explosions, including non-launch vehicle ejecta and the blast overpressure radius. The analysis must use a model for TNT yield of impact

explosion that accounts for the propellant weight at impact, the impact speed, the orientation of the propellant, and the impacted surface material.

(c) Debris model. A debris analysis must produce a model of the debris resulting from planned jettison and from unplanned breakup of a launch vehicle for use as input to other analyses, such as establishing flight safety limits and hazard areas and performing debris risk, toxic, and blast analyses. A launch operator's debris model must satisfy the following:

(1) Debris fragments. A debris model must provide the debris fragment data required by this section for the launch vehicle flight from the planned ignition time until the launch vehicle achieves orbital velocity for an orbital launch. For a sub-orbital launch, the debris model must provide the debris fragment data required by this section for the launch vehicle flight from the planned ignition time until thrust termination of the last thrusting stage. A debris model must provide debris fragment data for the number of time periods sufficient to meet the requirements for smooth and continuous contours used to define hazard areas as required by A417.23.

(2) Inert fragments. A debris model must identify all inert fragments that are not volatile and that do not burn or explode under normal and malfunction conditions. A debris model must identify inert fragments for each breakup time during flight corresponding to a critical event when the fragment catalog is significantly changed by the event. Critical events include staging, payload fairing jettison, and other normal hardware jettison activities.

(3) Explosive and non-explosive propellant fragments. A debris model must identify all propellant fragments that are explosive or non-explosive upon impact. The debris model must describe each propellant fragment as a function of time, from the time of breakup through ballistic free-fall to impact. The debris model must describe the characteristics of each fragment, including its origin on the launch vehicle, representative dimensions and weight at the time of

breakup and at the time of impact. For those fragments identified as un-contained or contained propellant fragments, whether explosive or non-explosive, the debris model must identify whether or not burning occurs during free fall, and provide the consumption rate during free fall. The debris model must identify:

(i) Solid propellant that is exposed directly to the atmosphere and that burns but does not explode upon impact as "un-contained non-explosive solid propellant."

(ii) Solid or liquid propellant that is enclosed in a container, such as a motor case or pressure vessel, and that burns but does not explode upon impact as "contained non-explosive propellant."

(iii) Solid or liquid propellant that is enclosed in a container, such as a motor case or pressure vessel, and that explodes upon impact as "contained explosive propellant fragment."

(iv) Solid propellant that is exposed directly to the atmosphere and that explodes upon impact as "un-contained explosive solid propellant fragment."

(4) Other non-inert debris fragments. In addition to the explosive and flammable fragments required by paragraph (c)(3) of this section, a debris model must identify any other non-inert debris fragments, such as toxic or radioactive fragments, that present any other hazards to the public.

(5) Fragment weight. At each modeled breakup time, the individual fragment weights must approximately add up to the sum total weight of inert material in the vehicle and the weight of contained liquid propellants and solid propellants that are not consumed in the initial breakup or conflagration.

(6) Fragment imparted velocity. A debris model must identify the maximum velocity imparted to each fragment due to potential explosion or pressure rupture. When accounting for imparted velocity, a debris model must:

(i) Use a Maxwellian distribution with the specified maximum value equal to the 97th percentile; or

(ii) If a debris model does not use a Maxwellian velocity distribution, the analysis products must identify the distribution, and must state whether or not the specified maximum value is a fixed value with no uncertainty.

(7) Fragment projected area. A debris model must include the axial, transverse, and mean tumbling areas of each fragment. If the fragment may stabilize under normal or malfunction conditions, the debris model must also provide the projected area normal to the drag force.

(8) Fragment ballistic coefficient. A debris model must include the axial, transverse, and tumble orientation ballistic coefficient for each fragment's projected area as required by paragraph (c)(7) of this section.

(9) Debris fragment count A debris model must include the total number of each type of fragment required by paragraphs (c)(2), (c)(3), and (c)(4) of this section and created by a malfunction.

(10) Fragment classes. A debris model must categorize malfunction debris fragments into classes where the characteristics of the mean fragment in each class conservatively represent every fragment in the class. The model must define fragment classes for fragments whose characteristics are similar enough to be described and treated by a single average set of

characteristics. A debris class must categorize debris by each of the following characteristics, and may include any other useful characteristics:

(i) The type of fragment, defined by paragraphs (c)(2), (c)(3), and (c)(4) of this section. All fragments within a class must be the same type, such as inert or explosive.

(ii) Debris subsonic ballistic coefficient (β_{sub}). The difference between the smallest $\log_{10}(\beta_{sub})$ value and the largest $\log_{10}(\beta_{sub})$ value in a class must not exceed 0.5, except for fragments with β_{sub} less than or equal to three. Fragments with β_{sub} less than or equal to three may be grouped within a class.

(iii) Breakup-imparted velocity (ΔV). A debris model must categorize fragments as a function of the range of ΔV for the fragments within a class and the class's median subsonic ballistic coefficient. For each class, the debris model must keep the ratio of the maximum breakup-imparted velocity (ΔV_{max}) to minimum breakup-imparted velocity (ΔV_{min}) within the following bound:

$$\frac{\Delta V_{max}}{\Delta V_{min}} < \frac{5}{2 + \log_{10}\left(\beta'_{sub}\right)}$$

Where: β'_{sub} is the median subsonic ballistic coefficient for the fragments in a class.

(d) Debris analysis products. The products of a debris analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) Debris model. The launch operator's debris model that satisfies the requirements of this section.

(2) Fragment description. A description of the fragments contained in the launch operator's debris model. The description must identify the fragment as a launch vehicle part or

component, describe its shape, representative dimensions, and may include drawings of the fragment.

(3) Intact impact TNT yield. For an intact impact of a launch vehicle, for each failure time, a launch operator must identify the TNT yield of each impact explosion and blast overpressure hazard radius.

(4) Fragment class data. The class name, the range of values for each parameter used to categorize fragments within a fragment class, and the number of fragments in any fragment class established in accordance with paragraph (c)(10) of this section.

(5) Ballistic coefficient. The mean ballistic coefficient (β) and plus and minus three-sigma values of the β for each fragment class. A launch operator must provide graphs of the coefficient of drag (C_d) as a function of Mach number for the nominal and three-sigma β variations for each fragment shape. The launch operator must label each graph with the shape represented by the curve and reference area used to develop the curve. A launch operator must provide a C_d vs. Mach curve for any axial, transverse, and tumble orientations for any fragment that will not stabilize during free-fall conditions. For any fragment that may stabilize during free-fall, a launch operator must provide C_d vs. Mach curves for the stability angle of attack. If the angle of attack where the fragment stabilizes is other than zero degrees, a launch operator must provide both the coefficient of lift (C_L) vs. Mach number and the C_d vs. Mach number curves. The launch operator must provide the equations for each C_d vs. Mach curve.

(6) Pre-flight propellant weight. The initial preflight weight of solid and liquid propellant for each launch vehicle component that contains solid or liquid propellant.

(7) Normal propellant consumption. The nominal and plus and minus three-sigma solid and liquid propellant consumption rate, and pre-malfunction consumption rate for each component that contains solid or liquid propellant.

(8) Fragment weight. The mean and plus and minus three-sigma weight of each fragment or fragment class.

(9) Projected area. The mean and plus and minus three-sigma axial, transverse, and tumbling areas for each fragment or fragment class. This information is not required for those fragment classes classified as burning propellant classes under (e)(17) of this section.

(10) Imparted velocities. The maximum incremental velocity imparted to each fragment class created by flight termination system activation, or explosive or overpressure loads at breakup. The launch operator must identify the velocity distribution as Maxwellian or must define the distribution, including whether or not the specified maximum value is a fixed value with no uncertainty.

(11) Fragment type. The fragment type for each fragment established in accordance with paragraphs (c)(2), (c)(3), and (c)(4) of this section.

(12) Origin. The part of the launch vehicle from which each fragment originated.

(13) Burning propellant classes. The propellant consumption rate for those fragments that burn during free-fall.

(14) Contained propellant fragments, explosive or non-explosive. For contained propellant fragments, whether explosive or non-explosive, a launch operator must provide the initial weight of contained propellant and the consumption rate during free-fall. The initial weight of the propellant in a contained propellant fragment is the weight of the propellant before any of the propellant is consumed by normal vehicle operation or failure of the launch vehicle.

(15) Solid propellant fragment snuff-out pressure. The ambient pressure and the pressure at the surface of a solid propellant fragment, in pounds per square inch, required to sustain a solid propellant fragment's combustion during free-fall.

(16) Other non-inert debris fragments. For each non-inert debris fragment identified in accordance with paragraph (c)(4) of this section, a launch operator must describe the diffusion, dispersion, deposition, radiation, or other hazard exposure characteristics used to determine the effective casualty area required by paragraph (c)(9) of this section.

(17) Residual thrust dispersion. For each thrusting or non-thrusting stage having residual thrust capability following a launch vehicle malfunction, a launch operator must provide either the total residual impulse imparted or the full-residual thrust in foot-pounds as a function of breakup time. For any stage not capable of thrust after a launch vehicle malfunction, a launch operator must provide the conditions under which the stage is no longer capable of thrust. For each stage that can be ignited as a result of a launch vehicle malfunction on a lower stage, a launch operator must identify the effects and duration of the potential thrust, and the maximum deviation of the instantaneous impact point which can be brought about by the thrust. A launch operator must provide the explosion effects of all remaining fuels, pressurized tanks, and remaining stages, particularly with respect to ignition or detonation of upper stages if the flight termination system is activated during the burning period of a lower stage.

A417.13 Flight safety limits.

(a) General. A flight safety analysis must include a flight safety limits analysis that satisfies the requirements of § 417.213. The requirements of this section apply to the computation of the flight safety limits and identifying the location of populated or other protected areas as required by § 417.213 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e).

(b) Flight safety limits constraints. The analysis must establish flight safety limits in accordance with the following:

(1) Flight safety limits must account for potential malfunction of a launch vehicle during the time from launch vehicle first motion through flight until the no longer terminate time determined as required by A417.19.

(2) For a flight termination at any time during launch vehicle flight, the flight safety limits must:

(i) Represent no less than the extent of the debris impact dispersion for all debris fragments with a ballistic coefficient greater than or equal to three; and

(ii) Ensure that the debris impact area on the Earth's surface that is bounded by the debris impact dispersion in the uprange, downrange and crossrange directions does not extend to any populated or other protected area.

(3) Each debris impact area determined by a flight safety limits analysis must be offset in a direction away from populated or other protected areas. The size of the offset must account for all parameters that may contribute to the impact dispersion. The parameters must include:

(i) Launch vehicle malfunction turn capabilities.

(ii) Effective casualty area produced in accordance with A417.25(b)(8).

(iii) All delays in the identification of a launch vehicle malfunction.

(iv) Malfunction imparted velocities, including any velocity imparted to vehicle fragments by breakup.

(v) Wind effects on the malfunctioning vehicle and falling debris.

(vi) Residual thrust remaining after flight termination.

(vii) Launch vehicle guidance and performance errors.

(viii) Lift and drag forces on the malfunctioning vehicle and falling debris including variations in drag predictions of fragments and debris.

(ix) All hardware and software delays during implementation of flight termination.

(x) All debris impact location uncertainties caused by conditions prior to, and after, activation of the flight termination system.

(xi) Any other impact dispersion parameters peculiar to the launch vehicle.

(xii) All uncertainty due to map errors and launch vehicle tracking errors.

(c) Risk management. The requirements for public risk management of § 417.205(a) apply to a flight safety limits analysis. When employing risk assessment, the analysis must establish flight safety limits that satisfy paragraph (b) of this section, account for the products of the debris risk analysis performed in accordance with A417.25, and ensure that any risk to the public satisfies the public risk criteria of § 417.107(b) of this part. When employing hazard isolation, the analysis must establish flight safety limits in accordance with the following:

(1) The flight safety limits must account for the maximum deviation impact locations for the most wind sensitive debris fragment with a minimum of 11 ft-lbs of kinetic energy at impact.

(2) The maximum deviation impact location of the debris identified in (c)(1) of this section for each trajectory time must account for the three-sigma impact location for the maximum deviation flight, and the launch day wind conditions that produce the maximum ballistic wind for that debris.

(3) The maximum deviation flight must account for the instantaneous impact point, of the debris identified in (c)(1) at breakup, that is closest to a protected area and the maximum ballistic wind directed from the breakup point toward that protected area.

(d) Flight safety limits analysis products. The products of a flight safety limits analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) A description of each method used to develop and implement the flight safety limits. The description must include equations and example computations used in the flight safety limits analysis.

(2) A description of how each analysis method meets the analysis requirements and constraints of this section, including how the method produces a worst case scenario for each impact dispersion area.

(3) A description of how the results of the analysis are used to protect populated and other protected areas.

(4) A graphic depiction or series of depictions of the flight safety limits, the launch point, all launch site boundaries, surrounding geographic area, all protected area boundaries, and the nominal and three-sigma launch vehicle instantaneous impact point ground traces from liftoff to orbital insertion or the end of flight. Each depiction must have labeled geodetic latitude and longitude lines. Each depiction must show the flight safety limits at trajectory time intervals sufficient to depict the mission success margin between the flight safety limits and the protected areas. The launch vehicle trajectory instantaneous impact points must be plotted with sufficient frequency to provide a conformal representation of the launch vehicle's instantaneous impact point ground trace curvature.

(5) A tabular description of the flight safety limits, including the geodetic latitude and longitude for any_flight safety limit. The table must contain quantitative values that define flight safety limits. The quantitative values must be rounded to the number of significant digits that can be determined from the uncertainty of the measurement device used to determine the flight safety limits and must be limited to a maximum of six decimal places.

(6) A map error table of direction and scale distortions as a function of distance from the point of tangency from a parallel of true scale and true direction or from a meridian of true scale and true direction. A launch operator must provide a table of tracking error as a function of downrange distance from the launch point for each tracking station used to make flight safety control decisions. A launch operator must submit a description of the method, showing equations and sample calculations, used to determine the tracking error. The table must contain the map and tracking error data points within 100 nautical miles of the reference point at an interval of one data point every 10 nautical miles, including the reference point. The table must contain map and tracking error data points beyond 100 nautical miles from the reference point at in interval of one data point every 100 nautical miles out to a distance that includes all populated or other areas protected by the flight safety limits.

(7) A launch operator must provide the equations used for geodetic datum conversions and one sample calculation for converting the geodetic latitude and longitude coordinates between the datum ellipsoids used. A launch operator must provide any equations used for range and bearing computations between geodetic coordinates and one sample calculation.

A417.15 Straight-up time.

(a) General. A flight safety analysis must include a straight-up time analysis that satisfies the requirements of § 417.215. The requirements of this section apply to the computation of straight-up time as required by § 417.215 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e). The analysis must establish a straight-up time as the latest time-after-liftoff, assuming a launch vehicle malfunctioned and flew in a vertical or near vertical direction above the launch point, at which activation of the launch vehicle's flight termination system or breakup of the launch vehicle would not cause hazardous debris or critical overpressure to affect any populated or other protected area.

(b) Straight-up time constraints. A straight-up-time analysis must account for the following:

(1) Launch vehicle trajectory. The analysis must use the straight-up trajectory determined in accordance with A417.7(e).

(2) Sources of debris impact dispersion of A417.13(b)(3)(iii) through (xii)

(b) Straight-up time analysis products. The products of a straight-up-time analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) The straight-up-time.

(2) A description of the methodology used to determine straight-up time.

A417.17 No-longer terminate gate.

(a) General. The flight safety analysis for a launch that involves flight over a populated or other protected area must include a no-longer terminate gate analysis that satisfies the requirements of § 417.217. Th e requirements of this section apply to determining a gate as required by § 417.217 and the analysis products that the launch operator must submit to the FAA as required by § 417.203(e). The analysis must determine the portion, referred to as a gate, of a flight safety limit, through which a launch vehicle's tracking representation will be allowed to proceed without flight termination.

(b) No-longer-terminate gate analysis constraints. The following analysis constraints apply to a gate analysis.

(1) For each gate in a flight safety limit, the criteria used for determining whether to allow passage through the gate or to terminate flight at the gate must use all the same launch vehicle flight status parameters as the criteria used for determining whether to terminate flight at a flight safety limit. For example, if the flight safety limits are a function of instantaneous impact point location, the criteria for determining whether to allow passage through a gate in the flight safety limit must also be a function of instantaneous impact point location. Likewise, if the flight safety limits are a function of drag impact point, the gate criteria must also be a function of drag impact point.

(2) When establishing a gate in a flight safety limit, the analysis must ensure that the launch vehicle flight satisfies the public risk criteria of § 417.107(b).

(3) For each established gate, the analysis must account for:

(i) All launch vehicle tracking and map errors.

(ii) All launch vehicle plus and minus three-sigma trajectory limits.

(iii) All debris impact dispersions.

(4) The width of a gate must restrict a launch vehicle's normal trajectory ground trace.

(c) No-longer-terminate gate analysis products. The products of a gate analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) A description of the methodology used to establish each gate.

(2) A description of the tracking representation.

(3) A tabular description of the input data.

(4) Example analysis computations performed to determine a gate. If a launch involves more than one gate and the same methodology is used to determine each gate, the launch operator need only submit the computations for one of the gates.

(5) A graphic depiction of each gate. A launch operator must provide a depiction or depictions showing flight safety limits, protected area outlines, nominal and 3-sigma left and right trajectory ground traces, protected area overflight regions, and predicted impact dispersion about the three-sigma trajectories within the gate. Each depiction must show latitude and longitude grid lines, gate latitude and longitude labels, and the map scale.

A417.19 Data loss flight time and no longer terminate time.

(a) General. A flight safety analysis must include a data loss flight time analysis that satisfies the requirements of § 417.219. The requirements of this section apply to the computation of data loss flight times and the no longer terminate time required by § 417.219, and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e).

(b) No longer terminate time. The analysis must establish a no longer terminate time for a launch in accordance with the following:

(1) For a suborbital launch, the analysis must determine a no longer terminate time as the time after liftoff that a launch vehicle's hazardous debris impact dispersion can no longer reach any protected area.

(2) For an orbital launch where the launch vehicle's instantaneous impact point does not overfly a protected area prior to reaching orbit, the analysis must establish the no-longer terminate time as the time after liftoff that the launch vehicle's hazardous debris impact dispersion can no longer reach any protected area or orbital insertion, whichever occurs first.

(3) For an orbital launch where a gate permits overflight of a protected area and where orbital insertion occurs after reaching the gate, the analysis must determine the no longer terminate time as the time after liftoff when the time for the launch vehicle's instantaneous impact point to reach the gate is less than the time for the instantaneous impact point to reach any flight safety limit.

(4) The analysis must account for a malfunction that causes the launch vehicle to proceed from its position at the trajectory time being evaluated toward the closest flight safety limit and protected area.

(5) The analysis must account for the launch vehicle thrust vector that produces the highest instantaneous impact point range-rate that the vehicle is capable of producing at the trajectory time being evaluated.

(c) Data loss flight times. For each launch vehicle trajectory time, from the predicted earliest launch vehicle tracking acquisition time until the no longer terminate time, the analysis must determine the data loss flight time in accordance with the following:

(1) The analysis must determine each data loss flight time as the minimum thrusting time for a launch vehicle to move from a normal trajectory position to a position where a flight termination would cause the malfunction debris impact dispersion to reach any protected area.

(2) A data loss flight time analysis must account for a malfunction that causes the launch vehicle to proceed from its position at the trajectory time being evaluated toward the closest flight safety limit and protected area.

(3) The analysis must account for the launch vehicle thrust vector that produces the highest instantaneous impact point range-rate that the vehicle is capable of producing at the trajectory time being evaluated.

(4) Each data loss flight time must account for the system delays at the time of flight.

(5) The analysis must determine a data loss flight time for time increments that do not exceed one second along the launch vehicle nominal trajectory.

(d) Products. The products of a data loss flight time and no longer terminate time analysis that a launch operator must submit as required by § 417.203(e) must include:

(1) A launch operator must describe the methodology used in its analysis, and identify all assumptions, techniques, input data, and equations used. A launch operator must submit calculations performed for one data loss flight time in the launch area and one data loss flight time that is no less than 50 seconds later in the downrange area.

(2) A launch operator must submit a graphical description or depictions of the flight safety limits, the launch point, the launch site boundaries, the surrounding geographic area, any protected areas, the no longer terminate time within any applicable scale requirements, latitude and longitude grid lines, and launch vehicle nominal and three-sigma instantaneous impact point ground traces from liftoff through orbital insertion for an orbital launch, and through final impact

for a suborbital launch. Each graph must show any launch vehicle trajectory instantaneous impact points plotted with sufficient frequency to provide a conformal estimate of the launch vehicle's instantaneous impact point ground trace curvature. A launch operator must provide labeled latitude and longitude lines and the map scale on the depiction.

(3) A launch operator must provide a tabular description of each data loss flight time. The tabular description must include the malfunction start time and the geodetic latitude (positive north of the equator) and longitude (positive east of the Greenwich Meridian) coordinates of the intersection of the launch vehicle instantaneous impact point trajectory with the flight safety limit. The table must identify the first data lost flight time and no longer terminate time. The tabular description must include data loss flight times for trajectory time increments not to exceed one second.

A417.21 Time delay.

(a) General. A flight safety analysis must include a time delay analysis that satisfies the requirements of § 417.221. The requirements of this section apply to the computation of time delays associated with a flight safety system and other launch vehicle systems and operations as required by § 417.221 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e).

(b) Time delay analysis constraints. The analysis must account for all significant causes of time delay between the violation of a flight termination rule and the time when a flight safety system is capable of terminating flight in accordance with the following:

(1) The analysis must account for decision and reaction times, including variation in human response time, for flight safety official and other personnel that are part of a launch operator's flight safety system as defined by subpart D of this part.

(2) The analyses must determine the time delay inherent in any data, from any source, used by a flight safety official for making flight termination decisions.

(3) A time delay analysis must account for all significant causes of time delay, including data flow rates and reaction times, for hardware and software, including, but not limited to the following:

(i) Tracking system. A time delay analysis must account for time delays between the launch vehicle's current location and last known location and that are associated with the hardware and software that make up the launch vehicle tracking system, whether or not it is located on the launch vehicle, such as transmitters, receivers, decoders, encoders, modulators, circuitry and any encryption and decryption of data.

(ii) Display systems. A time delay analysis must account for delays associated with hardware and software that make up any display system used by a flight safety official to aid in making flight control decisions. A time delay analysis must also account for any manual operations requirements, tracking source selection, tracking data processing, flight safety limit computations, inherent display delays, meteorological data processing, automated or manual system configuration control, automated or manual process control, automated or manual mission discrete control, and automated or manual failover decision control.

(iii) Flight termination system and command control system. A time delay analysis must account for delays and response times associated with flight termination system and command control system hardware and software, such as transmitters, decoders, encoders, modulators, relays and shutdown, arming and destruct devices, circuitry and any encryption and decryption of data.

(iv) Software specific time delays. A delay analysis must account for delays associated with any correlation of data performed by software, such as timing and sequencing; data filtering delays such as error correction, smoothing, editing, or tracking source selection; data transformation delays; and computation cycle time.

(4) A time delay analysis must determine the time delay plus and minus three-sigma values relative to the mean time delay.

(5) For use in any risk analysis, a time delay analysis must determine time delay distributions that account for the variance of time delays for potential launch vehicle failures, including but not limited to, the range of malfunction turn characteristics and the time of flight when the malfunction occurs.

(c) Time delay analysis products. The products of a time delay analysis that a launch operator must submit as required by § 417.203(e) must include:

(1) A description of the methodology used to produce the time delay analysis.

(2) A schematic drawing that maps the flight safety official's data flow time delays from the start of a launch vehicle malfunction through the final commanded flight termination on the launch vehicle, including the flight safety official's decision and reaction time. The drawings must indicate major systems, subsystems, major software functions, and data routing.

(3) A tabular listing of each time delay source and its individual mean and plus and minus three-sigma contribution to the overall time delay. The table must provide all time delay values in milliseconds.

(4) The mean delay time and the plus and minus three-sigma values of the delay time relative to the mean value.

A417.23 Flight hazard areas.

(a) General. A flight safety analysis must include a flight hazard area analysis that satisfies the requirements of § 417.223. The requirements of this section apply to the determination of flight hazard areas for orbital and ballistic launch vehicles that use a flight termination system to protect the public as required by § 417.223 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e). Requirements that apply to determining flight hazard areas for unguided suborbital rockets that use a wind weighting safety system are contained in appendix C of this part.

(b) Launch site flight hazard area. A flight hazard area analysis must establish a launch site flight hazard area that encompasses the launch point and:

(i) If the flight safety analysis employs hazard isolation to establish flight safety limits in accordance with A417.13(c), the launch site flight hazard area must encompass the flight safety limits.

(ii) If the flight safety analysis does not employ hazard isolation to establish the flight safety limits, the launch site flight hazard area must encompass all hazard areas established in accordance with paragraphs (d) through (j) of this section. Figure A417.23-1 illustrates a launch site flight hazard area for a coastal launch site. Figure A417.23-2 illustrates a launch site flight hazard area for an inland launch site.

(c) Flight corridor. For regions outside the flight hazard area, the analysis must define a flight corridor that extends downrange from a flight hazard area as illustrated by figure

A417.23-3. The flight safety limits established in accordance with A417.13 must bound the flight corridor. The flight corridor must include any land overflight permitted by a gate established in accordance with A417.17. A five-sigma cross range trajectory dispersion about the nominal launch vehicle trajectory must bound any land overflight area. A flight corridor must extend for all downrange positions from the flight hazard area to the no longer terminate time determined in accordance with A417.19.

(d) Debris impact hazard area. The analysis must establish a debris impact hazard area that accounts for the effects of impacting debris resulting from normal and malfunctioning launch vehicle flight, except for toxic effects, and accounts for potential impact locations of all debris fragments. The analysis must establish a debris hazard area in accordance with the following:

(1) An individual casualty contour that defines where the risk to an individual would exceed an expected casualty (E_C) criteria of 1×10^{-6} if one person were assumed to be in the open and inside the contour during launch vehicle flight must bound a debris hazard area. The analysis must produce an individual casualty contour in accordance with the following:

(i) The analysis must account for the location of a hypothetical person, and must vary the location of the person to determine when the risk would exceed the E_c criteria of 1×10^{-6}. The analysis must count a person as a casualty when the person's location is subjected to any inert debris impact with a mean expected kinetic energy greater than or equal to 11 ft-lbs or a peak incident overpressure equal to or greater than one psi due to explosive debris impact. The analysis must determine the peak incident overpressure using the Kingery-Bulmash relationship, without regard to sheltering, reflections, or atmospheric effects.

(ii) The analysis must account for person locations that are no more than 1000 feet apart in the downrange direction and no more than 1000 feet apart in the crossrange direction to produce an individual casualty contour. For each person location, the analysis must sum the probabilities of casualty over all flight times for all debris groups.

(iii) An individual casualty contour must consist of curves that are smooth and continuous. To accomplish this, the analysis must vary the time interval between the trajectory times assessed so that each location of a debris impact point is less than one-half sigma of the downrange dispersion distance.

(2) The input for determining a debris impact hazard area must account for the results of the trajectory analysis required by A417.7, the malfunction turn analysis required by A417.9, and the debris analysis required by A417.11 to define the impact locations of each class of debris established by the debris analysis, and the time delay analysis required by A417.21.

(3) The analysis must account for the extent of the impact debris dispersions for each debris class produced by normal and malfunctioning launch vehicle flight at each trajectory time. The analysis must also account for how the vehicle breaks up, either by the flight termination system or by aerodynamic forces, if the different breakup may result in a different probability of existence for each debris class. A debris impact hazard area must account for each impacting debris fragment classified in accordance with A417.11(c).

(4) The analysis must account for launch vehicle flight that exceeds a flight safety limit. The analysis must also account for trajectory conditions that maximize the mean debris impact distance during the flight safety system delay time determined in accordance with A417.21 and account for a debris model that is representative of a flight termination or aerodynamic breakup. For each launch vehicle breakup event, the analysis must account for

trajectory and breakup dispersions, variations in debris class characteristics, and debris dispersion due to any wind condition under which a launch would be attempted.

(5) The analysis must account for the probability of failure of each launch vehicle stage and the probability of existence of each debris class. The analysis must account for the probability of occurrence of each type of launch vehicle failure. The analysis must account for vehicle failure probabilities that vary depending on the time of flight.

(6) In addition to failure debris, the analysis must account for nominal jettisoned body debris impacts and the corresponding debris impact dispersions. The analysis must use a probability of occurrence of 1.0 for the planned debris fragments produced by normal separation events during flight.

(e) Near-launch-point blast hazard area. A flight hazard area analysis must define a blast overpressure hazard area as a circle extending from the launch point with a radius equal to the 1.0-psi overpressure distance produced by the equivalent TNT weight of the explosive capability of the vehicle. In addition, the analysis must establish a minimum near-pad blast hazard area to provide protection from hazardous fragments potentially propelled by an explosion. The analysis must account for the maximum possible total solid and liquid propellant explosive potential of the launch vehicle and any payload. The analysis must define a blast overpressure hazard area using the following equations:

$$R_{op} = 45 \cdot (NEW)^{1/3}$$

Where:

R_{op} is the over pressure distance in feet.

$NEW = W_E \cdot C$ (pounds).

W_E is the weight of the explosive in pounds.

C is the TNT equivalency coefficient of the propellant being evaluated. A launch operator must identify the TNT equivalency of each propellant on its launch vehicle including any payload. TNT equivalency data for common liquid propellants is provided in tables A417-1. Table A417-2 provides factors for converting gallons of specified liquid propellants to pounds.

(f) Other hazards. A flight hazard area analysis must identify any additional hazards, such as radioactive material, that may exist on the launch vehicle or payload. For each such hazard, the analysis must determine a hazard area that encompasses any debris impact point and its dispersion and includes an additional hazard radius that accounts for potential casualty due to the additional hazard. Analysis requirements for toxic release and far field blast overpressure are provided in § 417.27 and A417.29, respectively.

(g) Ship-hit contours. A flight hazard area analysis must establish ship hazard areas, referred to as ship-hit contours, to ensure that the probability of hitting a ship satisfies the collective probability threshold of 1×10^{-5} required by § 417.107(b) and to determine the area that may need to be surveyed on the day of launch. The analysis must determine the need to survey the ship hazard areas in accordance with paragraph (h) of this section. When paragraph (h) requires surveillance, a launch operator must not initiate flight while the number of ships within any ship-hit contour is greater than or equal to the number of ships for which the contour was established. The flight hazard area must encompass all ship-hit contours. The analysis must establish the ship-hit contours in accordance with the following:

(1) A ship-hit contour must account for the size of the largest ship that could be located in the flight hazard area. The analysis must demonstrate that the ship size used

represents the largest ship that could be present in the flight hazard area or, if the ship size is unknown, the analysis must use a ship size of 120,000 square feet. Additional contours may be established for smaller vessels if necessary to facilitate surveillance of the flight hazard area while ensuring that the 1×10^{-5} hit criteria is satisfied.

(2) The analysis must determine ship-hit contours for one to 10 ships in increments of one ship. For each given number of ships, the associated ship-hit contour must bound an area around the nominal instantaneous impact point trace where, if the given number of ships were located on the contour, the collective probability of impacting any ship would be less than or equal to the 1×10^{-5} ship-hit criteria.

(3) Each ship-hit contour must account for all debris as determined in accordance with A417.11. Each contour must account for each mean debris impact point and the extent of the impact dispersion for each simulated launch vehicle failure for increasing trajectory times, starting at liftoff. Each debris impact dispersion must account for the variance in winds, the aerodynamic properties of the debris and the variance in velocity of the debris resulting from vehicle breakup, the malfunction turn capabilities of the launch vehicle, and guidance and performance errors. The analysis must also account for the type of vehicle breakup, either by the flight termination system or by aerodynamic forces that may result in different debris characteristics.

(4) Each ship-hit contour must account for any inert debris impact with mean expected kinetic energy at impact greater than or equal to 11 ft-lbs and peak incident overpressure of greater than or equal to 1.0 psi due to any explosive debris impact. A ship-hit contour must consists of curves that are smooth and continuous. To accomplish this, the analysis must vary the time interval, between the trajectory times assessed such that the distance between

each debris impact point location for each time assessed is less than one-half sigma of the downrange dispersion distance.

(5) Each ship-hit contour must account for each nominal staging event and potential launch vehicle failure that may result in vehicle breakup in the flight hazard area. Each contour must account for the probability of failure of each launch vehicle stage and the probability of existence of each debris class. The analysis must account for each launch vehicle failure as a function of probability of occurrence. The analysis must account for each launch vehicle failure probability as a function of flight time. The analysis must account for all potential debris created by flight termination and aerodynamic breakup and the probability of occurrence of each. Each contour must account for breakup through aerodynamic breakup or a flight termination action and the different debris that would result from each type of breakup. The analysis must account for any planned debris impact, such as a stage or payload fairing impact and a probability of existence equal to the probability of success for the planned debris impact.

(h) Ship surveillance in the launch site flight hazard area. The launch site flight hazard area need not be surveyed for ships during the launch countdown if the analysis demonstrates, using statistical ship density data, that the total probability of a ship impact occurring is less than or equal to 1×10^{-5}. The analysis must establish whether a launch operator must conduct ship surveillance in the launch site flight hazard area for a launch in accordance with the following:

(1) The analysis must determine ship density for the launch site flight hazard area based on accurate statistical data. The ship density for the launch site flight hazard area must account for factors that affect the ship density, such as time of day. The analysis must use statistical ship density for the launch site flight hazard area multiplied by a safety factor of 10

unless the analysis includes a clear and convincing demonstration of the accuracy of the ship density data, and accounts for the associated ship density error in the collective ship-hit probability analysis.

(2) The analysis must establish the expected number of ships inside the 10-ship contour determined in accordance with paragraph (g) of this section, by determining the total water surface area within the 10-ship contour and multiplying this area by the ship density determined in accordance with paragraph (h)(1) of this section. If the resulting number of ships is less than 10, the launch operator need not perform ship surveillance in the flight hazard area. If the resulting number of ships is equal to or greater than 10, the launch operator must perform ship surveillance in the flight hazard area as required by § 417.121(f).

(i) Ship hazard area for notice to mariners. Regardless of whether ship surveillance is required in accordance with paragraph (h) of this section, the launch operator must provide the ship-hit contour for 10 ships determined in accordance with paragraph (e) of this section as a notice to mariners as required by § 417.121(e).

(j) Launch site flight hazard area aircraft-hit contour. A flight hazards area analysis must determine an aircraft-hit contour to be surveyed on the day of launch to ensure that the probability of hitting an aircraft satisfies the individual probability threshold of 1×10^{-8} as required by § 417.107(b) for the flight hazard area around the launch point. The launch site flight hazard area must contain an aircraft-hit contour that extends for altitudes from zero to 60,000 feet. The analysis must determine an aircraft-hit contour in accordance with the following:

(1) An aircraft-hit contour must bound an area around the nominal instantaneous impact point trace where, if an aircraft were located on the contour, the individual probability of impacting the aircraft would be less than or equal to 1×10^{-8}.

(2) The analysis must account for the dimension of the largest aircraft operated in the vicinity of the launch or, if unknown, the dimensions of a Boeing 747 aircraft.

(3) The analysis must account for all debris as determined under A417.11. An aircraft-hit contour must account for aircraft velocity and debris with kinetic energy relative to the aircraft greater than or equal to 11 ft-lbs.

(4) The analysis must account for each nominal staging event and potential vehicle failure that may result in vehicle breakup. The analysis must account for each vehicle failure as a function of probability of occurrence and as a function of time.

(5) The analysis must account for all debris for both flight termination and for aerodynamic breakup and the probability of occurrence of the debris. The analysis must account for each mean debris impact point and the extent of the debris impact dispersion.

(k) Flight corridor ship hazard areas. Within a flight corridor but outside of a launch site flight hazard area, the analysis must determine a ship hazard area for each planned debris impact for the issuance of notices to mariners. Each ship hazard area must consist of an area centered on a planned impact point and must be defined by the larger of the three-sigma impact dispersion ellipse or an ellipse with the same semi-major and semi-minor axis ratio as the impact dispersion, where, if a ship were located on the boundary of the ellipse, the probability of hitting the ship would be less than or equal to 1×10^{-5}. The analysis must establish each flight corridor ship hazard area in accordance with C417.5(h) and C417.5(i) of appendix C, which apply to both orbital and suborbital launch. The analysis must demonstrate whether surveillance of a ship hazard area must take place as required by C417.5(g) of appendix C of this part.

(l) Flight corridor aircraft hazard areas. Within a flight corridor but outside of a launch site flight hazard area, the analysis must establish an aircraft hazard area for each planned debris impact for the issuance of notices to airmen in accordance with § 417.121(e). Each aircraft hazard area must encompass an air space region, from an altitude of 60,000 feet to impact on the Earth's surface, that contains the larger of the three-sigma drag impact dispersion or an ellipse with the same semi-major and semi-minor axis ratio as the impact dispersion, where, if an aircraft were located on the boundary of the ellipse, the probability of hitting the aircraft would be less than or equal to 1×10^{-8}. The flight safety analysis must determine flight corridor aircraft hazard areas for both orbital and suborbital launch using the methodology contained in paragraph C417.5(f) of appendix C of this part.

(m) Flight hazard area analysis products. The products of a flight hazard area analysis that a launch operator must submit to the FAA in accordance with § 417.203(e) must include, but need not be limited to:

(1) A chart that depicts the launch site flight hazard area, including its size and location.

(2) A chart that depicts each hazard area required by this section.

(3) A description of each hazard for which analysis was performed; the methodology used to compute each hazard area; and the debris classes for aerodynamic breakup of the launch vehicle and for flight termination. For each debris class, the launch operator must identify the number of debris fragments, the variation in ballistic coefficient, and the standard deviation of the debris dispersion.

(4) A chart that depicts each of the ship-hit contours, the individual casualty contour, and the aircraft-hit contour.

(5) A chart that depicts the flight corridor, including any regions of land overflight.

(6) A description of the aircraft hazard area for each planned debris impact inside the flight corridor, the information to be published in a Notice to Airmen, and all information required as part of any agreement with the FAA ATC office having jurisdiction over the airspace through which flight will take place.

(7) A description of any ship hazard area for each planned debris impact inside the flight corridor and all information required in a Notice to Mariners.

(8) A description of the methodology used for determining each hazard area.

(9) A description of the hazard area operational controls and procedures to be implemented for flight.

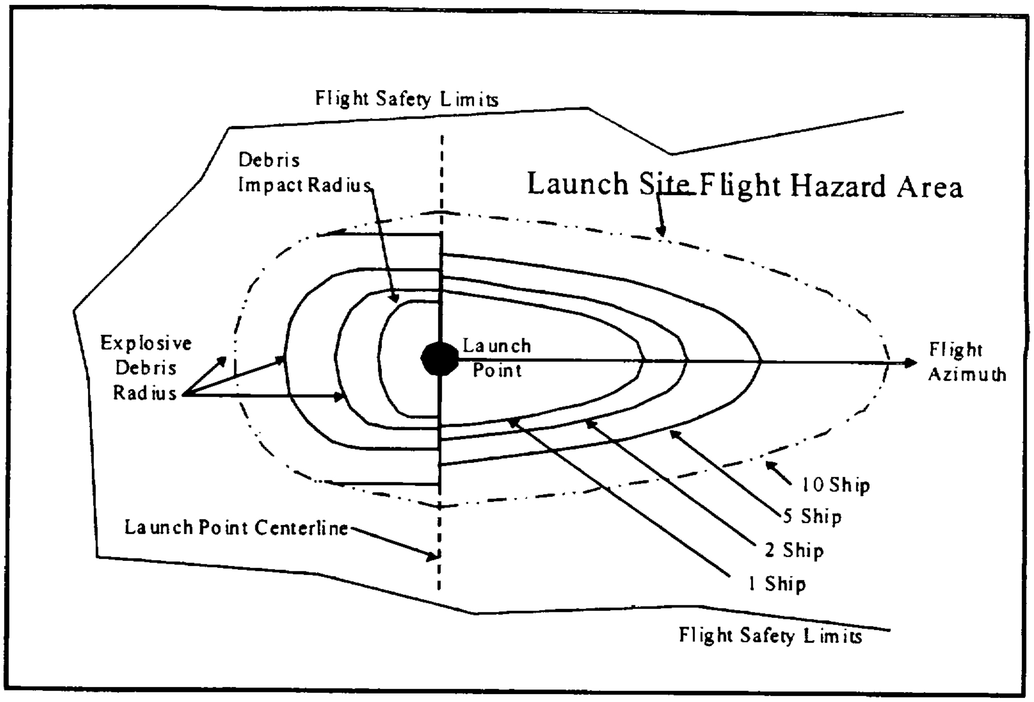

Figure A417.23- 1, Illustration of a Flight Hazard Area for a Coastal Launch Site

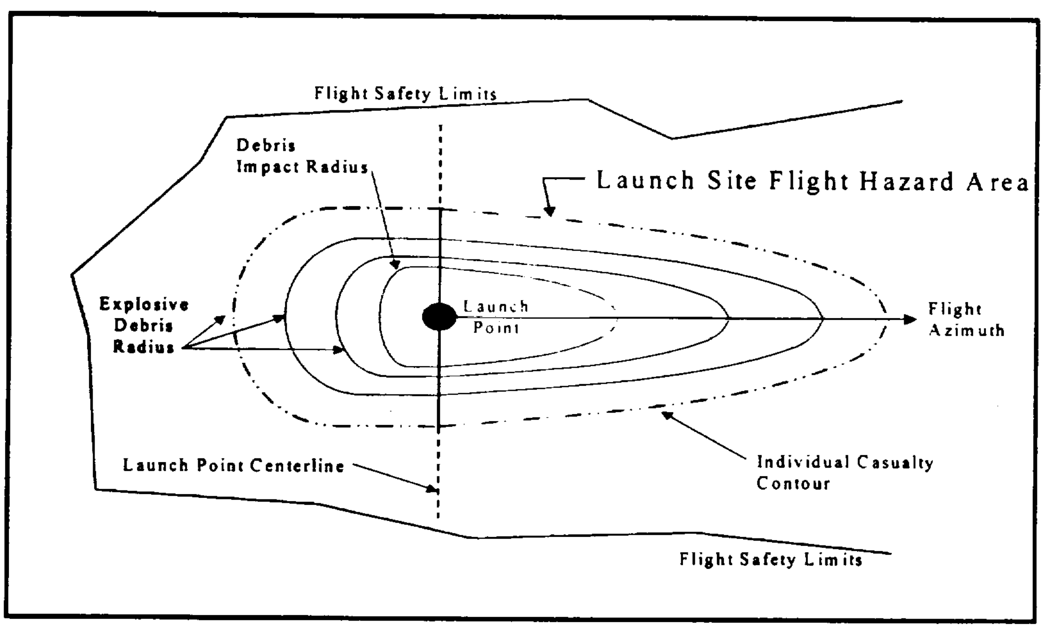

Figure A417.23- 2, Illustration of a Flight Hazard Area for an Inland Launch Site

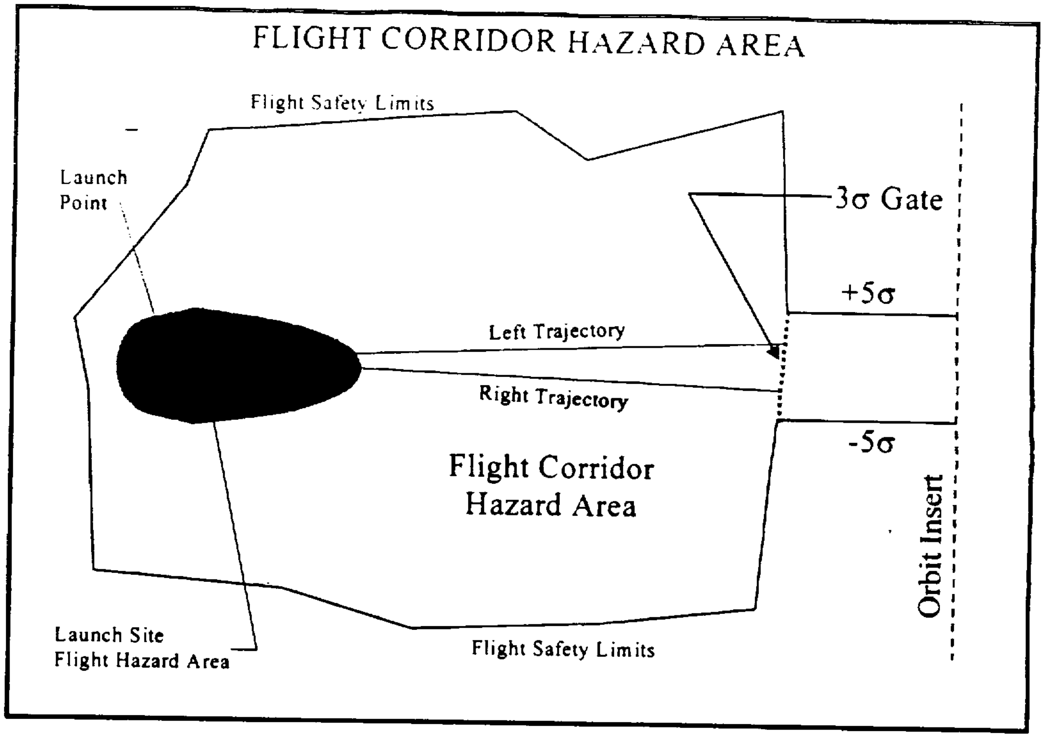

Figure A417.23- 3, Illustration of a Flight Corridor Hazard Area

Table A417-1, Liquid Propellant Explosive Equivalents

Propellant Combinations	**TNT Equivalents**
LO_2/LH_2	The larger of $8W^{2/3}$ or 14% of W. Where W is the weight of LO2/LH2.
$LO_2/LH_2 + LO_2/RP\text{-}1$	Sum of (20% for $LO_2/RP\text{-}1$) the larger of $8W^{2/3}$ or 14% of W. Where W is the weight of LO2/LH2.
$LO_2/RP\text{-}1$	20% of W up to 500,000 pounds + 10% of W over 500,000 pounds. Where W is the weight of LO2/RP-1.
N_2O_4/N_2H_4 (or UDMH or UDMH/N_2H_4 Mixture)	10% of W Where W is the weight of the propellant.

Table A417-2, Propellant Hazard and Compatibility Groupings and Factors to be Used When Converting Gallons of Propellant into Pounds

Propellant	Hazard Group	Compatibility Group	Pounds/gallon	°F
Hydrogen Peroxide	II	A	11.6	68
Hydrazine	III	C	8.4	68
Liquid Hydrogen	III	C	0.59	-423
Liquid Oxygen	II	A	9.5	-297
Nitrogen Tetroxide	I	A	12.1	68
RP-1	I	C	6.8	68
UDMH	III	C	6.6	68
UDHM/Hydrazine	III	C	7.5	68

A417.25 Debris risk.

(a) General. A flight safety analysis must include a debris risk analysis that satisfies the requirements of § 417.225. The requirements of this section apply to the computation of the average number of casualties (E_C) to the collective members of the public exposed to inert and explosive debris hazards from the proposed flight of a launch vehicle as required by § 417.225 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e).

(b) Debris risk analysis constraints. The following constraints apply to a debris risk analysis:

(1) A debris risk analysis must use the methodologies and equations of appendix B of this part.

(2) A debris risk analysis must account for the following populations:

(i) The overflight of populations located inside any flight safety limits.

(ii) All populations located within five-sigma left and right crossrange of a nominal trajectory instantaneous impact point ground trace and within five-sigma of each planned nominal debris impact.

(iii) Any planned overflight of the public within any gate overflight areas.

(iv) Any populations outside the flight safety limits identified in accordance with paragraph (b)(10) of this section.

(3) A debris risk analysis must account for both inert and explosive debris hazards produced from any impacting debris caused by normal and malfunctioning launch vehicle flight. The analysis must account for the debris classes determined by the debris analysis required by A417.11. A debris risk analysis must account for any inert debris impact with mean expected

kinetic energy at impact greater than or equal to 11 ft-lb and peak incident overpressure of greater than or equal to 1.0 psi due to any explosive debris impact. The analysis must account for all debris hazards as a function of flight time.

(4) A debris risk analysis must account for debris impact points and dispersion for each class of debris in accordance with the following:

(i) A debris risk analysis must account for drag corrected impact points and dispersions for each class of impacting debris resulting from normal and malfunctioning launch vehicle flight as a function of trajectory time from lift-off through orbital insertion, including each planned impact, for an orbital launch, and through final impact for a suborbital launch.

(ii) The dispersion for each debris class must account for the position and velocity state vector dispersions at breakup, the variance produced by breakup imparted velocities, the variance produced by winds, the variance produced by aerodynamic properties for each debris class, and any other dispersion variances.

(iii) A debris risk analysis must account for the survivability of debris fragments that are subject to reentry aerodynamic forces or heating. A debris class may be eliminated from the debris risk analysis if the launch operator demonstrates that the debris will not survive to impact.

(5) A debris risk analysis must account for launch vehicle failure probability. The following constraints apply:

(i) For a launch vehicle with fewer that 15 flights, a launch operator must use a launch vehicle failure probability of 0.31.

(ii) For a launch vehicle with at least 15 flights, but fewer than 30 flights, a launch operator must use a launch vehicle failure probability of 0.10 or the empirical failure probability, whichever is greater.

(iii) For a launch vehicle with 30 or more flights, a launch operator must use the empirical failure probability determined from the actual flight history.

(iv) For a launch vehicle with a previously established failure probability that undergoes a modification to a stage, and the modification could affect the reliability of that stage, the launch operator must apply the previously established failure probability to all unmodified stages and the failure probability requirements of paragraphs (b)(5)(i) through (b)(5)(iii) of this section to the modified stage.

(6) A debris risk analysis must account for the dwell time of the instantaneous impact point ground trace over each populated or protected area being evaluated.

(7) A debris risk analysis must account for the three-sigma instantaneous impact point trajectory variations in left-crossrange, right-crossrange, uprange, and downrange as a function of trajectory time, due to launch vehicle performance variations as determined by the trajectory analysis performed in accordance with A417.7.

(8) A debris risk analysis must account for the effective casualty area as a function of launch vehicle flight time for all impacting debris generated from a catastrophic launch vehicle malfunction event or a planned impact event. The effective casualty area must account for both payload and vehicle systems and subsystems debris. The effective casualty area must account for all debris fragments determined as part of a launch operator's debris analysis in accordance with A417.11. The effective casualty area for each explosive debris fragment must account for a 1.0-psi blast overpressure radius and the projected debris effects for all potentially explosive debris. The effective casualty area for each inert debris fragment must:

(i) Account for bounce, skip, slide, and splatter effects; or

(ii) Equal seven times the maximum projected area of the fragment.

(9) A debris risk analysis must account for current population density data obtained from a current population database for the region being evaluated or by estimating the current population using exponential population growth rate equations applied to the most current historical data available. The population model must define population centers that are similar enough to be described and treated as a single average set of characteristics without degrading the accuracy of the debris risk estimate.

(10) For a launch vehicle that uses a flight safety system, a debris risk analysis must account for the collective risk to any populations outside the flight safety limits in the area surrounding the launch site during flight, including people who will be at any public launch viewing area during flight. For such populations, in addition to the constraints listed in paragraphs (b)(1) through (b)(9) of this section, a launch operator's debris risk analysis must account for the following:

(i) The probability of a launch vehicle failure that would result in debris impact in protected areas outside the flight safety limits.

(ii) The failure rate of the launch operator's flight safety system. A flight safety system failure rate of 0.002 may be used if the flight safety system complies with the flight safety system requirements of subpart D of this part. For an alternate flight safety system approved in accordance with § 417.107(a)(3), the launch operator must demonstrate the validity of the probability of failure through the licensing process.

(iii) Current population density data and population projections for the day and time of flight for the areas outside the flight safety limits.

(c) Debris risk analysis products. The products of a debris risk analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) A debris risk analysis report that provides the analysis input data, probabilistic risk determination methods, sample computations, and text or graphical charts that characterize the public risk to geographical areas for each launch.

(2) Geographic data showing:

(i) The launch vehicle nominal, five-sigma left-crossrange and five-sigma right-crossrange instantaneous impact point ground traces;

(ii) All exclusion zones relative to the instantaneous impact point ground traces; and

(iii) All populated areas included in the debris risk analysis.

(3) A discussion of each launch vehicle failure scenario accounted for in the analysis and the probability of occurrence, which may vary with flight time, for each failure scenario. This information must include failure scenarios where a launch vehicle:

(i) Flies within normal limits until some malfunction causes spontaneous breakup or results in a commanded flight termination;

(ii) Experiences malfunction turns; and

(iii) Flight safety system fails to function.

(4) A population model applicable to the launch overflight regions that contains the following: region identification, location of the center of each population center by geodetic latitude and longitude, total area, number of persons in each population center, and a description of the shelter characteristics within the population center.

(5) A description of the launch vehicle, including general information concerning the nature and purpose of the launch and an overview of the launch vehicle, including a scaled diagram of the general arrangement and dimensions of the vehicle. A launch operator's debris risk analysis products may reference other documentation submitted to the FAA containing this

information. The launch operator must identify any changes in the launch vehicle description from that submitted during the licensing process in accordance with § 415.109(e). The description must include:

(i) Weights and dimensions of each stage.

(ii) Weights and dimensions of any booster motors attached.

(iii) The types of fuel used in each stage and booster.

(iv) Weights and dimensions of all interstage adapters and skirts.

(v) Payload dimensions, materials, construction, any payload fuel; payload fairing construction, materials, and dimensions; and any non-inert components or materials that add to the effective casualty area of the debris, such as radioactive or toxic materials or high-pressure vessels.

(6) A typical sequence of events showing times of ignition, cutoff, burnout, and jettison of each stage, firing of any ullage rockets, and starting and ending times of coast periods and control modes.

(7) The following information for each launch vehicle motor:

(i) Propellant type and composition;

(ii) Vacuum thrust profile;

(iii) Propellant weight and total motor weight as a function of time;

(iv) A description of each nozzle and steering mechanism;

(v) For solid rocket motors, internal pressure and average propellant thickness, or borehole radius, as a function of time;

(vi) Maximum impact point deviations as a function of failure time during destruct system delays. Burn rate as a function of ambient pressure;

(vii) A discussion of whether a commanded destruct could ignite a non-thrusting motor, and if so, under what conditions; and

(viii) Nozzle exit and entrance areas.

(8) The launch vehicle's launch and failure history, including a summary of past vehicle performance. For a new vehicle with little or no flight history, a launch operator must provide data on similar vehicles that include:

(i) Identification of the launches that have occurred;

(ii) Launch date, location, and direction of each launch;

(iii) The number of launches that performed normally;

(iv) Behavior and impact location of each abnormal experience;

(v) The time, altitude, and nature of each malfunction; and

(vi) Descriptions of corrective actions taken, including changes in vehicle design, flight termination, and guidance and control hardware and software.

(9) The values of probability of impact (P_I) and expected casualty (E_C) for each populated area.

A417.27 Toxic release hazard analysis.

A flight safety analysis must include a toxic release hazard analysis that satisfies the requirements of § 417.227. A launch operator's toxic release hazard analysis must satisfy the methodology requirements contained in appendix I of part 417. A launch operator must submit the analysis products identified in appendix I as required by § 417.203(e).

A417.29 Far field blast overpressure effects.

(a) General. A flight safety analysis must include a far field blast overpressure effects hazard analysis that satisfies the requirements of § 417.229. The requirements of this section apply to the computation of far field blast overpressure effects from the proposed flight of a launch vehicle as required by § 417.229 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e). The analysis must account for distant focus overpressure and any overpressure enhancement to establish the potential for broken windows due to peak incident overpressures below 1.0 psi and related casualties due to falling or projected glass shards. The analysis must employ either paragraph (b) of this section or the risk analysis of paragraph (c) of this section.

(b) Far field blast overpressure hazard analysis. Unless an analysis satisfies the requirements of paragraph (c) of this section a far field blast overpressure hazard analysis must satisfy the following:

(1) Explosive yield factors. The analysis must use explosive yield factor curves for each type or class of solid or liquid propellant used by the launch vehicle. Each explosive yield

factor curve must be based on the most accurate explosive yield data for the corresponding type or class of solid or liquid propellant based on empirical data or computational modeling.

(2) Establish the maximum credible explosive yield. The analysis must establish the maximum credible explosive yield resulting from normal and malfunctioning launch vehicle flight. The explosive yield must account for impact mass and velocity of impact on the Earth's surface. The analysis must account for explosive yield expressed as a TNT equivalent for peak overpressure.

(3) Characterize the population exposed to the hazard. The analysis must demonstrate whether any population centers are vulnerable to a distant focus overpressure hazard using the methodology provided by section 6.3.2.4 of the American National Standard Institute's ANSI S2.20-1983, "Estimating Air Blast Characteristics for Single Point Explosions in Air with a Guide to Evaluation of Atmospheric Propagation and Effects" and in accordance with the following:

(i) For the purposes of this analysis, a population center must include any area outside the launch site and not under the launch operator's control that contains an exposed site. An exposed site includes any structure that may be occupied by human beings, and that has at least one window, but does not include automobiles, airplanes, and waterborne vessels. The analysis must account for the most recent census information on each population center. The analysis must treat any exposed site for which no census information is available, or the census information indicates a population equal to or less than four persons, as a 'single residence.'

(ii) The analysis must identify the distance between the location of the maximum credible impact explosion and the location of each population center potentially exposed. Unless the location of the potential explosion site is limited to a defined region, the analysis must account for the distance between the potential explosion site and a population center as the minimum distance between any point within the region contained by the flight safety limits and the nearest exposed site within the population center.

(iii) The analysis must account for weather conditions optimized for a distant focus overpressure hazard and use an atmospheric blast "focus factor" (F) of 5.

(iv) The analysis must determine, using the methodology of section 6.3.2.4 of ANSI S2.20-1983, for each a population center, whether the maximum credible explosive yield of a launch meets, exceeds or is less than the "no damage yield limit," of the population center. If the maximum credible explosive yield is less than the "no damage yield limit" for all exposed sites, the remaining requirements of this section do not apply. If the maximum credible explosive yield meets or exceeds the "no damage yield limit" for a population center then that population center is vulnerable to far field blast overpressure from the launch and the requirements of paragraphs (b)(4) and (b)(5) of this section apply.

(4) Estimate the quantity of broken windows. The analysis must use a focus factor of 5 and the methods provided by ANSI S2.20-1983 to estimate the number of potential broken windows within each population center determined to be vulnerable to the distant focus overpressure hazard in accordance with paragraph (b)(3) of this section.

(5) Determine and implement measures necessary to prevent distant focus overpressure from breaking windows. For each population center that is vulnerable to far field blast overpressure from a launch, the analysis must identify mitigation measures to protect the public from serious injury from broken windows and the flight commit criteria of § 417.113(b) needed to enforce the mitigation measures. A launch operator's mitigation measures must include one or more of the following:

(i) Apply a minimum 4-millimeter thick anti-shatter film to all exposed sites where the maximum credible yield exceeds the "no damage yield limit."

(ii) Evacuate the exposed public to a location that is not vulnerable to the distant focus overpressure hazard at least two hours prior to the planned flight time.

(iii) If, in accordance with paragraph (b)(4) of this section, the analysis predicts that less than 20 windows will break, advise the public of the potential for glass breakage.

(c) Far field blast overpressure risk analysis. If a launch operator does not employ paragraph (b) of this section to perform a far field overpressure hazard analysis, the launch operator must conduct a risk analysis that demonstrates that the launch will be conducted in accordance with the public risk criteria of § 417.107(b).

(d) Far field blast overpressure effect products. The products of a far field blast overpressure analysis that a launch operator must submit to the FAA as required by § 417.203(e) must include:

(1) A description of the methodology used to produce the far field blast overpressure analysis results, a tabular description of the analysis input data, and a description of any far field blast overpressure mitigation measures implemented.

(2) For any far field blast overpressure risk analysis, an example set of the analysis computations.

(3) The values for the maximum credible explosive yield as a function of time of flight.

(4) The distance between the potential explosion location and any population center vulnerable to the far field blast overpressure hazard. For each population center, the launch operator must identify the exposed populations by location and number of people.

(5) Any mitigation measures established to protect the public from far field blast overpressure hazards and any flight commit criteria established to ensure the mitigation measures are enforced.

A417.31 Collision avoidance.

(a) General. A flight safety analysis must include a collision avoidance analysis that satisfies the requirements of § 417.231. The requirements of this section apply to the process of obtaining a collision avoidance assessment from United States Space Command as required by § 417.231 and to the analysis products that the launch operator must submit to the FAA as required by § 417.203(e). United States Space Command refers to a collision avoidance analysis for a space launch as a conjunction on launch assessment.

(b) Analysis constraints. A launch operator must satisfy the following when obtaining and implementing the results of a collision avoidance analysis:

(1) A launch operator must provide United States Space Command with the launch window and trajectory data needed to perform a conjunction on launch assessment for a launch as required by paragraph (c) of this section, at least 15 days before the first attempt at flight. The FAA will identify a launch operator to United States Space Command as part of issuing a license and provide a launch operator with current United States Space Command contact information.

(2) A launch operator must obtain a conjunction on launch assessment performed by United States Space Command 6 hours before the beginning of a launch window.

(3) A launch operator may use a conjunction on launch assessment for 12 hours from the time that United States Space Command determines the state vectors of the habitable orbiting objects. If a launch operator needs an updated conjunction on launch assessment due to a launch

delay, the launch operator must submit the request to United States Space Command at least 12 hours prior to the beginning of the new launch window.

(4) For every 90 minutes, or portion of 90 minutes, that pass between the time United States Space Command last determined the state vectors of the orbiting objects, a launch operator must expand each wait in a launch window by subtracting 15 seconds from the start of the wait in the launch window and adding 15 seconds to the end of the wait in the launch window. A launch operator must incorporate all the resulting waits in the launch window into its flight commit criteria established as required by § 417.113.

(c) Information required. A launch operator must prepare a conjunction on launch assessment worksheet for each launch using a standardized format that contains the input data required by this paragraph. A launch operator must submit the input data to United States Space Command for the purposes of completing a conjunction on launch assessment. A launch operator must submit the input data to the FAA as part of the license application process in accordance with § 415.115.

(1) Launch information. A launch operator must submit the following launch information:

(i) Mission name. A mnemonic given to the launch vehicle/payload combination identifying the launch mission from all others.

(ii) Segment number. A segment is defined as a launch vehicle stage or payload after the thrusting portion of its flight has ended. This includes the jettison or deployment of any stage or payload. A launch operator must provide a separate worksheet for each segment. For each segment, a launch operator must determine the "vector at injection" as defined by paragraph (c)(5) of this section. The data must present each segment number as a sequence number relative to the total number of segments for a launch, such as "1 of 5."

(iii) Launch window. The launch window opening and closing times in Greenwich Mean Time (referred to as ZULU time) and the Julian dates for each scheduled launch attempt.

(2) Point of contact. The person or office within a launch operator's organization that collects, analyzes, and distributes conjunction on launch assessment results.

(3) Conjunction on launch assessment analysis results transmission medium. A launch operator must identify the transmission medium, such as voice, FAX, or e-mail, for receiving results from United States Space Command.

(4) Requestor launch operator needs. A launch operator must indicate the types of analysis output formats required for establishing flight commit criteria for a launch:

(i) Waits. All the times within the launch window during which flight must not be initiated.

(ii) Windows. All the times within an overall launch window during which flight may be initiated.

(5) Vector at injection. A launch operator must identify the vector at injection for each segment. "Vector at injection" identifies the position and velocity of all orbital or suborbital segments after the thrust for a segment has ended.

(i) Epoch. The epoch time, in Greenwich Mean Time (GMT), of the expected launch vehicle liftoff time.

(ii) Position and velocity. The position coordinates in the EFG coordinate system measured in kilometers and the EFG components measured in kilometers per second, of each launch vehicle stage or payload after any burnout, jettison, or deployment.

(6) Time of powered flight. The elapsed time in seconds, from liftoff to arrival at the

launch vehicle vector at injection. The input data must include the time of powered flight for each stage or jettisoned component measured from liftoff.

(7) Time span for launch window file (LWF). A launch operator must provide the following information regarding its launch window:

(i) Launch window. The launch window measured in minutes from the initial proposed liftoff time.

(ii) Time of powered flight. The time provided in accordance with paragraph (c)(6) of this section measured in minutes rounded up to the nearest integer minute.

(iii) Screen duration. The time duration, after all thrusting periods of flight have ended, that a conjunction on launch assessment must screen for potential conjunctions with habitable orbital objects. Screen duration is measured in minutes and must be greater than or equal to 100 minutes for an orbital launch.

(iv) Extra pad. An additional period of time for conjunction on launch assessment screening to ensure the entire first orbit is screened for potential conjunctions with habitable orbital objects. This time must be 10 minutes unless otherwise specified by United States Space Command.

(v) Total. The summation total of the time spans provided in accordance with paragraphs (c)(7)(i) through (c)(7)(iv) expressed in minutes.

(8) Screening. A launch operator must select spherical or ellipsoidal screening as defined in this paragraph for determining any conjunction. The default must be the spherical screening method using an avoidance radius of 200 kilometers for habitable orbiting objects. If the launch operator requests screening for any uninhabitable objects, the default must be the spherical screening method using a miss-distance of 25 kilometers.

(i) Spherical screening. Spherical screening utilizes an impact exclusion sphere centered on each orbiting object's center-of-mass to determine any conjunction. A launch operator must specify the avoidance radius for habitable objects and for any uninhabitable objects if the launch operator elects to perform the analysis for uninhabitable objects.

(ii) Ellipsoidal screening. Ellipsoidal screening utilizes an impact exclusion ellipsoid of revolution centered on the orbiting object's center-of-mass to determine any conjunction. A launch operator must provide input in the UVW coordinate system in kilometers. The launch operator must provide delta-U measured in the radial-track direction, delta –V measured in the in-track direction, and delta –W measured in the cross-track direction.

(9) Orbiting objects to evaluate. A launch operator must identify the orbiting objects to be included in the analysis.

(10) Deliverable schedule/need dates. A launch operator must identify the times before flight, referred to as "L- times," for which the launch operator requests a conjunction on launch assessment.

(d) Collision avoidance assessment products. A launch operator must submit its conjunction on launch assessment products as required by § 417.203(e) and must include the input data required by paragraph (c) of this section. A launch operator must incorporate the result of the conjunction on launch assessment into its flight commit criteria established in accordance with § 417.113.

A417.33 Unguided suborbital rocket flown with a wind weighting safety system.

For launch of an unguided suborbital rocket flown with a wind weighting safety system, the flight safety analysis must satisfy the requirements of § 417.233. The analysis for an unguided suborbital rocket flown with a wind weighting safety system must incorporate the methodologies for trajectory analysis, flight hazard area analysis, and wind weighting analysis contained in appendix C of this part. The analysis must also include a debris risk analysis performed in accordance with A417.25 and appendix B of this part and a collision avoidance analysis performed in accordance with A417.31.

28. In B417.1 as proposed to be revised at 65 FR 64050, revise "§ 417.227" to read "§ 417.225" each place it appears.

29. In B417.3 as proposed to be revised at 65 FR 64050, revise "§ 417.227(b)(5)" to read "§ 417.225".

30. In B417.5(b)(1) as proposed to be revised at 65 FR 64051, revise "§ 417.205" to read "§ 417.207 and A417.7".

31. In B417.5(b)(2) as proposed to be revised at 65 FR 64051, revise "§ 417.227(b)(6)" to read "A417.25".

32. In B417.5(b)(3) as proposed to be revised at 65 FR 64051, revise "§ 417.209" to read "§ 417.211 and A417.11".

33. In B417.5(c) as proposed to be revised at 65 FR 64051, revise "§ 417.205(c)" to read "§ 417.207 and A417.7".

34. In B417.7(a) as proposed to be revised at 65 FR 64052, revise "§ 417.227(b)(11)" to read "§ 417.225 and A417.25".

35. In B417.9(a) as proposed to be revised at 65 FR 64056, revise "§ 417.227" to read "A417.25".

36. In C417.1 as proposed to be revised at 65 FR 64057, revise "§ 417.235" to read "§ 417.233".

37. In C417.3(g) introductory text as proposed to be revised at 65 FR 64059, revise "§ 417.235(g)" to read "A417.203(e)".

38. In C417.5(a) as proposed to be revised at 65 FR 64059, revise "§ 417.235(c)" to read "§ 417.233".

39. In C417.5(j) as proposed to be revised at 65 FR 64062, revise "§ 417.235(c)" to read "§ 417.203(e)".

40. In C417.7(d) as proposed to be revised at 65 FR 64063, revise "§ 417.235(g)" to read "§ 417.203(e)".

41. In D417.13(b) as proposed to be revised at 65 FR 64067, revise "§ 417.223(b)(3)" to read "§ 417.221 and A417.21".

42. In D417.19(a) as proposed to be revised at 65 FR 64068, revise "§ 417.221(c)" to read "§ 417.219 and A417.19".

43. In I417.1 as proposed to be revised at 65 FR 64116, revise "§ 417.229"to read "§ 417.227".

44. In I417.5(e) as proposed to be revised at 65 FR 64119, revise "§ 417.203(c)" to read "§ 417.203(e)".

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