Launch and Reentry License Requirements Improvement

Aerospace Rulemaking Committee

Recommendation Report

March 12, 2026

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I. Executive Summary

The Launch and Reentry License Requirements Improvement Aerospace Rulemaking Committee (Part 450 SpARC), chartered by the Federal Aviation Administration (FAA), conducted a comprehensive review of the implementation of 14 CFR Part 450, which governs commercial space launch and reentry licensing. The committee, comprising industry and government stakeholders, identified significant challenges in the current regulatory framework and FAA processes that hinder the efficiency, transparency, and predictability of commercial space launch and reentry licensing.

Key challenges include limited visibility into application progress, delayed and inconsistent FAA feedback, unclear escalation paths, excessive documentation requirements, opaque and lengthy pre-application processes, premature FAA demands for detailed evidence under means of compliance (MOC) requirements, and difficulties in obtaining incremental approvals. These issues collectively impede timely licensing decisions and increase costs for operators.

The SpARC offers a robust set of recommendations to streamline the licensing process, clarify regulatory definitions and scopes, improve FAA communication and feedback mechanisms, and enhance agency guidance materials.

The report also advocates for better alignment of FAA practices with federal statutes, increased acceptance of equivalent federal agency compliance products, and modernization of safety analysis requirements to reduce redundant and burdensome reviews. These reforms are intended to maintain high public safety standards while fostering innovation and competitiveness in the U.S. commercial space sector. The SpARC developed the recommendations presented in the tables below. The recommendations are discussed in detail in Sections VI through XI below. The SpARC recommended several regulatory changes. Its recommended changes are presented in the red-lined text in Appendix A.

By implementing these recommendations, the FAA can enhance regulatory clarity, reduce unnecessary burdens on applicants, and support the growth of a safe, efficient, and dynamic commercial space industry.

Tables of Recommendations

Table 1: Process Improvements ("REC-P") Recommendations	
REC-P01	PROCESS: The FAA should ensure transition to any revised sections of part 450 does not negatively impact existing part 450 licensees.
REC-P02	PROCESS: The FAA should implement electronic processing tools for licensing review and maintenance to simplify communications with applicants/licensees.
REC-P03	PROCESS: The FAA should set internal deadlines and standards for reviewing materials and responding to applicants / licensees to meet the needs of the industry.
REC-P04	PROCESS: The FAA should formalize a process for adjudicating on technical disagreements between FAA staff and applicants / licensees and appoint a technical authority responsible for decision making.
REC-P05	PROCESS / GUIDANCE: For licensed operations at Federal Ranges, the FAA should accept equivalent safety documentation in its original form and identify in applicable Advisory Circulars the documents the FAA will accept without modification.
REC-P06	PROCESS: The FAA should stop imposing a lengthy pre-application process by clarifying that the decision to submit a license application is up to the operator.
REC-P07	PROCESS: Given the inherent reliance on the term throughout part 450 and supporting guidance material, the FAA should define "means of compliance" (MOC) and differentiate MOC material from license application material.
REC-P08	PROCESS: The FAA should maintain documentation of all Federal agency services and facilities reviewed or under review by AST for compliance with FAA requirements.
REC-P09	PROCESS: The FAA should formalize the adjudication processes to leverage analyses beyond the scope of public safety to satisfy applicable public safety requirements.
REC-P10	PROCESS: The FAA should limit the scope of content in required environmental reviews, limiting it to activities within its regulatory authority and eliminating duplication with safety requirements already addressed in other subparts.
REC-P11	PROCESS: The FAA should continually review risk thresholds and their justifications, regulating only to the extent that safety requires.
REC-P12	PROCESS: In reviewing compliance with § 450.103, the FAA should apply differing levels of scrutiny based on the complexity of the system involved.
REC-P13	PROCESS: Consistent with the FAA's decision to accept tailored versions of RCC 319-19 and 324-11 as accepted means of compliance with § 450.145, the FAA should extricate itself from RCC tailoring process if administered by DoD or NASA and clarify precedence of FAA review if applicants use RCC documents without RCC tailoring for operations from commercial spaceports.
REC-P14	PROCESS: The FAA should amend § 450.115 and the FSA method approval process by any means necessary to remove unjustified roadblock to licensure.
REC-P15	PROCESS: The FAA should streamline approval under § 450.115 for FSA methods used under legacy licenses.
REC-P16	PROCESS: The FAA should require no more than a description of tools and components of trajectory methods under §§ 450.117 and 450.119.
REC-P17	PROCESS: The FAA should expand eligibility for experimental permits under part 437 to include all types of new vehicles.

Table 2: Guidance Request ("REC-G") Recommendations	
REC-G01	GUIDANCE: The FAA should publish additional Advisory Circulars, refine goals of their content, and incentivize adding new and novel MOCs for publication.
REC-G02	GUIDANCE: The FAA should provide guidance on categories of related data products necessary to build modules for incremental review.
REC-G03	GUIDANCE: The FAA should develop a flowchart that illustrates the best-fit interdependencies between regulations and deliverables for incremental or standard reviews.
REC-G04	PROCESS/GUIDANCE: For licensed operations at Federal Ranges, the FAA should accept equivalent safety documentation in its original form and identify in applicable Advisory Circulars the documents the FAA will accept without modification.
REC-G05	GUIDANCE: The FAA should publish checklists or other internal guidance regarding completeness determinations, especially for FSA methods.
REC-G06	GUIDANCE: If REC-R01is not accepted, the FAA should draft an Advisory Circular (AC) that describes the FAA criteria for making "by and for the government" determinations.
REC-G07	GUIDANCE: If REC-R10 is not accepted, the FAA should issue an AC or other guidance describing a process for accepting FAA airworthiness determinations without further showing by the applicant.
REC-G08	GUIDANCE: The FAA should update its guidance in AC 450.103-1 to clarify whether *any* change to a safety critical system would trigger documentation requirements in § 450.103(c)(2), (3).
REC-G09	GUIDANCE: In implementing REC-G08, the FAA should ensure the System Safety Program is included as an early requirement in licensing compliance.
REC-G10	GUIDANCE: The FAA should update AC 450.107 to clarify and further define the functional hazard analysis process so it may be applied equitably to both launch and reentry vehicles.
REC-G11	PROCESS/GUIDANCE: The FAA should make available a population database that applicants may use when overflying DoD sites in lieu of hiring USSF or using overly conservative modeling.

Table 3: Regulatory Text Changes ("REC-R") Recommendations	
REC-R01	REGULATORY TEXT: The FAA should move current text of § 450.1 to § 450.1(a), establishing a "general" paragraph and adopt language in a new § 450.1(b) that would establish an "exception" paragraph describing FAA criteria for whether a launch or reentry is carried out by and on behalf of the U.S. government.
REC-R02	REGULATORY TEXT: The FAA should update § 413.5 so that pre-application consultation is voluntary, not mandatory, for a license applicant.
REC-R03	REGULATORY TEXT: The FAA should strike § 450.35(a) to treat a means of compliance (MOC), its inputs, and its products as elements of a license application rather than a prerequisite for application acceptance.
REC-R04	REGULATORY TEXT: The FAA should redefine "mishap" to apply to a more clearly defined set of events.
REC-R05	REGULATORY TEXT: The FAA should redefine "safety critical" to minimize scope of compliance evidence for risks that are thoroughly mitigated.
REC-R06	REGULATORY TEXT: The FAA should revise scope of reentry in § 450.3(c) to enhance clarity, include all relevant public safety risks, and exclude operational and vehicle status not relevant to public safety.
REC-R07	REGULATORY TEXT: The FAA should revise § 450.37 to provide written notice and justification to applicants when the FAA makes a determination on an Equivalent Level of Safety (ELOS) under this provision.
REC-R08	REGULATORY TEXT: The FAA should provide additional flexibility for operators utilizing Federal launch or reentry sites, or other Federal entities providing services or facilities under contract to the operator.
REC-R09	REGULATORY TEXT: The FAA should adopt language in § 450.45 accepting FAA airworthiness decisions, without further showing, for aircraft used as components of launch vehicles licensed under part 450.
REC-R10	REGULATORY TEXT: The FAA should revise §450.47 to expand the application of categorical exclusions and to reflect FAA acceptance of preexisting environmental approvals by other federal agencies as applicable.
REC-R11	REGULATORY TEXT: The FAA should define "high consequence event" and amend § 450.101(c) to improve its applicability to all licensed operations.
REC-R12	REGULATORY TEXT: Prior to any rulemaking that modifies § 450.101(c)(2), the FAA should immediately issue a blanket waiver to relieve reentry and captive carry vehicles of that requirement.
REC-R13	REGULATORY TEXT: The FAA should refine the critical asset screening process and allow alternative risk probabilities when justified.
REC-R14	REGULATORY TEXT: The FAA should clarify the disposal criteria in § 450.101(d) and expand "disposal" definition in § 401.7 to include reentry vehicles.
REC-R15	REGULATORY TEXT: The FAA should allow a less restrictive alternative to the requirement for notification of 97% probability of containment in § 450.101(f).
REC-R16	REGULATORY TEXT: The FAA should eliminate § 450.101(g) and add the requirement to use accurate data and scientific principles to individual regulations requiring analysis compliant with § 450.101.
REC-R16.1	REGULATORY TEXT: The FAA should remove § 450.115(c) and instead levy the application requirements for each FSA section to assess FSA methods as appropriate.
REC-R16.2	REGULATORY TEXT: The FAA should replace each reference to § 450.115(c) in the application requirements of the FSA sections (§§ 450.117 – 450.139) with three simplified criteria.

REC-R17	REGULATORY TEXT: The FAA should clarify and restructure § 450.103(a) to ensure safety organization requirements apply only during licensed activities.
REC-R17.1	REGULATORY TEXT: The FAA should require operators to also account for ground safety hazards in § 450.103(b) "when applicable."
REC-R17.2	REGULATORY TEXT: The FAA should update § 450.103(b)(2) to require communication of hazard management updates only when an update is "material to public safety."
REC-R17.3	REGULATORY TEXT: The FAA should update language in § 450.103(c) to clarify non-applicability to exempt systems (like a highly reliable flight safety system, or systems adequately mitigated by hazard control strategies).
REC-R18	REGULATORY TEXT: The FAA should revise § 450.107 to require a performance-based system safety analysis that identifies critical systems and provide evidence of their qualification. Functionally, this combines the existing text from §§ 450.107 and 450.143.
REC-R19	REGULATORY TEXT: Should the FAA retain all or part of § 450.141, the FAA should allow operators to assign criticality of computing system safety items (CSSIs) in light of mitigations and align with DoD and industry interpretations of "mitigations."
REC-R20	REGULATORY TEXT: To encourage removal of vehicle debris from orbit, the FAA should eliminate or alleviate the requirement for a disposal FSA in § 450.113.
REC-R21	REGULATORY TEXT: The FAA should clarify its intent and provide a path to utilizing the FSA exception in § 450.113(b).
REC-R22	REGULATORY TEXT: The FAA should revise § 450.115(b)(1) to require only "reasonably likely" sources of uncertainty.
REC-R23	REGULATORY TEXT: The FAA should codify into the regulation the streamlined means of compliance for FSA outlined in AC 413.13.
REC-R24	REGULATORY TEXT: The FAA should replace six-degree of freedom requirement with performance-based metric(s) in § 450.117(b).
REC-R25	REGULATORY TEXT: The FAA should replace "uncertainty" with "incertitude" throughout § 450.117.
REC-R26	REGULATORY TEXT: The FAA should restructure malfunction, breakup, and debris impact hazard analyses across §§ 450.119-122 to reflect order of operations and simplify as well as clarify requirements.
REC-R27	REGULATORY TEXT: The FAA should relocate the LUM trajectory requirements that apply solely to operators using flight abort (§ 450.108) as their hazard control strategy from § 450.119(a)(3) to a new regulatory section dedicated to LUM, § 450.124.
REC-R28	REGULATORY TEXT: The FAA should revise § 450.123(c)(2) to require a "representative analysis."
REC-R29	REGULATORY TEXT: The FAA should streamline and rework the probability of failure analysis requirement in § 450.131 to reflect expected practice.
REC-R30	REGULATORY TEXT: As with § 450.101(f), the FAA should revise § 450.133 to allow operators to develop risk contours based on probability of casualty as an alternative to the existing requirements for 97% probability of containment.
REC-R31	REGULATORY TEXT: The FAA should parse the two analyses described in § 450.135 into two separate requirements, consistent with actual practice.
REC-R32	REGULATORY TEXT: The FAA should clarify far-field overpressure requirements in § 450.137 and align the regulation with industry and USSF practice.
REC-R33	REGULATORY TEXT: The FAA should stop levying § 450.35(a) to require toxic release hazard analysis and/or toxics catalog outside of the 180-day review period, in clear contravention of the regulatory text.
REC-R34	REGULATORY TEXT: The FAA should revise § 450.213(b)(2) to require only vacuum instantaneous impact points for planned impact points.

REC-R35	REGULATORY TEXT: The FAA should update § 450.161 to clarify hazard area control and surveillance requirements and constrain applicability to hazard areas surrounding the launch and/or landing area. Additionally, corresponding updates and details should be implemented in AC 450.161-1 and coordinated with USCG.
REC-R36	REGULATORY TEXT: The FAA should narrow the scope of application changes requiring license modification under § 450.211 and discontinue practice of reviewing compliance products generated under continuing accuracy requirements when the underlying process remains static and outcomes remain acceptable.
REC-R37	REGULATORY TEXT: The FAA should reduce scope of post-flight reporting under § 450.215.

II. Purpose

The Launch and Reentry License Requirements Improvement Aerospace Rulemaking Committee (Part 450 SpARC) was chartered by the Federal Aviation Administration (FAA) to provide consensus recommendations on improvements to the launch and reentry licensing requirements in title 14 of the Code of Federal Regulations (CFR) part 450 and related regulations, to achieve the goals of Part 450 with greater clarity and flexibility. The SpARC consisted of representatives from industry, academia, non-profit organizations, and other stakeholders with expertise in launch and reentry operations and regulations.

III. Background

The FAA's launch and reentry licensing framework in 14 CFR part 450 implements the Commercial Space Launch Act as recodified at 51 U.S.C. ch. 509, which authorizes the Department of Transportation (DOT), via the FAA, to license commercial launches, reentries, and launch or reentry sites to protect public health and safety while encouraging commercial space activity.[1] In Space Policy Directive-2, the President directed DOT/FAA to streamline commercial space regulations.[2] In 2019, the FAA convened the Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Committee (ARC) to inform the FAA's proposal for Part 450.[3] The FAA then issued a notice of proposed rulemaking (NPRM) on April 15, 2019, proposing a single set of performance-based requirements for a "vehicle operator license" that would replace existing licensing requirements in Parts 415, 417, 431, 435 (i.e. "legacy" regulations) and substitute prescriptive rules with risk-based criteria.[4] The comment period was extended to July 30, 2019.[5] The FAA published the final rule, "Streamlined Launch and Reentry License Requirements," in the *Federal Register* on December 10, 2020, establishing part 450's unified, performance-based framework, to take effect March 21, 2021.[6] The final rule provides for a transition period under which legacy licenses expire no later than March 9, 2026, and the legacy regulations are removed from the CFR on March 10, 2026, after which all operators must comply with Part 450. The FAA has supported implementation of Part 450 through Advisory Circulars (ACs) articulating acceptable means of compliance under the performance-based regime. As the FAA continues to implement these regulations, both the agency and the industry have

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[1] 51 U.S.C. § 50901 et seq. (Commercial Space Launch Act, as recodified by Pub. L. No. 111-314, 124 Stat. 3328 (Dec. 18, 2010)).

[2] Space Policy Directive-2: Streamlining Regulations on Commercial Use of Space (Apr. 24, 2018), Presidential Memorandum, 83 FR 24901 (May 30, 2018). https://trumpwhitehouse.archives.gov/presidential-actions/space-policy-directive-2-streamlining-regulations-commercial-use-space/

[3] Federal Aviation Administration, Streamlined Launch and Reentry Licensing Requirements (Aviation Rulemaking Committee Final Report) (2019). https://www.faa.gov/regulationspolicies/rulemaking/committees/documents/streamlined-launch-and-reentry-licensing-0

[4] Federal Aviation Administration, Notice of Proposed Rulemaking: Streamlined Launch and Reentry License Requirements, 84 FR 15296 (Apr. 15, 2019). https://www.federalregister.gov/documents/2019/04/15/2019-05972/streamlined-launch-and-reentry-licensing-requirements

[5] Federal Aviation Administration, Extension of Comment Period for Notice of Proposed Rulemaking, 84 FR 25207 (June 24, 2019). https://www.federalregister.gov/documents/2019/05/31/2019-11286/streamlined-launch-and-reentry-licensing-requirements-extension-of-comment-period

[6] Federal Aviation Administration, Final Rule, Streamlined Launch and Reentry License Requirements, 85 FR 79566 (Dec. 10, 2020).

identified areas for improvement. To address these, the FAA formed the Part 450 SpARC to gather advice and recommendations for revising Part 450.

IV. Challenges and Concerns with Part 450 Implementation to Date

Although the Part 450 regulations were intended to create a streamlined, performance-based licensing process, implementation of the regulations to date has failed to achieve this purpose. The SpARC recognizes the FAA's commitment to improving the regulatory framework and its implementation. In that spirit, this report provides regulatory, advisory, and process recommendations based on direct applicant experience to better achieve the initial goals of Part 450. These recommendations are shaped by the experience of SpARC members in operating under the legacy regulations and now Part 450, which provides important context to the recommendations provided below.

A. Visibility of application progress.

Applicants consistently report that day-to-day visibility of an application's status is limited. There is no applicant-facing dashboard that shows the status of each deliverable, which party is on the clock, and when the next action is due. As a result, applicants build their own trackers and Gantt charts to manage hundreds of artifacts and comment threads. The FAA's Licensing Electronic Application Portal (LEAP) has been in development for years, but industry commentary in trade press and at public meetings has noted slow rollout and uneven adoption, with many interactions still handled by email and shared drives.[7] Several witnesses in congressional hearings and members of the FAA's Commercial Space Transportation Advisory Committee (COMSTAC) [8]have urged the FAA to rely more on commercial off-the-shelf workflow tools and to standardize status reporting to enable both sides to see the same milestones and aging metrics.

B. Timely communication of issues.

Another common complaint is the bundling of comments into large "rounds" that arrive only after the FAA's internal coordination is complete. That approach can delay simple clarifications that could otherwise be answered in hours or days. Technical interchange meetings (TIMs) help, but the FAA has acknowledged resource constraints and growing workload, and industry has testified that TIMs are not encouraged or available at the cadence needed. Compounding this, comment histories are often scattered across individual email threads and spreadsheets, making it hard for larger FAA teams and applicants to maintain continuity as personnel rotate. Turnover or reassignment often forces both sides to recreate context unless there is a deliberate and effective transfer of records.

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[7] *House Science Committee asks GAO to review FAA commercial launch licensing* process, Space News, Feb. 13, 2025, https://spacenews.com/house-science-committee-asks-gao-to-review-faa-commercial-launch-licensing-process/. Commercial *Space Launch and Reentry Regulations: Overview and Select Issues*, Congressional Research Service, June 23, 2025, https://www.congress.gov/crs_external_products/R/PDF/R48582/R48582.2.pdf.

[8] *See, e.g., Risks and Rewards: Encouraging Commercial Space Innovation While Maintaining Public Safety*, Hearings before the Subcommittee on Space and Aeronautics of the Committee on Science, Space, and Technology of the House of Representatives, 118th Cong. (2024), https://www.congress.gov/event/118th-congress/house-event/LC74428/text See also *Federal* Aviation Administration, *Information Memorandum to the Secretary,* COMSTAC Meeting Minutes – April 23, 2024 (May 28, 2024), https://www.faa.gov/media/81211.

C. Unclear authorities and escalation paths.

Companies have described situations where a single reviewer or small team effectively becomes a single point of failure, with outcomes and expectations varying by team assignment. Industry testimony has also emphasized that the internal separation between licensing and safety/standards functions can require escalation to senior leadership to resolve what are, in practice, crosscutting interpretation issues. FAA leadership has acknowledged in public forums that workload growth has outpaced staffing, which exacerbates bottlenecks and slows cross-division coordination. Meanwhile, operators bear the brunt of FAA inefficiency, expending countless resources waiting on FAA reviews, which ultimately drive up costs across the U.S. commercial space industry.

D. More documentation as a substitute for better process.

Multiple operators have stated publicly that documents of reasonable length at the outset expand significantly during FAA review, as reviewers request additional analyses, edge cases, supplemental references, and alternative formulations. Some of this is unavoidable given mission diversity and the novelty of many systems, but industry groups have argued that growing document volume is sometimes used as a substitute for early agreement on scope and acceptance criteria, increasing time and cost without commensurate safety benefit. The FAA's insistence on voluminous products and elongated process is the reason that many of the SpARC's recommendations are aimed at improving the FAA's implementation and interpretation of Part 450. Indeed, although some areas of Part 450 need to be improved, in many cases it is the FAA's implementation that derails soundly written provisions.

E. Opaque and lengthy reapplication processes.

Part 450 encourages early engagement, but operators and trade associations have told Congress[9] that preapplication phases can be protracted, with little to no accountability to timelines for method approvals and for determining when a package is "complete enough" to begin formal review. Because the preapplication stage is largely process driven and tailored to each operator, experiences vary widely; however, anecdotes shared in industry working groups and reported by trade media[10] describe months to years of preapplication interactions before the first formal clock starts: FAA's 30-day review to determine whether the application is complete enough to begin FAA's 180-day review. Both COMSTAC recommendations and witness testimony have urged FAA to publish and abide by clear service targets and

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[9] *See, e.g., Risks and Rewards: Encouraging Commercial Space Innovation While Maintaining Public Safety*, Hearings before the Subcommittee on Space and Aeronautics of the Committee on Science, Space, and Technology of the House of Representatives, 118th Cong. (2024), *https://www.congress.gov/event/118th-congress/house-event/LC74428/text. See also,* House Committee on Science, Space, and Technology, *Letter to GAO Comproller General requesting GAO review of commercial launch and reentry licensing*, Feb. 12, 2025, https://republicans-science.house.gov/_cache/files/f/7/f722d474-0997-430c-8cc3-7554c4dd5829/AC73412458B7EB01FA5CEE722B363157.gao-letter-on-part-450---clean-25-02-12.pdf.

[10] *See, Congressmen push FAA to accelerate licensing progress,* Space News, Dec. 9, 2024, https://spacenews.com/congressmen-push-faa-to-accelerate-licensing-process/; *Lawmakers Direct GAO Review of FAA's Part 450*, Payload Space, Feb. 14, 2025, https://payloadspace.com/lawmakers-direct-gao-review-of-faas-part-450/; *Pending Regulatory Approval: launch companies struggle with licening*, The Space Review, Sept. 23, 2024, https://www.thespacereview.com/article/4861/1.

to transparently track preapplication durations the same way formal review clocks are tracked.[11] Failure to do so means companies will continue to languish in pre-review, draining valuable time and resources that ought to be directed toward enhancing U.S. leadership in the space sector.

F. FAA prematurely requires implementation evidence for means of compliance approvals.

Operators have reported that gaining acceptance for a means of compliance (MOC) often requires mature implementation details and output data. Combined with the opaque timelines noted above, this can stall progress until the vehicle and mission architecture are largely finalized, limiting design agility. This dynamic is especially pronounced for Flight Safety Analysis (FSA) and Autonomous Flight Safety Systems (AFSS), where FAA reviewers expect end-to-end data, verification artifacts, and sometimes range coordination products before providing substantive acceptance. When Department of Defense (DoD) ranges are involved, coordination with range safety policies and Range Commanders Council (RCC) standards introduces additional interfaces and reviews that can further delay method acceptance unless managed in parallel with clear expectations.

G. Incremental approvals are essentially impossible.

Multiple operators have tried to stage submittals and secure incremental approvals for discrete methods or subparts (for example, approving a casualty risk method while AFSS details mature). Applicants report that, in practice, such approvals are rarely granted in isolation, with FAA reviewers deferring decisions until the broader application context is available. FAA reviewers have explained in public forums that Part 450 subparts are interlinked—system safety, FSA, flight safety systems, and operations risk management depend on each other—approving one element without the others can create rework. Industry argues, however, that clearer scoping of MOCs and a stronger commitment to incremental acceptances would reduce schedule risk and spread workload more evenly.

H. "Complete enough" as a barrier to efficient review.

The informal "complete enough" threshold used to start formal review is frequently cited by applicants as a problem. Industry notes that criteria for "complete enough" can be interpreted differently by different FAA teams, and that withholding formal application review until the applicant achieves this elusive standard is misaligned with iterative, risk-based development. This gating approach effectively prevents "review when ready," even for mature artifacts, and contributes to batching that further stretches schedules. FAA leadership has recognized in public remarks that clarifying upfront expectations and sequencing could help but has emphasized that comprehensive packages reduce iterations later. The SpARC members resolutely reject this assertion, having expended months to years iterating with the FAA on application material to surpass the "complete enough" gate.

I. Novel means of compliance.

Operators developing new architectures or safety approaches often describe a "guilty until proven innocent" experience: departures from ACs and previously accepted methods face a high burden of proof, multiple review loops, and extended coordination.Although the FAA touts ACs to be guidance – "one means, but

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[11] *Federal* Aviation Administration, *Information Memorandum to the Secretary,* COMSTAC Meeting Minutes – April 23, 2024 (May 28, 2024), https://www.faa.gov/media/81211; COMSTAC Regulatory Working Group Report, *Part 450 – Challenges and Recommendations*, July 11, 2023, https://www.faa.gov/media/68016.

not the only means of complying" with a given regulation – industry witnesses report that ACs often function as de facto prescriptive requirements because deviations require significant justification and time to review. The FAA has defended the use of ACs as reflecting accumulated safety practice while noting that novel approaches will be considered with sufficient evidence. The practical effect, though, as reflected in trade press and testimony,[12] is that innovation is slowed by uncertainty about what constitutes adequate evidence for acceptance and by the absence of predictable timelines for adjudicating new MOCs.

[12] *Risks and Rewards: Encouraging Commercial Space Innovation While Maintaining Public Safety*, Hearings before the Subcommittee on Space and Aeronautics of the Committee on Science, Space, and Technology of the House of Representatives, 118th Cong. (2024), *https://www.congress.gov/event/118th-congress/house-event/LC74428/text. See also, Pending regulatory approval: launch companies struggle with licensing*, The Space Review, Sept. 23, 2024.

V. The Part 450 Regulations

SpARC recommendations below range from highly tactical to strategic to address concerns and challenges noted in previous sections. Regulatory change should be matched by organizational alignments to support a streamlined framework. Within the FAA's Office of Commercial Space (AST), industry desires to see AST-200 fully coordinated across the individual disciplinary requirements of the regulations, with AST-100 serving as an aggregator and integrator of holistic technical and safety feedback. Where regulatory interconnectivity exists, it must be explicit and clearly articulated; reliance on implied linkages or interpretive judgments by AST introduces ambiguity, creates unnecessary burden, and is ultimately counterproductive for operators. Flight safety analysis should remain the core metric by which a licensed activity is evaluated and approved. System safety analyses, while essential, should be understood as tools for identifying hazards that require risk analysis and mitigation rather than as standalone approval mechanisms, particularly because they lack defined quantitative performance thresholds.

This approach is intended to promote regulatory predictability, transparency, and consistency in licensing decisions, while providing operators with clear, objective criteria against which compliance and approval are assessed.

VI. Recommendations – General Process

REC-P01 Streamline Rollout of Any New Rules

REC-P01	PROCESS: The FAA should ensure transition to any revised sections of part 450 does not negatively impact existing part 450 licensees.

INTENT:

The intent is to avoid further delay or hardship to the industry by ensuring any revisions made to part 450 do not disrupt ongoing licensed operations, including by ensuring the continued validity of previous compliance material and mapping the updated regulations so licensees may take advantage of new efficiencies.

RATIONALE:

The transition from legacy licenses to part 450 has been ungainly, and a single operator has successfully transitioned at the time of this report's writing. The FAA has regarded applicants seeking to transition their legacy license to part 450 as if presenting the FAA with a new vehicle or operation. Legacy operators have been asked to generate enormous amounts of additional compliance data to demonstrate the same results that the FAA previously deemed sufficient. Many of these vehicles have robust compliance and flight history that is only minimally considered during the FAA's evaluation of legacy operations for compliance with part 450.

The goals of the recommended regulatory changes found in this report are largely to clarify requirements and descope submissions that do not add to the overall safety case of a launch operation. With this in mind, none of the SpARC's recommended regulatory changes would add materials to demonstrate compliance. Also, the FAA should explicitly state in regulatory text when revising part 450 that existing demonstrations of compliance will continue to meet, if not exceed, the revised requirement. Therefore, the FAA should remove from the license application all previous compliance documentation that is no longer required, to reduce the burden of continuing accuracy and/or modification review for the FAA.

APPROACH:

The FAA should ensure that any revisions to part 450 is accompanied by explicit regulatory text that confirms that existing compliance evidence will continue to meet, if not exceed, the revised requirement(s). Minimizing scope for existing licensees will ease transition compliance and avoid further strain on the industry due to part 450 implementation.

REC-P02 Increased Utilization of Standardized Project Management Tools

REC-P02	PROCESS: The FAA should implement electronic processing tools for licensing review and maintenance to simplify communications with applicants/licensees.

INTENT:

The intent is to improve transparency and to avoid re-litigation of settled issues through timely implementation of an electronic system that communicates application status, next steps, compliance history, and feedback.

RATIONALE:

As noted above, applicants consistently report that day-to-day visibility of where an application stands or next steps is limited. As a result, applicants build their own trackers and Gantt charts to manage hundreds of artifacts and comment threads. Licensees struggle similarly with no common database between the FAA to preserve records of settled issues, compliance history, or FAA feedback. Reassignment of work among FAA reviewers after a license has been issued often causes additional delay as new staff come up to speed on the prior record, often without meaningful context for the decisions reached by prior FAA reviewers.

The FAA's Licensing Electronic Application Portal (LEAP) has been in development for years but delays to rollout have left most submissions still handled by email and shared drives. The SpARC encourages the FAA to rely on commercial, off-the-shelf workflow tools and to standardize status reporting so both sides can see the same milestones, metrics, and record of decisions.

APPROACH:

The FAA should undertake an immediate assessment of LEAP's development and consider adopting an alternative tool if a system cannot be put in place within 120 days of this report's publication. The FAA should consider off the shelf, commercial options that can provide the required capabilities immediately (e.g. a Jira system).

The FAA should propose the basic requirements of their desired toolset and allow industry to comment on the most impactful features.

The FAA should determine if Research, Engineering, Development funding can be pursued to maintain consistency outside of Operations budget for AST.

The FAA should deploy a lessons learned repository and, until such a platform is established, should develop and execute an interim process to communicate safety-critical alerts.

REC-P03 Ensure Reasonable Feedback Mechanism/Timing

REC-P03	PROCESS: The FAA should set internal deadlines and standards for reviewing materials and responding to applicants/licensees to meet the needs of the industry.

INTENT:

The intent is to eliminate undue burden to the commercial space industry occasioned due to slow, ineffective FAA feedback by establishing deadlines and standards for responding to applicants or licensees. The intent of this recommendation is to create internal FAA standards for effectively responding to applicants or licensees in a manner conducive to the demands of this industry. This recommendation goes hand in hand with P02.

RATIONALE:

Timely government review and approval of licensing materials are critical to the success of the U.S. space industry. Opacity as to the review status of application materials, the protracted periods of time needed to receive even minor comments from the FAA, and the ineffective way the FAA bundles and internally coordinates comments before returning them to applicants prevent commercial entities from conducting launches and reentries at the rate needed to ensure U.S. competitiveness. Without established timelines for reviewing and responding to applicants, delays accrue, which can lead to missed launch windows, increased costs, and lost market opportunities. The FAA should adopt internal deadlines for reviewing and responding to application deliverables. If the FAA cannot meet the established deadline, then the FAA should communicate this and the rationale to the applicant or, in the case of a license modification, the licensee. Adhering to turnaround times will promote better 'interim' feedback. If, for example, the scope of a submission is too large to reasonably review within the set deadline, the FAA can communicate this and either iterate its feedback or ask clarifying questions from FAA reviewers prior to performing a more comprehensive review. Deadlines would also help measure resource sufficiency and regulatory scope; deadline exceedances would help identify which subject matter expertise most requires supplementation and which regulations may be unexpectedly burdensome.

Similarly, setting standards that optimize the way the FAA returns feedback on deliverables would provide much needed consistency and accountability across licensing teams. SpARC members note that the FAA's current "sprint" format for review has been helpful in expectation management, but less helpful if the packaged feedback contains far more clarification questions than substantive feedback. The sprint structure notably limits applicants' access to FAA reviewers. For instance, if the FAA returns a document with a handful of easily-answered comments, even if the applicant returns responses within the hour, the applicant will still need to wait weeks—more likely, months—for the FAA's confirmation that the responses are acceptable. This fragmented exchange is particularly costly to applicants when it involves FSA methods, the approval of which the FAA uses as a gating mechanism to application delivery. There should be flexibility for FAA personnel to get immediate feedback from operators, particularly if it pertains to straightforward matters like locating data of interest within an existing submission.

APPROACH:

The FAA should establish and enforce deadlines and standards for expediently responding to applicants/licensees and reviewing licensing deliverables. These deadlines and feedback standards must be sufficient to meet the demands of this industry, at a minimum, prioritizing aggressive turnaround times for critical reviews. The FAA should balance the need for longer review times to provide complete, substantive feedback that, once adjudicated, closes a review versus the need for clarification on a new submission in setting these goals.

The FAA should collect and publish metrics to assess its performance against these deadlines and standards.

REC-P04 Implement Escalation Processes / Technical Ownership

REC-P04	PROCESS: The FAA should formalize a process for adjudicating on technical disagreements between FAA staff and applicants / licensees and appoint a technical authority responsible for decision making.

INTENT:

The intent is to minimize long-term stalemates due to substantive disagreement between FAA reviewers and applicants or licensee.

RATIONALE:

Companies have described situations where a single FAA reviewer or small team effectively becomes a single point of failure to license progression, with outcomes and expectations varying by team assignment. Industry discussions have also emphasized that the internal separation between the FAA's licensing team and the safety/standards functions can require escalation to senior leadership to resolve what are, in practice, crosscutting interpretation issues. FAA leadership has acknowledged in public forums that workload growth has outpaced staffing, which exacerbates bottlenecks and slows cross-division coordination. Meanwhile, operators bear the brunt of FAA inefficiency, expending countless resources waiting on FAA reviews, which ultimately drive-up costs across the U.S. commercial space industry.

APPROACH:

The FAA should implement a technical escalation process through which disputes can be adjudicated. This process, which may be requested by the applicant or licensee, should ensure a consistent standard of review between all license applications, provide equal opportunity for licensing material that may represent new or innovative solutions, and ensure that individual FAA licensing staff can access additional resources for critical decisions. The process must include the license applicant, require determinations to be made within 15 days, and require that rationale be documented and shared with the applicant.

REC-G01 Increase Availability and Utility of Advisory Circulars

REC-G01	GUIDANCE: The FAA should publish additional Advisory Circulars, refine goals of their content, and incentivize adding new and novel MOCs for publication.

INTENT:

The intent is to generate a more robust catalog of compliance strategies and insights for use by the FAA and by industry.

RATIONALE:

Although the FAA has dedicated significant time and resources to publishing ACs intended to identify means of complying with various part 450 requirements, few of the published ACs offer concrete MOC that an operator could simply follow and achieve compliance. Many of the ACs offer little more than a restatement of the applicable regulation, explanation of the rationale underlying the requirement, or general advice as to what an applicant should consider in developing its MOC with a given regulation. The lack of clear means of satisfying part 450's performance-based standards guarantee the lengthy, iterative application review process observed today. To empower actual streamlining of licensing, the FAA must provide clear MOC with its requirements, including a robust catalog of compliance strategies that affords flexibility while incentivizing additional new or novel MOC for publication. The industry would also benefit from FAA publication (either in ACs or other guidance) of any lessons learned in applying part 450 to different operations and programs, particularly for findings that are applicable to multiple vehicles.

APPROACH:

To achieve the objectives outlined above, the SpARC recommends the FAA adjust its approach to ACs in the following ways.

Strategic Prioritization. The SpARC recommends the FAA continue to publish ACs and prioritize those with the largest potential impact on application timelines, especially the distinction between license updates that are "continuing accuracy" and "material to public safety." Clarifying expectations on level of detail, acceptable source documentation, known and/or universally acceptable tailoring of standards, should be goals of these efforts to help operators increase the probability of success of their first submissions.

Incentivized Additions. As new and novel MOC are approved for use by the FAA for any regulation, related AC content should be evaluated for improvement. While specific licensee data may be inappropriate for sharing broadly with other operators, FAA personnel should be incentivized to consider what non-proprietary learnings could be shared based on their approvals. Licensees may also be incentivized to assist in publishing a genericized version of their compliance methods to gain the surety of continued acceptance if or when resources change within their review teams.

Specific Advisory Circular Additions. ACs for §§ 450.103, 450.107, 450.115, and all FSA requirements should be revised to provide specific MOC, including the steps operators can take to meet the respective regulations. These ACs should also clearly distinguish "exposition" to what would demonstrate compliance from actual compliance and identify the regulations being addressed.

For example, FAA feedback on applicants' § 450.103 submissions often includes citations to other regulations and their accompanying advisory circulars that do not provide further examples of compliance formatting or clearly point an applicant to further guidance. For instance, the section in the 450.103 AC dedicated to hazard management essentially restates the requirements in § 450.103(b)(1) without providing additional substantive guidance, nor a clear example of how an operator can demonstrate compliance by "connecting the dots" between a functional hazard analysis, flight hazard analysis, and FSA. If, as § 450.101(e)(2) states, an applicant must provide "a summary of the processes and products identified in … paragraphs (b), (c), and (d)…" the AC should do the same, using a hypothetical operator structure.

The SpARC also recommends changes to the 450.107 AC. First, the AC cross-references AC 450.143-1, which does not exist or was removed from the FAA's website. Second, the template Functional Hazard Analysis in the 450.107 AC is outdated and should be updated. Applicants have submitted feedback forms to the FAA requesting an update and some applicants have spent hundreds of hours formatting an incomplete template. Finally, AC450.107 should clarify that, while functional hazard analysis exists at both system and subsystem levels, sufficient risk mitigation at the system level can eliminate the need to extend analysis to the subsystem level. A flowchart diagram should be included to illustrate system level and subsystem level requirements and how to determine when the latter is applicable.

Finally, all existing ACs should be updated by including regulatory citations in the section headings to better orient the reader, such as "System Assessment Methods – 14 CFR 450.103(b)," rather than just "System Assessment Methods." This is a recommendation the FAA has provided to applicants when drafting compliance documentation; the SpARC recommends the FAA employ the same practice in its ACs.

REC-G02 Operationalize Incremental Review

REC-G02	GUIDANCE: The FAA should provide guidance on categories of related data products necessary to build modules for incremental review.

INTENT:

The intent is to clarify application deliverable dependencies and define pathways for incremental review to enable applicant use.

RATIONALE:

Multiple operators have tried to utilize the incremental review provisions afforded by part 450 by seeking incremental approvals for discrete methods or subparts (for example, approving a casualty risk method while AFSS details mature). Applicants report that, to date, none have been able to use the incremental review process as described in part 450; rather than approving application sections, FAA reviewers defer most decisions until the broader application context is available. The FAA has effectively rejected the process it promulgated in part 450 on the grounds that part 450's subparts (i.e. system safety, FSA, flight safety systems, and ground operations) are so interdependent that it cannot approve one element without the others. The SpARC believes that clearer scoping of MOCs and a stronger commitment to incremental acceptances would reduce schedule risk and spread workload more evenly.

The preamble to both the proposed and final versions of part 450 heralded incremental review as an alternative strategy to submitting a full license application. FAA's descriptions of § 450.33 starkly contradict the experiences of applicants who have endeavored to avail themselves of this option. SpARC members report that proposals for incremental review are often rejected due to interrelationships between the proposed module data products and other deliverables. This has resulted in virtually no meaningful change in how the FAA receives and reviews applications and, in some cases, grossly extended the amount of time that operators spent preparing and awaiting review of their submissions.

While AC 413.13 introduces the concept of a phased approach, this is centered around review vs. document delivery. Phase 1 requires submission of all application data necessary for acceptance but involves only high-level administrative review. Only in Phases 2 and 3 are more technical data required, but these are expected in the form of more maturity in the same documents. This phased approach is inconsistent with how operators develop and release documentation, and results in iterative FAA reviews and operator documentation updates. Additionally, iterative reviews frequently result in comments and questions that could have been provided in earlier reviews.

In contrast, incremental review would prioritize the full review of modules containing related information or prerequisite and resulting information. This would enable operators to focus on a set of deliverables that could be developed, submitted, and accepted in priority order. A defined set of example modules, such as System Safety Analysis, FSA, Flight Safety Systems, Testing and Operations, could identify the minimum set of data products needed to approve those modules. Similarly, Environmental review could be its own module, with approval independent of final acceptance of the full application.

Certainly, there may be verifications outstanding in one module that could affect contents of another module, but such situations could be handled by conditional acceptance of the earlier module, contingent upon verification of the later associated module.

This process would streamline review, avoid iterative phased reviews, and spread resource loading across the application period vs. concentrating it at the end. It would also establish proposed means of compliance as prerequisites to their respective applicable dependent modules.

APPROACH:

The FAA should prioritize the issuance of AC 450.33 and/or update AC 450. 413.11/13 to provide guidance on compiling and submitting application data modules for incremental review. A defined set of modules for FSA, system safety, flight safety system, and testing and ground operations—including the minimum set of data products needed to approve these modules—would be beneficial. The SpARC recommends in several sections of this report that the FAA refocus its ACs to provide tangible MOC with subject requirements. Clearer scoping of MOCs, coupled with an internal FAA commitment to allowing incremental approvals, would reduce schedule risk and spread workload more evenly among FAA reviewers.

REC-G03 Generate Licensing Flowchart

REC-G03	GUIDANCE: The FAA should develop a flowchart that illustrates the best-fit interdependencies between regulations and deliverables for incremental or standard reviews.

INTENT:

The intent is to clarify application deliverable dependencies and define pathways for incremental or standard reviews to better align applicant and regulator focus.

RATIONALE:

The SpARC recognizes that after nearly five years of Part 450 implementation, the FAA has developed a sense of the order in which applicants should address its various requirements. As noted above, the FAA has also publicly stated that the subsections of Part 450 are interdependent, such that there is an order in which applicants should prepare certain deliverables to move through review expediently. It would benefit both applicants and FAA reviewers if the FAA prepared a flowchart or other guidance illustrating the best order of operations based on the interdependencies for Part 450. Such guidance should outline review pathways for both incremental and standard review if FAA finds that those pathways differ. Clarification of the relationship of Part 450 components and expected deliverables would clarify expectations and help applicants prepare material that aligns with FAA expectations at various stages of FAA review.

APPROACH:

The FAA should augment and refine the existing flow chart in the Part 450 preamble to include all relevant regulations and provide guidance on the order in which applicants should address requirement for expediency. This will help visualize the structure of Part 450 and lead applicants to prepare materials that align with FAA expectations during application review. The augmented and refined flow chart should include, at a minimum:

a. The flow, connectivity, and optimal order of operations for addressing part 450 requirements.
b. Transparency into how regulations flow across AST organizations. For example, where regulations from the System Safety Branch and Flight Safety System Branch interact or feed into those in the FSA Branch, and vice versa. The goal is to reduce iterations and "go backs," saving valuable AST and applicant resources.
c. A clear roadmap on the order in which applicants should tackle §§ 450.117-450.137 to maximize efficiency that is not apparent from the regulatory text or their order of appearance in the CFR. For example, it has become apparent to applicants and FAA reviewers that probability of failure (§ 450.131) should be analyzed and approved by the FAA before an applicant begins to develop a methodology for analyzing malfunction trajectories under § 450.119.

REC-G04/REC-P05 Clarify Acceptance of Equivalent Federal Agency Compliance Products

REC-G04 **REC-P05**	PROCESS/GUIDANCE: For licensed operations at Federal Ranges, the FAA should accept equivalent safety documentation in its original form and identify in applicable Advisory Circulars the documents the FAA will accept without modification.

INTENT:

The intent is to harmonize civil and defense launch safety frameworks to ensure efficiency without compromising safety while also reducing duplicative compliance burdens on the launch user. By clearly relating launch safety implementation frameworks and allowing dual-use documentation, we can enable faster licensing under 14 CFR part 450 for missions with national security relevance and DoD or NASA mission assurance. The recommendation here is also intended to preserve the FAA's licensing authority for public safety while leveraging existing, rigorous DoD standards and processes.

RATIONALE:

The FAA has taken steps to identify federal services that the FAA will accept without additional evidence from applicants under § 450.45, but applicants launching or reentering from federal sites continue to endure duplicative, at times inconsistent, reviews of materials from the FAA and either the DoD or NASA. This is particularly true when applicants seek to use the documents prepared to meet Federal Range requirements (e.g. Missile System Prelaunch Safety Package (MSPSP), System Safety Program Plan, etc.) to meet nearly identical requirements as part 450, which requires the applicant to triage comments on a single document from two entities.

The following list identifies Range documentation that meets or exceeds requirements of part 450. Given the degree to which these documents cover the stated part 450 requirements and the FAA's familiarity with both the data product and the iterative process underlying each, the FAA should accept the following Range documents in their original form, without modification by the applicant, as compliant with the applicable requirements of part 450:

- *System Safety Program Plan*: The U.S. Space Force (USSF) requires under SSCMAN 91-710 that all Range users prepare a system safety program plan that meets each of the criteria listed in § 450.103, in addition to many other requirements.
- *MSPSP and other SSCMAN 91-710 safety-critical system evidence*: DoD missions and others operating on a USSF Range must prepare detailed safety-critical system design, test, and lifecycle documentation that meets, if not exceeds, § 450.143. Assuming the FAA does not strike or severely reduce the scope of § 450.143 per the SpARC's recommendation, the FAA should accept any safety-critical evidence prepared in accordance with SSCMAN 91-710 as compliant with § 450.143.
- *RCC 319-19*: The FAA has recognized RCC 319-19 as an accepted MOC with § 450.145. As noted in this report, the SpARC recommends the FAA extricate itself from USSF-led RCC processes,

consistent with the FAA's own finding that this tailoring process and resultant product are at least inclusive of § 450.145.

- *RCC 324:* USSF requires Range users to meet extensive criteria for tracking systems in RCC 324, which go well beyond the criteria in § 450.167.
- Commercial vehicle operators under DoD and NASA contracts cannot avoid preparing these contractual deliverables. The FAA requirements are nearly identical, so to avoid development of duplicative documentation, applicants should be able to leverage contractual documents as the FAA compliance documentation to the maximum extent.

The FAA need not amend part 450 to implement this change. Rather, the SpARC encourages the FAA to revise its process to begin immediately accepting these materials from applicants in their original form, without having to modify these materials or generate additional products. The FAA should also update applicable ACs to specify the Range deliverables that the FAA will accept without additional evidence from the applicant. Doing so would further part 450's objectives of streamlining licensing, avoiding duplicative federal regulation, and ensuring efficiency for both applicants and federal reviewers—all without compromising safety.

APPROACH:

The FAA should immediately revise its practice to accept in their original form the Range documents identified above as compliant with the relevant requirements of part 450, as well as any other Range materials the FAA deems equivalent to its own requirements. The FAA should also update applicable ACs to identify the Range documents that the FAA will accept without modification or supplementation, given that they meet or exceed certain part 450 requirements.

The SpARC specifically requests the following updates to published ACs:

1. Update AC 450.103 to include, "For US Government-sponsored missions, the System Safety Program requirements of § 450.103 may be satisfied by equivalent System Safety Program contract deliverables in their original form."
2. If the FAA retains all or part of § 450.143, clarify in an AC that US Government deliverables, such as mission assurance packages and Range Safety documentation, are acceptable means of compliance with § 450.143.
3. For §§ 450.145 and 450.167, specify that for phases of flight governed by Range Safety requirements, Range Safety certification packages approved under RCC-319, RCC-324, or equivalent US Government standards are acceptable means of compliance.

REC-G05 Publish Internal FAA Guidance for Completeness Determinations

REC-G05	GUIDANCE: The FAA should publish checklists or other internal guidance regarding completeness determinations, especially for FSA methods.

INTENT:

The intent is to improve clarity and transparency in the FAA's evaluation of FSA methods, thereby enabling applicants to prepare materials that align with the FAA's expectations and generally expediating the licensing process.

RATIONALE:

The informal "complete enough" threshold used to start formal review is frequently cited by applicants as a problem area. Industry feedback is that criteria for "complete enough" can be interpreted differently by different teams, and that waiting to achieve it across the entire application before any formal review can begin is misaligned with iterative, risk-based development. This gating approach effectively prevents "review when ready," even for mature artifacts, and contributes to batching that stretches schedules. FAA leadership has recognized in public remarks that clarifying upfront expectations and sequencing could help but has emphasized that comprehensive packages reduce itereations later. The SpARC members resolutely reject this assertion, having expended months to years iterating with the FAA on application material to surpass the "complete enough" gate.

Multiple SpARC representatives have caught references by their AST licensing teams to internal guidance or checklists that FAA analysts use to evaluate the completeness of application deliverables, especially for FSA methods under § 450.115 or the individual FSA sections (§§ 450.117-139). The FAA should publish any such guidance to improve transparency and consistency in the FAA's evaluation of FSA methods. Publication of such guidance would also improve the quality of part 450 applications and expedite the licensing process overall.

SpARC members have also noted that when the FAA rejects a methodology document as incomplete from the standpoint of § 450.115(c), the determination may not come with a justification or citation to the specific issue. Publishing internal directives that inform agency decision-making and routinely providing applicants with specific feedback on § 450.115 deficiencies would help applicants prepare applications that better address FAA pertinencies.

APPROACH:

To improve transparency and consistency in the FAA's evaluation of application deliverables, particularly the FSA methods, the FAA should publish any internal checklists or guidance used to evaluate such deliverables, including FSA methods under § 450.115 or the individual FSA sections (§§ 450.117-139). Where the FAA finds an FSA method or other application deliverable regulatorily deficient, the FAA should require its staff to clearly and expeditiously communicate to the applicant the deficiency and justification.

VII. Recommendations Definitions, Scope, and License Requirements

REC-R01/REC-G06 USG Mission Exemptions

REC-R01	REGULATORY TEXT: The FAA should move the current text of § 450.1 to § 450.1(a), establishing a "general" paragraph and adopt language in a new § 450.1(b) that would establish an "exception" paragraph describing FAA criteria for whether a launch or reentry is carried out by and on behalf of the U.S. government.
REC-G06	GUIDANCE: If REC-R01 is not accepted, the FAA should draft an Advisory Circular (AC) that describes the FAA criteria for making "by and for the government" determinations.

INTENT:

The FAA should clearly communicate the standards the administrator uses to determine whether a proposed launch or reentry is carried out by and on behalf of the government such that it is exempt from FAA's licensing requirements. In the past, this statutory test was referred to as assessing whether a launch or reentry was "by and for the government."

RATIONALE:

As the federal government increasingly turns to commercial providers for launch and reentry support, applicants must repeatedly navigate FAA's murky process for determining when a launch or reentry performed by a commercial entity in support of government missions may be exempt from FAA licensure.

The FAA currently provides notice in 14 CFR 400.2(a) that states only that, "[t]he regulations in this chapter do not apply to – …[s]pace activities carried out by the United States Government on behalf of the United States Government." This mirrors the text of the non-application section in 51 U.S.C. § 50919(g) but does not include the text of § 50919(g)(A) or § 50919(g)(2)(A-B), which are also relevant to launch operators attempting to determine if the chapter applies to their operations.

FAA AST staff purport to perform a case-by-case review of proposed launch or reentry activities to determine if such activities meet unpublished standards for the purpose of determining if AST will require licensure under the chapter. One industry party commented that they achieved a written concurrence from AST that their operation was "by and for the government" only after substantial iterative communication and redrafting of contractual language with their customer. That same industry party indicated that a subsequent mission of substantially similar design duplicated that effort and ultimately resulted in AST sharing an unofficial list of standards that AST purported to use to make such determinations. AST's ultimate resolution stated "Essentially, it is the launch operator's responsibility to determine whether a launch needs an FAA license or not."

Taken together, these two factors establish that (1) FAA AST is not communicating all standards it uses to determine whether it believes a launch is "carried out by and on behalf of the U.S. government," and (2) the launch and reentry service providers are expected to make their own interpretations and determinations

of the chapter's applicability to their operations without fulsome knowledge of any established government standards.

APPROACH:

The FAA should adopt language in § 450.1 that would establish an "exception" paragraph describing FAA criteria for whether an operation is carried out by and on behalf of the government under § 450.1. Suggested regulatory language is found in Appendix A of this report.

If the FAA does not accept the regulatory language or otherwise implement this change by revising any of the definitions in § 401.7, then the FAA should issue guidance in the form of an AC that describes FAA criteria for determining when a launch or reentry may be considered to be "carried out by and on behalf of the U.S. government" such that it is exempt from FAA licensure.

REC-P06/REC-R02/REC-R03 MOC Approvals from Pre-Application

REC-P06	PROCESS: The FAA should stop imposing a lengthy pre-application process by clarifying that the decision to submit a license application is up to the operator.
REC-R02	REGULATORY TEXT: The FAA should update § 413.5 so that pre-application consultation is voluntary, not mandatory, for a license applicant.
REC-R03	REGULATORY TEXT: The FAA should strike § 450.35(a) to treat a means of compliance (MOC), its inputs, and its products as elements of a license application rather than a prerequisite for application acceptance.

INTENT:

The intent is to bring FAA practice into compliance with the Congressional requirement to make licensing determinations within 180 days of receiving an application, while alleviating bottleneck and burden on industry resources by removing unhelpful pre-application requirements.

RATIONALE:

This recommendation consists of several parts. Broadly stated, the SpARC recommends both that the FAA change certain practices in the near term, and that the FAA revise its regulations going forward to comply with 51 U.S.C. Ch. 509. Lastly, the FAA should issue guidance clarifying that even under current regulations, § 450.35 does not require a launch operator to produce the output of a MOC to approve use of the MOC generally. These recommendations apply to license applications submitted to start the FAA's 180-day review clock. It does not apply to incremental applications.

As the Congressional Research Service noted in a recent report discussing the pre-application process:

> At a 2024 hearing of the House Science, Space, and Technology Committee, President of the Commercial Spaceflight Federation Dave Cavossa described this as "an endless back-and-forth process" lasting years for some companies. Stakeholders assert that such consultation is creating delays. For instance, Cavossa stated that the implementation of part 450 "has caused severe licensing delays." The costs to navigate the licensing process, he asserted, run into "millions of dollars" per mission and "when combined with uncertainty and schedule delays, it's crippling our [industry's] efforts to launch and reenter new launch vehicles, support new customers, and raise new capital."[13]

Congress established a deadline for the FAA to issue a license for a launch or reentry vehicle within 180 days of accepting a license application in 51 U.S.C. § 50905(a)(1). That same provision requires the FAA to inform an applicant in writing 120 days after the FAA accepts an application if there are any pending issues and of any action needed to resolve those issues. This provision states the FAA must make its decision

[13] *Commercial Space Launch and Reentry Licensing Regulations: Overview and Select Issues*, Congressional Research Service (Jun. 23, 2025) (internal citations omitted). https://www.congress.gov/crs-product/R48582?q=%7B%22search%22%3A%22faa%22%7D&s=2&r=1

"not later than 180 days after accepting an application *in accordance with criteria established pursuant to subsection (b)(2)(D)*,[1]" To the extent the italicized language creates confusion because (b)(2)(D) refers to the creation of human space flight regulations, a statutory annotation clears that up; Congress re-designated the (b)(2)(D) reference in (a)(1) to(b)(2)(E).[14] That section provides that the FAA may prescribe "regulations establishing criteria for accepting or rejecting an application for a license under this chapter within 60 days after receipt of such application." In other words, the FAA may prescribe regulations containing such criteria to apply "after receipt"—that is, once an application has been filed.

Instead, the FAA created a pre-application consultation process that circumvents the 180-day timeline Congress mandated. The FAA's regulation states:

> A prospective applicant must consult with the FAA before submitting an application to discuss the application process and possible issues relevant to the FAA's licensing or permitting decision. Early consultation helps an applicant to identify possible regulatory issues at the planning stage when changes to an application or to proposed licensed or permitted activities are less likely to result in significant delay or costs to the applicant.[15]

If this provision required only a single meeting, there would be little harm and much benefit. However, in practice, the pre-application consultation runs for many months and longer, with the FAA requiring review of application materials, including MOC under § 450.35, without a timeline on the length of those reviews.[16] Most applicants face multiple repeated reviews—again, with no mandatory timeline attached. Operators have languished in this limbo for months and, at times, years. Operators report that pre-application consultation was shorter and more advisory before the FAA promulgated part 450.

Part 450 introduced a new framework for accepting applications as complete enough for review that prevents acceptance of an operator's application until the FAA has approved the MOC defined by criteria in § 450.35—most notably the FSA methods and their compliance to § 450.115(b). The FAA's FSA team can take many months to conduct a two-part review (preliminary screening and Subject Matter Expert review) of each FSA method, making pre-application consultation far longer under part 450 than it did under the previous regulations.

After part 450 was released, not only did the FAA's pre-application process take longer, but applicants generally lost access to AST's technical analysts to ask questions. AST now tells applicants to write their

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[14] The continued presence of the reference to (b)(2)(D) appears to be an error that crept in between 1988 and 2004. As the statutory annotations to 51 USC 50905 explain, when Congress added a new (b)(2)(D) in 2004, and moved the prior language to (b)(2)(E), it neglected to fix the reference in (a)(1) to (b)(2)(E). Cornell notes that "Subsection (b)(2)(D), referred to in subsec. (a)(1), was redesignated subsection (b)(2)(E) by Pub. L. 108–492, § 2(c)(10), Dec. 23, 2004, 118 Stat. 3977.") https://www.law.cornell.edu/uscode/text/51/50905#fn002010 (last checked Jun. 27, 2025). When Congress first referenced (b)(2)(D) in 1988, (b)(2)(D) contained the language now in the current version of (b)(2)(E). Pub. L. 105-303 at 6, 112 Stat. 2848 (Oct. 28, 1988) (adding "'(D) regulations establishing criteria for accepting or rejecting an application for a license under this chapter within 60 days after receipt of such application."). The same amendment added the reference to (b)(2)(D) in paragraph (a)(1), thus showing that Congress originally referred to the correct number and thus to criteria for rejecting or accepting applications within 60 days, as is now contained within (b)(2)(E), not to human space flight regulations. The continued presence of the reference to (b)(2)(D) appears to be an error.

[15] 14 CFR 413.5.

[16] *See also, Commercial Space Launch and Reentry Licensing Regulations*, Congressional Review Service (Jun. 23, 2025) https://www.congress.gov/crs-product/R48582?q=%7B%22search%22%3A%22faa%22%7D&s=2&r=1 .

questions by email, which has often meant weeks before receiving a response. Others have asked for a technical expert to attend certain meetings to provide feedback, but operators are then told that nothing provided verbally counts as a formal or final response. Although AST has established FSA office hours to answer industry questions, AST is adamant that verbal instructions relayed during these sessions do not constitute official agency guidance. This forum is also not appropriate for all issues, particularly vehicle-specific concerns that require discussion of proprietary data. Additionally, different AST staff review pre-application submittals, provide different responses, and may request different or additional detail compared to the previous reviewer. AST licensing leads also frequently change over the protracted period, compounding delay. Industry recognizes that not all applicants have fully formed plans, but pre-application consultations move at a glacial pace even for those who are ready to file an application.

Significantly, AST staff advise that applications cannot be evaluated until AST deems the application "complete enough," which includes the FAA approving MOC. This practice causes a chilling effect. Even if an applicant believes it has satisfied all the information required by the FAA's regulations, having a person who might be reviewing MOC for the application say it is not ready creates a reluctance to officially file the complete application for reasons unrelated to the application's merits. Some applicants will not, for example, want to irritate staff by filing an application already characterized as lacking in some respect. Additionally, the maturity rating is a discouraging metric, with documents the operators consider ready often returned with unexplained low maturity scores.

These examples show that without the discipline of following a statutory deadline, delays accumulate and proliferate. Where Congress contemplated 180 days from start to finish, the FAA has added an amorphous period with no deadlines, so that the review of application drafts takes place repeatedly over months and even years before the 180-day clock starts running. This defies both the plain language of the statute and Congressional intent.

Neither federal law nor the FAA's regulations allow the current situation. Congress mandated 180 days for the FAA to decide whether to grant a license. Congress allows the FAA to establish criteria for rejecting an application within 60 days of receipt. The statutory criteria apply after an applicant files, not before. Accordingly, this provision does not constitute permission to advise an applicant that its license is not ready for filing, to require the review of drafts, or to otherwise delay a filing.

The regulations allow the FAA to respond to a license applicant's failure to provide necessary information. Obviously, if an applicant does not meet the regulatory criteria, the FAA may reject an application. The regulations also allow for a more measured approach by allowing the clock to stop when an applicant owes the FAA additional information. Section 413.15(a) states "[u]nless otherwise specified in this chapter, the FAA reviews and makes a license or permit determination on an accepted application in accordance with the time frame specified in 51 USC 50905(a)(1)," which is the statutory section mandating 180 days. Paragraph (b) of that same regulation states (underline added):

> *Review period tolled*. If an accepted application does not provide sufficient information to continue or complete the reviews or evaluations required by this chapter for a license, permit, or incremental determination, or an issue exists that would affect a determination, the FAA notifies the applicant, in writing, and informs the applicant of any information required to complete the application. If the FAA cannot review an accepted application because of lack of information or for any other reason,

the FAA will toll the review period until the FAA receives the information it needs or the applicant resolves the issue.

In short, if an accepted application does not contain sufficient information, the FAA's regulations allow it to pause the 180-day clock until the FAA receives the necessary information. At one point in AST's history, AST would set a reasonable date by which an applicant was expected to provide the requested missing information, while allowing review of other application materials to continue. If the applicant missed that deadline, the FAA would "stop the clock." This approach had its benefits. It was transparent; both sides knew who was responsible for whether the clock was running. It was fair; if an applicant submitted an incomplete application, it wouldn't have been right to penalize the FAA by claiming the agency was "slow," not meeting its statutory deadline, and had to confess its lapse to the House Committee on Science, Space, and Technology and the Senate Committee on Commerce, Science, and Transportation. Conversely, if an applicant has a complete application and a Congressional mandate for the FAA to decide within 180 days, it is neither fair nor compliant with federal law for the FAA to pressure an applicant to hold off on filing.

The FAA should identify what has incentivized the current state of the process, as described, and eradicate undue burden on applicants. This matters because the FAA's own regulations—which the courts require an agency to follow—state that the FAA will initially screen an application to determine whether it is complete enough for the FAA to start its review. After completing the initial screening, the FAA will notify the applicant in writing of one of the following:

(a) The FAA accepts the application and will initiate review; or

(b) The application is so incomplete or indefinite that the FAA cannot start to evaluate it. The FAA will reject it and notify the applicant, stating each reason for rejecting it and what action the applicant must take for the FAA to accept the application. The FAA may return a rejected application to the applicant or may hold it until the applicant takes the required actions.[17]

In other words, the regulations provide for the FAA to accept an application, unless it is so incomplete or indefinite that the FAA "*cannot start* to evaluate it." (Emphasis added.) Accordingly, under its own rules, the FAA must accept an application if it can start. Additionally, the regulations establish an iterative process that keeps track of who owes what information to whom, and against whom the clock should run. That the FAA has moved this process to take place before the clock even starts defies the plain language of both the statute and the FAA's own regulations while injecting uncertainties and unmonitored points of failure in the application process.

The SpARC recommends that the FAA amend § 413.5 so that pre-application consultation is voluntary, rather than mandatory, for a license applicant**.** Currently, § 413.5 states "A prospective applicant must consult with the FAA before submitting an application to discuss the application process and possible issues relevant to the FAA's licensing or permitting decision." The SpARC recommends that this provision allow for pre-application consultation by changing "must" to "may," so that "A prospective applicant *may* consult with the FAA before submitting an application." (emphasis added).

Although on its face a requirement to consult with the FAA need not conflict with the statute's 180-day

[17] 14 CFR 413.11.

requirement, in practice it does. Even if the FAA were to immediately change its current practices, the FAA should also change this regulation to avoid future episodes of unduly lengthy pre-application consultations.

Section 450.35(a) also conflicts with the statute and with § 413.11 by requiring that MOCs be accepted prior to an application's acceptance. MOC address how the launch operator will satisfy the FAA's safety requirements, which is what an application is intended to demonstrate. The FAA's arbitrary removal of this analysis from the 180-day clock does not conform to the plain language of the statute and should be revised. If the FAA's current approach were acceptable under the statute, it would be permissible for the FAA to move a host of—even all— application requirements outside of the 180-day clock.

The SpARC recommends removing § 450.35(a) in its entirety, so that § 450.35 would contain only the statement currently found in paragraph (b): "A person requesting acceptance of a proposed means of compliance outside a license application must submit the proposed means of compliance to the FAA in a form and manner acceptable to the FAA." Section 450.35(a) creates an unnecessary roadblock to application submission, as FAA reviewers hold MOC—principally, FSA methods—in pre-application review for months to years. Striking § 450.35(a) would allow applicants to submit license applications when ready and help bring FAA practice into compliance with federal law. If applicants desire to submit FSA methods or other MOC to the FAA for approval outside of the license application process, the remaining language in § 450.35 would permit this, as would the incremental review process, assuming the FAA provides guidance that enables use of part 450's incremental process.

The SpARC attests that the FAA will erroneously rely on § 450.35(a) to require that operators not only identify acceptable MOC prior to the acceptance of an application but also require the resulting data-product of the listed MOC categories before the FAA can begin to evaluate the application.

One operator's experience illustrates the peril of the FAA's approach. During pre-application, a launch operator advised the FAA that it would use AC 450-115.1 as its MOC, which provides "one means but not the only means" of meeting this regulation. The FAA did not, however, let the operator file its application. Instead, it required the operator to conduct the full FSA, including outputs that should have been filed with the application. The FAA should have simply agreed that its own AC provided an acceptable MOC as stated in the published document. Similarly, if a launch operator were to ask the FAA to accept a NASA or European Space Agency approach to FSA, and the FAA reviewed and accepted it, under the language of § 450.35, the FAA would be said to have accepted the NASA or ESA MOC and allowed an operator to file its application and start the 180-day clock.

The SpARC considers the use of MOCs as a three-part process. The first step consists of the identification or creation of a MOC, or an approach, an applicant will use to demonstrate satisfaction of an FAA regulation. The approach provided in an AC is an example of an MOC. Adding inputs to the MOC, such as vehicle specifications for a FSA MOC, is the second step; this constitutes development of methodology from an MOC that is implementable by the operator. This is distinct from the approach, or MOC, which is more generic and lacks all the technical data required to execute a methodology and determine outputs. The third and final step is execution of the methodology to produce outputs. For example, a risk number may be a product. As noted in this report, the SpARC recommends the FAA remove § 450.35(a), but the FAA also has options to bring MOC practices in line with the statute's 180-day requirement right away. The FAA could immediately stop asking to see the second and third steps of an applicant's MOC process during pre-application consultation. Section 450.35 says only that an MOC must be accepted prior to an applicant

filing its application. The regulation does not say that an applicant must show the inputs to the MOC, nor actual or representative outputs. Although § 450.35 references other regulatory provisions, that reference does not incorporate those regulations into the pre-application process. Doing so is inconsistent with the 180-day requirement, and the FAA should not apply its regulations in in a way that conflicts with federal law.

In addition to immediately revising current practices, it would help operators and FAA staff if the FAA published guidance verifying that identification of an appropriate means of compliance is a separate step from an applicant's production of deliverables after applying its MOC. Production of deliverables should be a later step, reviewed within the 180-day period because these submissions are not identified as prerequisites for accepting an application in the first place.

The FAA should explore whether it may ignore—without rulemaking—§ 450.35's requirement that the FAA accept a MOC before an applicant files its application. If a regulation violates its governing statute, perhaps an agency should not follow it.

The SpARC recommends the FAA rectify its current practices on two fronts. First, the FAA should stop imposing such a lengthy pre-application process and update § 413.5 to make pre-application consultation voluntary. The regulations do not require applicants to submit draft applications to the FAA; this should be voluntary. No regulatory change is required for the FAA to allow an applicant to decide when to file an application. The decision as to when to file its license application should rest with the applicant alone and not be influenced by the FAA. The industry recognizes that this may result in more applications being denied; appropriate mechanisms for remediating an unsuitable application (tolling, 60-day denial, 120-day notice of defect and request for mitigation) are already in place.

Second, the FAA should remove § 450.35(a) and treat MOC as a potential element of an application rather than a prerequisite for submission. The former is necessary for the FAA to comply with the Congressional requirement. The latter is necessary because, even if the FAA were to correct course and abide by federal law in the immediate future, it might return to using the mandatory nature of pre-application consultation to re-institute current practices.

APPROACH:

Changes to current practice. The FAA should immediately change its current practice of indefinitely extending pre-application consultation to bring itself in line with the Congressional requirement to decide on a license application within 180 days of receipt and its own regulation at § 413.5. The FAA's current pre-application practices inappropriately avoid the 180-day Congressionally mandated deadline and cost the industry and the agency both time and money.

Changes to FAA regulations. The FAA should amend § 413.5 so that pre-application consultation is voluntary, not mandatory, for a license applicant**.** Currently, § 413.5 states "A prospective applicant must consult with the FAA before submitting an application to discuss the application process and possible issues relevant to the FAA's licensing or permitting decision." The SpARC recommends that this provision allow for pre-application consultation by changing "must" to "may," so that "A prospective applicant *may* consult with FAA before submitting an application...." (emphasis added).

The FAA should also remove § 450.35(a) and treat FAA approval of MOC as an element of an application rather than a prerequisite for submitting an application, bringing FAA practice into compliance with the Congressional directive to review license applications within 180 days. This recommendation applies to any MOC, its inputs, and its products.

Changes to legal interpretation. Lastly, the FAA should address whether it is properly applying the 180-day clock to its reviews under the National Environmental Policy Act (NEPA). Section 50905(a)(1) may implicitly repeal those aspects of NEPA that conflict with the statutory deadlines.

REC-P07 Define MOC separately from License Application Material

REC-P07	PROCESS: Given the inherent reliance on the term throughout part 450 and supporting guidance material, the FAA should define "means of compliance" (MOC) and differentiate MOC material from license application material.

INTENT:

The intent is to clarify the FAA's intent and manner of use of "means of compliance" as used throughout Part 450 to satisfy regulatory requirements.

RATIONALE:

The preambles to the Part 450 NPRM and final rule describe a MOC as a prescriptive set of requirements that, if met, satisfy the performance-based requirements contained in the regulation. ***An MOC itself is not a demonstration of compliance***. This is clearly exemplified in other types of MOCs that have been accepted by AST, which include FAA ACs, legacy regulations, and government standards, none of which include vehicle-specific data or a demonstration of compliance. For example, NASA-STD-4010, accepted by AST in accordance with § 450.35, does not utilize vehicle-specific data or information on implementation to justify its approach to mitigating lightning hazards.

The Part 450 NPRM states that when the FAA reviews a unique MOC, the FAA will take into account such factors as complexity of the MOC, whether the MOC is an industry, government, or voluntary consensus standard, and whether the MOC is peer-reviewed to determine if the MOC satisfies the *regulatory* safety standard.[18] The final rule provides even more detailed insight:

> When submitting a unique means of compliance, an applicant's proposal should identify the regulation that the proposed means of compliance will address and provide the rationale as to why it demonstrates compliance with the applicable regulation. When reviewing a unique means of compliance, the FAA will consider past engineering practices, the technical quality of the proposal to demonstrate compliance with the part 450 regulations, the safety risk of the proposal, best practice history, and consultations with technical specialists for additional guidance.[19]

This description indicates that review of a unique MOC is not intended to evaluate whether an MOC *can* or *should* be used for a specific vehicle/application but rather determine whether the MOC *may* be used to satisfy the regulatory requirement more generally. In other words, a MOC should be evaluated for its viability as a sound practice and not based on the outcomes it yields for a given vehicle or operation. If an MOC produces results for a particular vehicle that violate regulated thresholds, such as risk requirements, it is not a reflection of the validity or quality of the MOC but rather concludes the MOC is not applicable to the vehicle or operation.

Further, AST often uses the terms "methodology" and "MOC" interchangeably in reference to FSA requirements, and its published guidance is divided on whether these terms are synonymous. For example,

[18] 84 FR 153304, April 15, 2019.
[19] 85 FR 75988, December 10, 2020.

AC 413.13-1 states that the objective criteria to determine application completeness is to ask: "Does the methodology reference an accepted means of compliance?" This text presumes that "methodology" and "MOC" are distinct concepts. However, this is later contradicted in section 11.3.5 of the same AC 413.13- 1, which states the following with regards to FSA MOCs:

> In accordance with § 450.35(a)(1), the FAA will only accept an application that uses previously accepted flight safety analysis *methodologies* for all sub-analyses for all phases of flight.[20]

Section 450.35 is titled "Means of compliance" implying here that "methodologies" *are* equivalent to MOC, which is in direct conflict with the previous quote. The contradictions continue in § 450.35(a)(1), which ties MOC acceptance to § 450.115(b)(1), a requirement where an:

> [FSA] method must have a level of fidelity sufficient to demonstrate that any risk to the public satisfies the safety criteria of § 450.101, including the use of mitigations, accounting for all known sources of uncertainty, using a means of compliance accepted by the Administrator.

This therefore ties *results* of an analysis approach to the definition of MOC.

Yet if operators turn to AC 450.115-1B, the guidance presents steps for how to perform a high-fidelity FSA and addresses what must be accounted for in each sub-analysis but notably *does not* include a description of methods for each FSA sub-analysis that meets § 450.115(c). Instead, Section 6.1 of AC 450.115-1B contains the steps to perform a high-fidelity FSA method and references AC 450.131-1, AC 450.117-1, AC 450.119-1 (which does not exist), and AC 450.108-1, which are accepted means of compliance for their respective sub-analyses. This guidance does not tie results to satisfaction of § 450.115(b).

Notably, the FAA already has a definition of MOC for Remote ID drones. Per FAA's website:

> A Remote ID MOC describes the methods by which a person complies with the performance-based requirements for Remote ID. These performance-based requirements indicate the desired outcomes, goals, and results for Remote ID without establishing a specific means or process for regulated entities to follow. Anyone may submit a Remote ID MOC to the FAA for evaluation and possible acceptance. In particular, the FAA encourages consensus standards bodies to develop Remote ID MOC and submit for acceptance because these bodies generally incorporate openness, balance, due process, appeals process, and peer review.[21]

While this text still conflates "methods" and "MOC," the lack of specificity encouraged by this guidance is in alignment with operators' recommendation to distinguish MOC as general approaches from more vehicle- or operation-specific license application material. AC 89-1 "Means of Compliance Process for Remote Identification of Unmanned Aircraft" provides guidance of the material an operator should address in its proposed MOC, including a description and justification of an approach, supporting documentation (e.g. design, testing, analysis, and validation material), and compliance with the applicable performance requirements of part 89. This implies an MOC is generic enough to be scoped beyond a single operator.

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[20] FAA. Advisory Circular 413.11, *Guidance on Submitting a Complete Enough and Complete Application for a Vehicle Operator License,* (12-18-2023) p. 33.
[21] *Remote ID for Industry and Standards Bodies*, FAA (last accessed Oct. 20, 2025) https://www.faa.gov/uas/getting_started/remote_id/industry.

To summarize, AST has published a variety of contradictory literature on the definition of MOC as well as the *differentiation* of MOC material from methods or other application material. This should be rectified in a rulemaking with a new definition for MOC and updates to guidance that clarifies the relationship between MOC and application material. The SpARC asserts operators should be able to use an MOC to satisfy respective regulations if their operations are within the appropriate scope of the MOC. For example, MOCs may be scoped to a vehicle type, operation type, or other metric within a specified range of parameters, but an MOC should not be so narrowly scoped to limit it to a single vehicle, operation, or mission. MOCs should also be evaluated by AST independent of the results they yield and instead focus on the technical validity of the approach at high level without representative data.

APPROACH:

The FAA should regulatorily define MOC as an approach used to satisfy one or more sections or subsections of part 450. Thus, every requirement would have a MOC, and MOCs are inherently independent of license application material. The FAA should then correct all published guidance to align with this revision, ensuring consistent use of "MOC" and "method."

The FAA should also review other uses of MOC within FAA materials, such as the Remote ID drone example provided in this document, to synchronize its approach across the agency and draw inspiration for any MOC review process improvements and lessons learned from outside AST.

Lastly, the FAA should remove § 450.35(a) and treat MOCs as elements of a license application to be reviewed during the 180-day review period. Alternatively, should the FAA retain all or part of § 450.35(a), the SpARC urges the FAA to remove the reference to § 450.115(b) so that FSA MOCs do not need to demonstrate compliance to risk criteria for licenses to be accepted by the FAA. As discussed in other sections of this report, the FAA's protracted FSA methodology review keeps applicants in the pre-application stage months to years before they can begin the 180-day review. The FAA's practice of requiring representative outputs and exorbitant amounts of data for FSA methods at the MOC stage frontloads FSA review in contravention of the regulatory text regarding MOC and skirts Congress's directive that FAA review license applications for no more than 180 days.

REC-R04 Redefine scope of mishap

REC-R04	REGULATORY TEXT: The FAA should redefine "mishap" to apply to a more clearly defined set of events.

INTENT:

The intent is to remove undue burden on licensees and FAA inspectors by narrowing the pool of events constituting a "mishap" under § 401.7 to those which may impact public safety.

RATIONALE:

In today's dynamic world of space exploration and innovation, failure is an option so long as public safety is maintained. However, the existing definition of "mishap" in § 401.7 is so broad and punishing that it has a chilling effect on commercial launch and reentry operators. The FAA should remove overly conservative language in the definition of "mishap" in § 401.7 that precludes operators from failing safely without substantial pre-coordination under § 450.175. Specifically, the FAA should modify subsections 3 and 5 of the definition to reduce its scope and strike subsections 6 and 7 to avoid punishing operators that fail safely.

The SpARC recommends these revisions to limit the determination of a mishap to events posing an increased risk to public safety or property. The SpARC recommends revising subsections 3 and 5 to improve clarity and remove uncertainty in whether a mishap has occurred. For example, "substantial damage" can easily be determined by whether a claim has been filed against an operator's mandatory Maximum Probable Loss insurance under § 440, also allowing for the deletion of the word "substantial." Additionally, as written, subsection 3 is overbroad in that it could be read to include a wide range of minute discrepancies having no bearing on the overall success of the licensed activity, much less public safety risk.

The SpARC recommends removing subsections 6 and 7 entirely to promote safe and rapid development of vehicles. If an operator chooses to adopt a "hardware rich" development campaign, and it does so safely by retaining failures within pre-defined hazard areas, it should not be artificially punished by being required to initiate a mishap investigation and grounding the vehicle. Rather, those failures should be handled under the scope of an "anomaly."

Current subsection 9 would be renumbered as subsection 7, and the SpARC recommends the FAA connect this criterion to the preflight reporting requirement in § 450.213(b) to avoid overbroad application and ambiguity as to whether an event qualifies as a mishap.

The SpARC notes that events occurring outside of the de-scoped language below would not be removed from safety considerations. Rather, those events would fall under the broader, less punishing definition of "anomaly." This change would adequately preserve public safety by requiring a formal mishap investigation in scenarios that impact public safety, while allowing operators to fail safely and resolve de-scoped events as anomalies instead.

APPROACH:

The SpARC recommends the FAA revise the definition of "mishap" in § 401.7. Recommended regulatory text is provided in Appendix A.

REC-R05 Redefine ‘Safety Critical’

REC-R05	REGULATORY TEXT: The FAA should redefine “safety critical” to minimize scope of compliance evidence for risks that are thoroughly mitigated.

INTENT:

The intent is to narrow the definition of “safety critical” in § 401.7 so that it considers systems after mitigations are applied, rather than before, thereby avoiding FAA regulation beyond what is necessary to protect public safety.

RATIONALE:

The FAA’s definition of “safety critical” is too broad, leading to overregulation with no meaningful safety benefit. Allowing for the consideration of hazard control strategies or other mitigations would significantly reduce redundant documentation requirements without impacting safety.

As written, the definition does not clearly allow for a system to be exempt from its scope after implementation of a hazard control strategy or other mitigation that nullifies associated public risk. This has led to the FAA identifying systems that are sufficiently mitigated, and thus not “essential” to public safety, as safety critical. For example, a typical expendable launch vehicle will launch from the coastline and almost never overfly uncontrolled areas again until it is nearly orbital and beyond the flight termination “safety gate.” Thus, the typical hazard control strategy for the entire system is flight abort. Therefore, the only safety critical systems on an expendable launch vehicle in this concept of operations should be its flight termination system and the tracking, telemetry, and data processing systems that feed it.

The FAA has disagreed with this argument several times based on a textualist interpretation of the definition of “safety critical” – identifying the vehicle’s engines, structure, and fluid systems as safety critical. However, a failure of any of these systems that would result in an inability to achieve a useful mission would be resolved with flight termination, preserving public safety and making identification of these systems as safety critical redundant, overburdensome, and unnecessary.

The FAA has applied the term, “safety critical,” to systems tangential to those used for flight abort, increasing the potential documentation required to meet the FAA’s system safety requirements. Critically, this burden is compounded for reentry vehicle operators because beyond the baseline qualification and acceptance testing requirements for all operators, reusable vehicle operators must provide additional reusability analysis.

Lacking the clarity required to better identify and enforce the use of “safety critical” across licensing, the FAA’s approach, at times, resembles certification-like approaches to regulation. This is counter to statute, which limits the FAA’s authority to regulate for public safety rather than for mission assurance.

To alleviate undue burden on applicants with no material benefit to public safety, the FAA should narrow the definition of “safety critical” in § 401.7 to only consider systems in light of the mitigation applied. The FAA should only consider “safety critical” those systems, components, functions, operations, etc. that are necessary to mitigate a catastrophic hazard to ensure compliance with § 450.101, or whose malfunction

may cause a catastrophic hazard that cannot be mitigated to meet § 450.101. This recommendation should be read in connection with the SpARC's proposal to consolidate and simplify the FAA's system-safety requirements under § 450.107 and strike § 450.143.

APPROACH:

The SpARC recommends the FAA alter this definition to only identify safety critical systems *after* hazard control strategies or other mitigations are implemented. De-scoping this definition would remove undue burden on applicants with no material impact on public safety, while also leveraging the system safety process for identifying hazards. Recommended redlines are provided in Appendix A.

REC-R06 Revise Scope of Reentry Operations

REC-R06	REGULATORY TEXT: The FAA should revise scope of reentry in § 450.3(c) to enhance clarity, include all relevant public safety risks, and exclude operational and vehicle status not relevant to public safety.

INTENT:

The FAA should revise the scope of reentry licensing to improve clarity, align with the scope of launch licensing in § 450.3(b), and de-scope activities having no material impact on public safety.

RATIONALE:

As currently written, reentry scope "includes activities conducted in Earth orbit or outer space to determine reentry readiness and that are critical to ensuring public health and safety and the safety of property during reentry flight. Reentry also includes activities necessary to return the reentry vehicle, or vehicle component, to a safe condition on the ground after impact or landing."

Beginning of scope: The language "to determine reentry readiness" is open-ended and ambiguous. Reentry vehicle performance may be assessed from the time it first achieves orbit, as the vehicle is subject to verifications of systems and functions considered safety-critical for reentry. Multiple system assessments are also conducted during on-orbit operations. Such operations do not impact public safety and are analogous to launch vehicle testing that occurs prior to launch operations.

For comparison, the beginning of launch operations occurs at the first point a public hazard is introduced, and launch is imminent. Reentry vehicles have multiple phases of operations prior to reentry that do not impact public safety, such as on-orbit functions and undocking from orbital platforms. None of these operations imply that reentry is imminent, as the vehicle may not be in the same orbit or correct Right Ascension of the Ascending Node (RAAN) to enable the planned return trajectory. Because there are no hazardous operations prior to deorbit, it is reasonable to use logic that places launch conditions in reverse order: imminent reentry is first, followed by public safety risk. Rather than each operator defining and the FAA coordinating a unique operation that initiates reentry license scope, the SpARC, with the intent to avoid work that does not improve public safety, finds it necessary to narrow on-orbit scope to the readiness poll for deorbit/reentry. If commit criteria assessment shows that all public safety risks and mitigations are acceptable, reentry can be considered imminent; if not deemed safe, the vehicle will stay in orbit without presenting public safety risk. With this, reentry scope should begin with the initiation of a maneuver that intends to result in reentry or impact on Earth—an activity that occurs after a readiness poll.

End of scope: If the vehicle reenters and lands or impacts, license scope includes return of the vehicle to a safe condition; however, these activities are not always conducted on the ground; some are at sea. For a vehicle capable of creating a public hazard (e.g., potential explosion or toxic release), license scope is implied through verification of a safe vehicle or control of the hazard to mitigate public risk. .

If initiation of a deorbit maneuver does not result in reentry, but will be reattempted, then the FAA should treat this situation like a launch scrub, with reentry ending after activities necessary to return the vehicle to a safe condition on orbit prior to another attempt. This includes both the situation of a deorbit burn scrub and an incomplete deorbit burn that leaves the reentry vehicle in a stable orbit. If a reentry vehicle

experiences an incomplete deorbit burn that did not result in imminent reentry, updated orbital parameters and revised deorbit maneuver plans (if applicable) should be supplied for collision avoidance analysis as part of returning the vehicle to a safe configuration on orbit. If a deorbit is unsuccessful and will not be reattempted, then reentry license scope should end with on-orbit safing or passivation of the vehicle in a matter akin to the requirements of § 450.171(a) for launch vehicles.

APPROACH:

Recommended redlines are provided in Appendix A.

REC-R07 ELOS Determination Procedure

REC-R07	REGULATORY TEXT: The FAA should revise § 450.37 to provide written notice and justification to applicants when the FAA makes a determination on an Equivalent Level of Safety (ELOS) under this provision.

INTENT:

The intent is to improve transparency and consistency in how the FAA reaches ELOS determinations, as well as operator application quality.

RATIONALE:

The FAA's procedures for evaluating and issuing ELOS findings in connection with part 450 applications are entirely opaque. While § 450.37 identifies the criteria the FAA applies to find ELOS in operator MOC or licensing material, the regulation is silent as to whether an applicant must request an ELOS versus allowing the FAA to issue them *sua sponte*. SpARC members have seen the FAA reach ELOS determinations by both means. The FAA generally confirms whether they granted or denied the ELOS, but that practice is inconsistent and the FAA rarely includes written justifications for its decisions. Understanding what aspects of an applicant's alternative approach led to the FAA finding safety equivalence is essential to developing regulatorily compliant applications and understanding whether and to what extent any deviations from that approach will require license modifications down the line. Requiring the FAA staff to provide written justifications whenever they find an ELOS would enhance transparency and consistency—which are essential for good government as well as for industry operations.

APPROACH:

The FAA should add paragraph (c) to § 450.37 to read, "FAA shall provide the applicant with written notice and justification for its decision whenever the FAA grants or denies an equivalent level of safety."

REC-R08/REC-P08/REC-P09 Clarify Evaluation of Federal Services for Compliance

REC-R08	REGULATORY TEXT: The FAA should provide additional flexibility for operators utilizing federal launch or reentry sites, or other federal entities providing services or facilities under contract to the operator.
REC-P08	PROCESS: The FAA should maintain documentation of all federal agency services and facilities reviewed or under review by AST for compliance with FAA requirements.
REC-P09	PROCESS: The FAA should formalize the adjudication processes to leverage analyses beyond the scope of public safety to satisfy applicable public safety requirements.

INTENT:

The intent is to provide explicit acknowledgement of federal government agencies providing services and facilities without implication of operator responsibility to facilitate discussions on compliance or equivalence to FAA requirements.

RATIONALE:

While the FAA has issued notices of determination regarding acceptance of practices at major federal launch ranges, additional services at those ranges remain that fulfill licensing requirements but have not been publicly accepted by the FAA. Additionally, other federal agencies (primarily DoD and NASA) provide services and facilities under support agreements with launch and reentry operators. Examples of these services include approving hazardous procedures, providing hazard area surveillance and control, responding to hazardous conditions, performing safety analysis, and even providing vehicle command and control.

Industry has limited insight into the extent of interagency coordination occurring between AST and these agencies but agrees that operators should not be involved in defending compliance or serving as a go-between to facilitate AST discussion on acceptance of their services. While § 450.45(b) currently allows for operator use of accepted federal agency facilities and services, it does not provide for evaluation of such services with a goal of acceptance. The potential result is operators taking on the burden to demonstrate compliance, and the risk of delays and eventual non-acceptance that could cause significant operator schedule and cost impact.

The FAA has struggled with leveraging system safety documentation in NASA/DoD formats developed for mission assurance and/or crew safety purposes, such as hazard reports and Probabalistic Risk Assessment (PRA), that also satisfy public safety requirements. This has created gaps in capturing adjudications for public safety when the formats are not consistent with FAA standards, leading to difficulty in crediting an operator's probability of failure (PoF) using industry standard system safety processes and flight hazard analyses. Leveraging such government data products could significantly reduce operator PoF analysis efforts and improve FAA's efficiency in reviewing flight risk mitigation pertinent to functional/flight hazard analysis and FSA.

APPROACH:

The FAA should revise § 450.45(b) to reflect FAA evaluation of federal agency-provided services or property.

The FAA should provide and maintain publicly available documentation on each federal agency and regulatory section(s) under which determination is/was sought, disposition of the evaluation (e.g., under review with ECD, complete), determination (accepted, waiver, non-compliant), and notes/rationale for items not accepted. This would enable operators to quickly assess accepted and approval-pending services to determine if implementation is practical in the time allotted.

The FAA should update ACs to reflect adjudications of non-public safety standards that meet public safety requirements, and develop a crosswalk map to identify overlaps between FAA public safety requirements and other safety and mission assurance standards.

Incorporate USG mission assurance data, where relevant, to credit operators' PoF with system safety processes.

REC-R09/REC-G07 Limit Duplicative Authority for Hybrid Vehicles

REC-R09	REGULATORY TEXT: The FAA should adopt language in § 450.45 accepting FAA airworthiness decisions, without further showing, for aircraft used as components of launch vehicles licensed under part 450.
REC-G07	GUIDANCE: If REC-R10 is not accepted, the FAA should issue an AC or other guidance describing a process for accepting FAA airworthiness determinations without further showing by the applicant.

INTENT:

The FAA should establish a mechanism for accepting FAA airworthiness determinations as presumptively appropriate for determining that aircraft used as components of launch vehicles licensed under part 450 need not make additional showing that the maintenance, air crew certifications, operations areas, or other controlling strictures contained in airworthiness determinations authorizing their safe operation are appropriate for similar operation of such vehicles during activities licensed under part 450.

RATIONALE:

Efficient government requires that the FAA/AST take full advantage of the regulatory and operational determinations made by other parts of the FAA. AST must recognize those organizations' ongoing oversight role for advancing public safety to ensure its licensing regime is efficient and effective, and that it maximizes the use of the FAA's limited resources. The aircraft airworthiness certification and operational processes, including those for experimental aircraft, are highly effective in protecting public safety. However, AST generally does not recognize these processes as applicable to the safety of hybrid launch vehicles licensed under part 450.

There are currently over 33,000 aircraft with experimental airworthiness certifications issued by the FAA's Office of Aviation Safety (AVS), and these aircraft routinely operate safely in the national airspace under the approvals granted by AVS, and in accordance with the airspace requirements, routes, airspace procedures, and clearances issued by the FAA's Air Traffic Organization (ATO).[22] These approvals and operations are authorized in accordance with FAA's aviation regulations, including parts 21 and 91, and the procedures put forth for aviation safety inspectors in FAA Order 8130.2K, Airworthiness Certification of Aircraft. This order provides instructions for FAA safety inspectors evaluating and completing airworthiness certification for any aircraft, including experimental and other special use aircraft.

FAA Order 8130.2K contains prudent, yet rigorous, procedures for experimental approval and operating privileges that protect public safety. These procedures start with the review of an initial application for airworthiness certification, to FAA inspections of the vehicle and its documentation, leading to its initial airworthiness approval and its associated operating limitations. Following initial approval, FAA Order 8130.2K states:

[22] Experimental Aircraft Information, Experimental Aircraft Association, https://www.eaa.org/eaa/about-eaa/eaa-media-room/experimental-aircraft-information.

> Section 91.319 requires that an experimental aircraft be assigned to a flight test area until it is shown that the aircraft is controllable throughout its normal range of speeds, is controllable throughout all maneuvers to be executed, and has no hazardous operating characteristics or design features. Per § 91.305, verify the assigned test area includes only open water, or sparsely populated areas, and having light air traffic.[23]

The order further outlines the process to coordinate additional needs and safety considerations, such as additional flight test areas, routes of flight, and management of hazards or flight from airports in or near densely populated areas as the aircraft demonstrates its capabilities under its authorized initial test program.

The scope of approval and limitations are managed through the experimental airworthiness certificate and its stated limitations, program letters, and other auditable documentation that specify range of operational, maintenance, and other procedures that must be followed as the aircraft moves through its initial program and into more expansive operations. The FAA inspectors may witness flights, inspect the aircraft or documentation at their discretion at any time during or after its initial test program. The aircraft is confined to its defined flight test area until such time that it can successfully complete its program, based upon the type and complexity of the aircraft, its mission, and the testing. Once the applicant has shown that the aircraft can comply with § 91.319(b), is controllable throughout its normal range of speeds and planned maneuvers; and has no hazardous operating characteristics or design features, the FAA can modify the airworthiness certificate and operating limitations upon applicant's request. This allows the aircraft to operate beyond the initial flight test area(s) and execute additional missions consistent with its intended purpose(s). The applicant must ensure that the aircraft is always operated and maintained in accordance with all regulations and any other terms, conditions, or limitations associated with its airworthiness certificate and its FAA approval, including air traffic control requirements.

Elements of hybrid launch systems – notably carrier aircraft – typically obtain an FAA experimental airworthiness certification to support the system validation and for other necessary operations. Their testing programs are conducted under AVS regulatory oversight. The programs are extensive and go well beyond basic airworthiness determinations. These comprehensive programs typically validate all aspects of their intended use in support of spaceflight missions, including demonstrating and understanding their ability to support the full flight and operational environment of captive carry operations. This includes carrying rockets or other flight vehicles throughout the flight envelope, launch vehicle fueling and unfueling, return to base operations with or without the launch vehicle, simulated failure scenarios, and simulated launch and vehicle drop testing. Note that FAA Order 8120.2K contains provisions for the safe management of vehicles with explosive devices and jettisonable stores.

Instead of relying on this work by AVS and the applicant in the application evaluation processes, AST requires the applicant to duplicate this work and requires its limited staff to re-evaluate that work using different models and methods. This requires significant expenditure of resources, along with regulatory uncertainty, with no material benefit to public safety. By ignoring the demonstrated reliability and safety of an aircraft that already has FAA airworthiness and operational approval to fly any day in the national

[23] Federal Aviation Administration, *FAA Order 8130.2L, Airworthiness Certification of Products and Articles*, ch. 4 (superseding FAA Order 8130.2K), discussing compliance with 14 C.F.R. §§ 91.319 and 91.305.

airspace within the bounds of its authorized limitations, AST is inappropriately disregarding the FAA's own findings.

Although the FAA purported to take a more flexible approach with part 450, the FAA has asked applicants to fit into their numerically based reliability and safety assessment scheme or pursue waivers or ELOS. The same issue occurs for demonstrating the safety critical features of the carrier aircraft using the flight test process. Despite saying the rules are performance based and flexible, they instruct applicants to seek an ELOS for the provisions of § 450.143. By AST's own admission, alternate approaches for captive carrier aircraft meet the safety performance goals of part 450 and are in the public interest. Because waivers and ELOS are more burdensome for both the applicant and the FAA, especially compared to compliance with appropriately stated safety objectives, it is incumbent upon the FAA to clarify safety performance objectives in the rules, while increasing the efficiency and effectiveness of launch licensing under part 450. Fully leveraging existing safety approvals made by other organizations within the FAA will allow them to do just that for critical aspects of hybrid launch systems regulation.

APPROACH:

The FAA should adopt language in § 450.45 to establish that other FAA airworthiness decisions shall be accepted, without further showing, to provide for the appropriateness of the specific MOCs for which they are proffered. The SpARC recommends that such language mirror the following language to the extent possible:

> *§ 450.45(c): Reliance on other FAA approvals***.** The Office of Commercial Space Transportation shall accept, without further showing, any current airworthiness and operational approvals from the Office of Aviation Safety and the Air Traffic Organization for use in launch licensing determinations and subsequent operations under this part.

The FAA should also issue agency guidance in the form of an AC that describes a process for accepting other FAA airworthiness determinations. The guidance should include the following explanation regarding the applicability of the regulation:

> A vehicle subject to an FAA airworthiness determination is exempt from licensing requirements if it is used as a component of a launch or reentry system, and:
>
> - The vehicle has a valid FAA-issued airworthiness certificate;
> - The vehicle is operated in accordance with the approved operational procedures and airworthiness limitations issued by the Office of Aviation Safety;
> - The vehicle is operated along transit routes and within approved operational areas designated by the Air Traffic Organization; and,
>
> Any airworthiness limitation on the vehicle's use for compensation or hire shall not apply for the purpose of the launch licensing determination or launch operations.
>
> Operation of the subject vehicle shall require documentation of informed consent of all space flight participants in accordance with § 460.45, notwithstanding any contrary provision of an airworthiness certificate or the regulations or requirements under which such certificate is issued.

- AST shall coordinate with launch and reentry service providers to identify which sections of 14 CFR part 450 shall be subject to this section.

REC-P10/REC-R10 Limit NEPA Application

REC-P10	PROCESS: The FAA should limit the scope of content in required environmental reviews, limiting it to activities within its regulatory authority and eliminating duplication with safety requirements already addressed in other subparts.
REC-R10	REGULATORY TEXT: The FAA should revise § 450.47 to expand the application of categorical exclusions and to reflect FAA acceptance of preexisting environmental approvals by other federal agencies as applicable.

INTENT:

The intent is to reduce the scope of environmental review under § 450.47 to the environmental impact of the proposed licensed activities not already addressed within existing federal environmental approvals. This would reduce effort and costs to industry and the government associated with developing and reviewing NEPA documentation beyond the scope of AST's regulatory authority.

RATIONALE:

In the course of applying NEPA requirements to commercial space operations, the FAA has required extensive NEPA documentation, including activities unrelated to establishing facilities for or conducting launch and reentry operations. Examples include assessing air quality for indirect sources of emissions such as construction vehicles, employee commuting vehicles, and surface vessels supporting delivery or retrieval of flight hardware.

In addition, requiring applicants to identify aircraft and surface vessel hazard areas to comply with NEPA duplicates documentation already required for Safety Review, subjecting the already lengthy environmental review process to out-of-cycle updates once hazard areas have been calculated and resulting in additional delay. The subject hazard areas, which may differ between missions or be reduced over time, are not a direct indication of spaceflight impact on the environment. Not only is air quality impact from rerouting aircraft or surface vessels a downstream effect within the regulatory authority of AST, but the FAA Air Traffic Organization reports that impact to aviation from space operations is consistent with that from weather systems.[24]

Although these specific areas of assessment are not dictated by FAA Order 1050.1G Environmental Impacts: Policies and Procedures, they have become standard practice reflecting scope growth beyond the information required in the order.

In May, the United States Supreme Court's decision in the case *Seven County Infrastructure Coalition v. Eagle County* clarified that NEPA compliance does not necessitate analysis of environmental effects of

[24] T.J. Furr, *Evaluating NAS Delay Impacts from Orbital Launch* (doctoral thesis, Florida Institute of Technology, 2022), https://repository.fit.edu/cgi/viewcontent.cgi?article=1016&context=etd.

projects and activities upstream and downstream of the proposed project for which the agency conducting NEPA review exercises regulatory authority[25].

Additionally, a Council on Environmental Quality (CEQ) interim final rule (IFR) effective April 11, 2025, rescinded all government-wide regulations implementing NEPA, giving individual agencies flexibility in navigating NEPA compliance. This is consistent with the Executive Order, *Enabling Competition in the Commercial Space Industry*, Section 3: Reforming Regulatory Barriers to Commercial Launch and Reentry.

Finally, Part 450 requires approved FAA NEPA documentation, not recognizing that the same flight operations may have been conducted for the government prior to commercial licensing. If the proposed activity is enveloped by a NEPA review conducted by another federal agency, then no additional review should be required, unless the applicant proposes additional scope beyond the existing NEPA document.

APPROACH:

Consistent with the May 2025 Executive Order and April 2025 CEQ IFR, FAA should immediately eliminate NEPA documentation requirements that exceed the scope of its regulatory authority for commercial space activities or duplicate documentation required by other sections of part 450.[26]

Similarly, the FAA should streamline NEPA review to the maximum extent by expanding the availability of categorical exclusions and to reflect FAA acceptance of preexisting environmental approvals by other federal agencies as applicable. To this end, the FAA should revise §§ 450.47(c) and (d) as follows:

> § *450.47 Environmental review*.
>
> […]
>
> (c) *Categorical exclusion.* The FAA may determine that a categorical exclusion is appropriate upon receipt of supporting information from an applicant. The FAA may adopt categorical exclusions from other Federal agencies for similar major federal actions according to the requirements of NEPA Section 109. The FAA may determine that a categorical exclusion is appropriate for major federal actions similar to previous major federal actions for which the FAA has issued a finding of no significant impact (FONSI).
>
> (d) *Application requirements*. An application must include an approved Environmental Assessment, Environmental Impact Statement, categorical exclusion determination, or written re-evaluation, which should address compliance with any other applicable environmental laws and executive orders covering all planned licensed activities in compliance with NEPA.

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[25] *Seven County Infrastructure Coalition et al. v. Eagle County, Colorado,* No. 23-975, slip op. (U.S. May 29, 2025), https://www.supremecourt.gov/opinions/24pdf/23-975_m648.pdf

[26] Updating Permitting Technology for the 21st Century, Presidential Memorandum, The White House (Apr. 15, 2025), https://www.whitehouse.gov/presidential-actions/2025/04/updating-permitting-technology-for-the-21st-century/; Enabling Competition in the Commercial Space Industry, Executive Order 14335, The White House (Aug. 13, 2025), https://www.whitehouse.gov/presidential-actions/2025/08/enabling-competition-in-the-commercial-space-industry/.

VIII. Recommendations - Safety Regulations – Risk Criteria

REC-P11 Review Risk Criteria

REC-P11	PROCESS: The FAA should continually review risk thresholds and their justifications, regulating only to the extent that safety requires.

INTENT:

To ensure that the risk thresholds (or "safety criteria") bounding launch and reentry operations are no more restrictive than necessary, given current technology.

RATIONALE:

The risk thresholds in §§ 450.101(a) and (b) reflect those adopted by Federal Ranges over 15 years ago. Given the extent to which our collective understanding of launch and reentry has grown, including major technological advancements, the SpARC has identified that these values may constrain the country's ability to expand access to space for civil, defense, and commercial uses. Overly restrictive risk criteria inhibit launch and reentry activity, hindering the development of industries upon which we increasingly rely (e.g. GPS, satellite comms, weather tracking). Overly conservative thresholds for land overflight also incentivize operators to conduct almost all launch and reentry operations over the ocean – often in many of the same spots if launching from the Cape, which creates heightened ocean risk. As interest in inland launch increases to build further U.S. launch capacity, there are real questions about feasibility under existing risk terms.

Further, the FAA expanded the scope of launch and reentry operators' risk analysis under § 450.101 by incorporating risk to maritime vessels outside the launch or landing areas. The consideration of these new sources of risk was not matched by changes to the risk thresholds in §§ 450.101(a) or (b); nor did FAA provide justification for its decision to retain these thresholds. Requiring operators to fit additional sources of risk within the same risk criteria means that launch and reentry operations previously approved under the legacy regulations (i.e. 14 CFR parts 417, 431, etc.) may not be allowed under part 450 or may be subject to mitigations or other operational restrictions that were not required under the previous regulations. Having to account for additional maritime risk also limits the days and/or times in which launches can take place, increasing operators' costs due to lost launch opportunities.

The FAA also presented an alternative approach to risk criteria for SpARC consideration: establishing limits per mission as a function of capability (e.g. mass to LEO for launch), with industry-wide allowable annual risk "budget" commensurate with value to the nation of industry as compared to other transportation industries. Some SpARC members were intrigued by the notion of establishing criteria per operation based on capability, benchmarking risk versus capability relationship, instead of a stagnant risk criterion. However, the SpARC members ultimately did not unanimously agree with any approach.

The SpARC encourages the FAA to continue to evaluate if an increase to risk criteria could be appropriate based on growing economic and technological criticality of the industry and/or the growing body of supporting data. A focus should be on whether the values sufficiently account for higher fidelity analysis methods and the growing dataset available for use in justifying the circumstances under which an increase to risk criteria or dynamic risk criteria would be appropriate.

APPROACH:

The FAA should continually review the risk thresholds in §§ 450.101(a) and (b) and the underlying justifications to ensure that these bounding criteria are no more restrictive than necessary, given current technology. The FAA should consider increased risk thresholds with updated justification for the values, given increased sources of risk not previously considered under legacy launch and reentry requirements..

The FAA should also amend the risk thresholds to account for increased sources of risk not previously considered under the legacy launch and reentry requirements or revert to accepted legacy maritime surveillance practices. In either instance, the FAA should provide written justification for its determination.

REC-R11 Redefine High Consequence Event Protection

REC-R11	REGULATORY TEXT: The FAA should define "high consequence event" and amend § 450.101(c) to improve its applicability to all licensed operations.

INTENT:

To clarify the intent of the high consequence event protection requirement in § 450.101(c) and improve its applicability to all activities licensable under part 450, thereby reducing the need for waivers or equivalent levels of safety (ELOS) for reentry and hybrid operators.

RATIONALE:

The FAA's addition of the requirement in § 450.101(c) to protect against high consequence events using conditional expected casualties (CEc) has proven challenging, if not unworkable, for reentry and hybrid operators. As stated in the preamble to the part 450 final rule, the FAA introduced CEc as a means of quantitatively demonstrating when a flight safety system (FSS) may be unnecessary to protect public safety.[27] Ultimately, after several changes from the proposed rules, the final § 450.101(c) provides three means of protecting against high consequence events: use of flight abort in accordance with § 450.108, ensuring the consequence of any reasonably foreseeable failure mode in any significant failure mode is no greater than 1×10^{-3} CEc, or demonstrating sufficient reliability to the Administrator based on CEc criteria during that phase of flight.

While these three options can work well for vertical launch operations, none of them is suitable to reentry or hybrid launch operations. CEc calculations have proven virtually impossible for reentry operations due to the breadth of analysis, which includes all uncontrolled areas of land which could be impacted by reentering debris, and the value of the threshold, which is exceedingly low relative to normal land overflight that occurs during reentry operations. Unless an operator can satisfy either of the CEc criteria in § 450.101(c), the only way to meet § 450.101(c) is to use flight abort, which may not be an option for reentry and hybrid operators for mission assurance purposes . As a result, certain previously licensed reentry and hybrid operations are no longer allowed under part 450, and operators routinely seek waivers or ELOS for this requirement. This is further compounded by the FAA's omission from § 450.101(c) the option to use system safety methodologies to demonstrate a mitigation of hazards, which the FAA previously allowed under the legacy regulations.

To improve the applicability of § 450.101(c) to all licensed operations and reduce the need for waivers and ELOS, the FAA should replace § 450.101(c) with a performance-based metric and move the options outlined in current § 450.101(c)(1)-(3) to an AC, along with any other means of compliance that the FAA might accept for high consequence event protection. In lieu of the quantitative CEc value, the SpARC recommends FAA align the threshold for high consequence event protection with that currently used in §§ 450.109 and 450.143 for hazards posing a risk of death or serious injury by requiring operators to show

[27] Federal Aviation Administration, Final Rule, Streamlined Launch and Reentry License Requirements, 85 FR 79566 (Dec. 10, 2020).

that the risk of such events is "extremely remote." To provide greater flexibility and consistency among part 450 licensees, the FAA should allow operators to protect against high consequence events using "a mitigation commensurate with the magnitude of the event." In no case should FAA's broadening of § 450.101(c) to better suit all part 450 licensees result in imposition of criteria more restrictive than 1E-3, though, which would not be justified. Lastly, to eliminate superfluous analysis, the FAA should only require a demonstration under § 450.101(c) for those phases of flight capable of resulting in a high consequence event.

This performance-based standard would achieve FAA's objective of preventing improbable but catastrophic events, while (1) providing scalability based on the actual risk presented; (2) applying § 450.101(c) only to relevant flight phases; and (3) ensuring flexibility, and thus, consistency among all part 450 applicants.

Additionally, FAA regulations do not define "high consequence event," which operators report has led to inconsistent guidance from FAA licensing teams. Providing clarity to the industry on the meaning of this term and the assumptions underlying the criteria in § 450.101(c) would greatly assist operators in protecting against high consequence events, particularly in the context of reentry operations. To ensure that this definition is neither underinclusive nor overinclusive, the FAA should limit "high consequence events" to events resulting in multiple casualties occurring on lands not controlled by the applicant. Multiple casualties would align with the FAA's description of high consequence events in the preamble to the Part 450 final rule: "an unlikely but catastrophic event."[28]

APPROACH:

The FAA should define "high consequence event" in § 401.7 as "an event resulting in multiple casualties on an uncontrolled area of land."

The FAA should replace § 450.101(c) with a performance-based metric and move the options outlined in current §§ 450.101(c)(1)-(3) to an AC, along with any other means of compliance that the FAA would accept for high consequence event protection. The FAA should include among the means of compliance in that AC the use of hazard analyses to demonstrate hazard mitigation, as previously allowed under the legacy regulations. The SpARC's recommended revision to § 450.101(c) appears in Appendix A.

To mitigate any lag between revision of § 450.101(c) and the publication of a corresponding AC, the preamble announcing the regulatory change should stipulate that the FAA will continue to accept existing means of compliance with § 450.101(c). Accepted means of compliance would include the existing CEc thresholds, flight abort under § 450.108, as well as risk profiles, flight hazard analysis, or any other mechanism satisfactory to FAA.

[28] 85 FR 79566, December 10, 2020, p. 79600.

REC-R12 Enable Reentry Waiver to § 450.101(c)(2)

REC-R12	REGULATORY TEXT: Prior to any rulemaking that modifies § 450.101(c)(2), the FAA should immediately issue a blanket waiver to relieve reentry and captive carry vehicles of that requirement.

INTENT:

To clarify that application of the conditional expectation of casualty (CEc) requirement in § 450.101(c)(2) pertains to launch vehicles only, exempting reentry and captive carry vehicles for which flight safety systems are not appropriate and do not enhance safety.

RATIONALE:

Currently, each reentry and captive carry vehicle operator is required to submit a waiver to § 450.101(c)(2), an administrative burden on both operators and the FAA, and a bureaucratic hurdle that does not benefit public safety.

APPROACH:

The FAA should immediately issue a waiver to § 450.101(c)(2) for all reentry and captive carry vehicles, effective through implementation of final rulemaking that responds to REC-R12. The SpARC recommends the following content for such a waiver:

Effectivity/Scope : This waiver is intended to apply to all reentry vehicles and captive carry vehicles until a regulatory change is implemented that eliminates the need for a waiver.

Requirement Being Waived: This document seeks to waive 14 CFR 450.101(c)(2).

Problem Statement: Under part 450, all operators are subject to a conditional Ec (CEc) requirement as a mitigation to high consequence events. For reentry and captive carry vehicles, this requirement is neither practically achievable nor effective in protecting public safety.

Inclusion of the CEc requirement in part 450 deviates from legacy reentry compliance strategies in parts 431 and 435 and presents an unprecedented compliance challenge for all reentry vehicle operators, as well as all captive carry vehicles.

1. Reentry Operation Compliance to § 450.101(c)

   Under § 450.101(c), operators must protect for high consequence events in uncontrolled areas using one of three strategies. Given the unique nature of reentry vehicles, the strategies defined in §§ 450.101(c)(1) and (c)(3) are not feasible, thus funneling reentry operators into compliance with § 450.101(c)(2), which defines the CEc criteria. CEc is not a suitable measure of compliance to ensure high consequence event protection for reentry vehicles for the following reasons.

   a. Impractical Compliance under § 450.101(c)(1)

   Flight abort to mitigate CEc is not a viable solution for a reentry vehicle. While flight abort capability could be implemented using one of three distinct methods (a primary vehicle system, an

independently actuated system, or a traditional FTS), all of these options result in solutions that cannot mitigate CEc for a reentry vehicle.

i. Primary Vehicle System

This approach assumes that the vehicle is designed at such a level of reliability that it would meet the requirements of a flight safety system and thus be able perform a flight abort to mitigate a high consequence event. The ability to design a vehicle with this level of reliability is very costly and likely not commercially viable. Even if it were, because CEc is calculated based on consequences without consideration of reliability, a violation would still occur.

ii. Independent Actuation System

This approach assumes that a vehicle is designed with an independent system to actuate an abort mitigation that is different from a traditional FTS, which causes thrust termination or destruction of the vehicle. For reentry vehicles, such as a lifting body or capsule, this is not a practical solution. As an example, to implement a nondestructive abort of a lifting body reentry vehicle that does not use the primary flight control surfaces would require independently actuated flight control surfaces. This type of design is not feasible. For many reentry vehicles, the failure mode(s) mitigated by an FTS would require actuation of the same system that has failed and resulted in the failure mode intended to be prevented. By way of example, a lifting body reentry vehicle typically has a failure mode associated with loss of control due to a failure on the aero control surfaces. To implement a non-destructive FTS system, the FTS would need to command an aero control surface to change the flight path of the vehicle. This example speaks to the impracticality of having an independently actuated system on reentry vehicles. A similar logic follows for crewed captive carry systems where it would be inappropriate for an independent actuation to override any action of the pilot(s).

iii. Traditional FTS

This approach assumes a system that, once actuated, either terminates vehicle thrust or breaks the vehicle into many small pieces. As the vast majority of public risk occurs after propulsive maneuvers are complete, thrust termination would not mitigate a high consequence event. A vehicle destruct system is not an appropriate solution for a reentry vehicle as it would ensure dispersion of debris, resulting in the very type of high consequence event that was intended to be mitigated. Furthermore, having an explosive FTS is antithetical to human space flight vehicles and other vehicles that dock/berth with the International Space Station. This logic follows for captive carry systems that have crew and/or spaceflight participants onboard.

b. Impractical Compliance under § 450.101(c)(3)

Section 450.101(c)(3) provides the option to show compliance by demonstrating reliability during the applicable phase of flight. Advisory Circular 450.101-1B states that demonstrated reliability for launch and reentry vehicle operations is measured against “fatal accidents

involving U.S. civil aviation aircraft with standard airworthiness certificates," citing demonstrated reliability as no failures in 87,000 flights.[29]

The FAA believes that at this time, no reentry vehicle or captive carry system exists that can meet this standard. As of the date of this publication, the FAA has licensed over 900 launches and 54 reentries. This flight history is statistically insignificant, and despite significant growth of industry, current projections would require thousands of years to collect sufficient reliability data to show reliability equivalent to no failures in 87,000 flights. Based on the above rationale, any attempt to utilize the § 450.101(c)(3) pathway for demonstrating mitigations to high consequence events is premature.

c. Compliance to § 450.101(c)(2)

Given that § 450.101(c)(1) and (c)(3) are impractical for reentry vehicles, the only remaining approach is § 450.101(c)(2), which involves conducting a CEc analysis. CEc is driven by population overflight, which for launch is typically mitigated by measures taken to meet basic public risk thresholds. Reentry vehicles can meet the same public risk thresholds but cannot avoid overflight in all situations, whether the flight proceeds as planned or in the event of a failure. Overflight may be required to enable return from a specific orbit, or to land at the designated target. Because CEc calculations do not consider the probability of failure, even a robustly designed reentry vehicle with extremely remote probabilities of failure will violate CEc solely due to population overflight.

2. Captive Carry Operation Compliance to § 450.101(c)

Captive carry vehicles share similar concerns as reentry vehicles regarding demonstrated reliability. Captive carry vehicles will hold Special Airworthiness Certificates in the Experimental category issued per 14 CFR 21.191, hereinafter referred to as an Experimental Airworthiness Certificate or EAC. For years, the FAA has successfully employed a regulatory strategy to ensure public safety with respect to the conduct of flight operations by aircraft certificated in the Experimental category throughout the national airspace system. This strategy includes application of operating limitations and licensing authorizations for flight crew, as well as FAA approval of vehicle inspection programs per § 91.409(f).

The risk accepted under Part 91 operations represents a far broader scope than what will be used for space operations, where additional levels of protection against risk to the public are deployed.

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[29] 14 C.F.R. § 450.101(c)(3) provides that an applicant may show compliance by "demonstrating reliability during the applicable phase of flight." *Advisory Circular 450.101-1B, High Consequence Event Protection*, at 13 (Federal Aviation Administration) explains that demonstrated reliability for launch and reentry vehicle operations is measured against "fatal accidents involving U.S. civil aviation aircraft with standard airworthiness certificates," and notes that a binomial approach would require data from *87,000 flights without a failure* to demonstrate a reliability corresponding to an 8×10^{-6} failure rate at the 50% confidence level; Updating Permitting Technology for the 21st Century (Apr. 15, 2025); Enabling Competition in the Commercial Space Industry (Aug. 13, 2025), Presidential Actions, The White House.

Thus, it is an unnecessary to require a captive carry operator to perform additional risk analyses, such as CEc, when the FAA has already deemed captive carry vehicles safe under Part 91.

Rationale for Relief:

1. An Equivalent Level of Safety (ELOS) is not appropriate

   Part 450 allows operators to "convincingly demonstrate that an alternative approach provides an equivalent level of safety (ELOS) to the requirement."[30] The final rule states "Most significantly, this change also allows an applicant to propose an equivalent level of safety to the use of a CE_C of 1×10^{-3} as the measure of a high consequence event in § 450.101(c)(2)."[31]

   ELOS provides flexibility in how an operator demonstrates compliance but does not change what an operator must comply with. An ELOS is not appropriate when a reentry operation is incapable of meeting the CEc threshold in § 450.101(c)(2), regardless of how CEc is determined. Therefore, use of an ELOS is not a viable alternative to a waiver.

2. CEc is not a suitable metric for reentry vehicles

   AC 450.101-1B Section 8.4 states: "CEC must be computed for any 'significant' period of flight. A period of flight would be significant if it is long enough for a mitigation… to decrease the public risks or consequences materially from any reasonably foreseeable failure mode." The FAA recognizes that there are times when a mitigation cannot be taken to decrease public risk, though a violation of CEc criteria may exist. This applies to reentry vehicles in two ways: the first is that any customary mitigation action, such as flight abort, would not materially decrease public risk; secondly, reentry begins in a high consequence energy state in which the vehicle is at high altitude traveling just below orbital velocity. For this reason, the dwell time over any given populated area is extremely short, and by the time a high consequence failure is detected, it is too late to execute a mitigating action. In fact, the time to execute would likely result in realized risk to a different population center along the trajectory.

3. Public Interest

   Captive carry and reentry vehicles provide space transportation that benefits the public through numerous space capabilities, including advanced technologies, research and development, logistics, space exploration, national security, and human spaceflight. These capabilities serve the public with a myriad of benefits and provide substantial economic gain.

Recovery Plan: Implementation of rulemaking that clarifies § 450.101(c)(2) does not apply to reentry and captive carry vehicles.

[30] 85 FR 79566, December 10, 2020, p.79575
[31] *Id*. at 79575-79576.

REC-R13 Refine Critical Asset Screening

REC-R13	REGULATORY TEXT: The FAA should refine the critical asset screening process and allow alternative risk probabilities when justified.

INTENT:

The intent is to elucidate the critical asset screening process inherent to §§ 450.101(a)(4) and 450.101(b)(4) and afford greater flexibility when necessary.

RATIONALE:

SpARC members expressed concern about the inconsistency and lack of transparency in the critical asset screening process carried out between the FAA and Department of Defense (DoD)—namely, the Department of the Air Force (DAF) under its Memorandum of Agreement (MOA) with FAA. The FAA's deference to asset owners for identification of "critical assets" for the purpose of part 450 makes sense; however, the lack of an objective metric for assessing risk or a process/timeline for reviewing designation of such assets has caused delay and/or restricted operability for some launch or reentry operators. Moreover, it has been observed that risk-averse asset owners have abused the critical asset screening process to identify entire buildings equivalent to the size of the International Space Station as "critical payloads," when the payload in question remained only in a small portion of the building, blocking several commercial launches for months since 2020. Improvements to the transparency and efficacy of this process, particularly when it comes to DoD-owned assets, would benefit applicants by reducing delays and improving operability.

Consistent with FAA's deference to asset owners on critical asset identification, the FAA should also allow asset owners to accept different risk thresholds for such assets when justified. The SpARC also recommends the FAA strike the sentence in §§ 450.101(a)(4) and (b)(4) requiring that the Administrator accept any identification by the Secretary of Defense that an asset is critical to national security, as it is unnecessary given the interagency process at work beyond this regulation such as the DAF-FAA MOA.

APPROACH:

To improve transparency, consistency, and timeliness of critical asset screening, the FAA should review and revise its screening process with DAF and other critical asset owners. The SpARC encourages quantitative assessments of actual risk posed to an asset to avoid subjective, and thus, inconsistent results.[32] The FAA should also allow asset owners to assume risk or accept an alternative risk threshold, with the goal of improving opportunities for commercial launch and reentry activity. The SpARC recommends revising §§ 450.101(a)(4) and (b)(4) to allow the Administrator to determine, in consultation with relevant federal agencies, that an "alternate" (not "more stringent") probability may be used when deemed "acceptable" to protect the national interests of the United States, and to remove the unnecessary and unqualified statement

[32] The current thresholds were established with a formula in the RCC 321 Supplement, assuming each asset is threatened equally and equal number of times at all ranges (33 launches per year). This process is no longer representative of high cadence ranges like Cape Canaveral Space Force Station, and has never been representative of launch sites on the Northern side of Vandenberg Space Force Station.

that the FAA will accept any DoD finding that an asset is critical to national security. Finally, the FAA should work with DoD and NASA to limit what can be self-identified as a "critical payload."

REC-R14 Clarify Disposal Criteria and Expand Applicability to Reentry Vehicles

REC-R14	REGULATORY TEXT: The FAA should clarify the disposal criteria in § 450.101(d) and expand "disposal" definition in § 401.7 to include reentry vehicles.

INTENT:

The intent is to encourage controlled deorbits of vehicle stages by clarifying the risk criteria associated with disposals and expanding applicability of "disposal" to reentry vehicle stages or components.

RATIONALE:

In promulgating part 450's risk criteria, the FAA introduced risk criteria for "disposals," which the FAA defines in § 401.7 as a purposeful attempt to return a vehicle stage or component from orbit to Earth in a controlled manner. Although controlled disposals differ radically from reentry operations in terms of operator control, objective, and—very often—the scope of foreseeable risk, the FAA elected to require in § 450.101(d) that any controlled disposal performed under part 450 meet the reentry risk criteria outlined in §§ 450.101(b)(1)-(3) (i.e. collective, individual, and aircraft risk thresholds), unless targeting a broad ocean area. The FAA not only added a risk threshold for disposals, but also, requires operators to conduct a flight safety analysis (FSA), including cumbersome FSA methodologies, for any disposal.

The FAA's addition of disposal risk criteria has greatly increased the burden on operators seeking to mitigate orbital debris by removing their vehicle stages from orbit. Rather than enhancing public safety or space sustainability, § 450.101(d) has disincentivized controlled disposals. Operators are instead leaving stages in orbit, at least for early flights, to allow FAA's flight safety analysts time to review the disposal maneuver for compliance with § 450.101(d) and applicable FSA requirements.

The FAA should immediately remove the perverse incentive created by § 450.101(d) to leave vehicle stages in orbit by clarifying what an applicant must demonstrate to meet § 450.101(d) and any applicable FSA requirements, ensuring that the burden on applicants is no greater than necessary to protect public safety. The FAA should specifically clarify the meaning of "broad ocean area" and "target" in § 450.101(d), through guidance or new regulatory definitions in § 401.7. These terms are ambiguous and have further complicated industry's efforts to execute disposals in accordance with § 450.101(d). The SpARC also supports a change to § 450.101(d) to align with how the FAA treated debris under § 417.223. This change would encourage operators to remove their debris from orbit, thereby promoting orbital safety and reducing uncontrolled disposals to Earth.

Lastly, the FAA should remove the exclusion for reentry vehicles currently found in § 401.7. If a reentry vehicle is unable to achieve its nominal mission, then the operator should have the option to safely dispose of the reentry vehicle or any of its components, particularly if this would be the safer alternative to leaving the vehicle in orbit. In all cases, the FAA should incentivize safe operations and avoid situations in which reentry licensees must rely on waivers to perform controlled disposals if their vehicle is unable to complete the planned reentry.

APPROACH:

The FAA should immediately remove the perverse incentive created by § 450.101(d) to leave vehicle stages in orbit by clarifying how applicants can meet § 450.101(d), including by defining "broad ocean area" and "target" in guidance or in § 401.7. Alternatively, the FAA should reduce the burden on applicants to align with how the FAA treated debris under § 417.223. Removing vehicle stages from orbit should be no more difficult under part 450 than it was to do a flight hazard area analysis under § 417.223, in which operators analyzed potential debris impacts for hazard areas and published hazard areas where necessary.

The FAA should also remove the exception for reentry vehicles in the definition of "disposal" in § 401.7. Disposals should include any return or attempt to return a vehicle stage or component (not just launch vehicles) from Earth orbit to Earth in a controlled manner. Please see the redlined text in Appendix A.

REC-R15 Alternative means of compliance for § 450.101(f)

REC-R15	REGULATORY TEXT: The FAA should allow a less restrictive alternative to the requirement for notification of 97% probability of containment in § 450.101(f).

INTENT:

The intent is to provide an alternative means of compliance with the notification requirement in § 450.101(f) based on actual risk contours.

RATIONALE:

Section 450.101(f) requires operators to provide notification to *any* public contained within a 97% probability of containment contour, regardless of the risk to which said population is exposed. Applicants, particularly those seeking reentry licenses, have found the 97% containment requirement overly conservative, particularly for areas of land and air. A 97% containment contour can contain multiple probability of casualty risk thresholds that are well below the risk thresholds contemplated in §§ 450.101(a)(2) and (b)(2). In practice, it is conceivable that a planned impact could exist in an area where remote populations exist that are difficult to notify and further, are exposed to risk well below the acceptable level of individual risk in other sections of § 450.101. Under the current regulation, these populations still require notification by a licensee of the planned impact. This creates a situation where, in certain scenarios, a licensee would be required to expend significant effort to provide notification to the affected public that are exposed to very low risk, thus resulting in little to no additional safety benefit relative to the effort expended by the licensee.

Instead of requiring all applicants to establish 97% containment for all areas of land, sea, or air, the FAA should allow applicants the option to identify areas in which there is an actual risk of casualty, then publish notices accordingly. The SpARC recommends the FAA use one order of magnitude less than the individual risk threshold in § 450.101, which would require notification for areas presenting a probability of casualty exceeds 1×10^{-7}. Applicants could still choose to use the 97% containment requirement, if suitable or simpler for their operations, but the recommended revision would also allow an alternate route without having to seek a waiver or ELOS.

APPROACH:

The FAA should revise § 450.101(f) to require notification of planned impacts based on either the existing 97% containment requirement or areas in which the probability of casualty exceeds 1×10^{-7}.

REC-R16 Restructure methods/analysis validity requirements

REC-R16	REGULATORY TEXT: The FAA should eliminate § 450.101(g) and add the requirement to use accurate data and scientific principles to individual regulations requiring analysis compliant with § 450.101.
REC-R16.1	REGULATORY TEXT: The FAA should remove § 450.115(c) and instead levy the application requirements for each FSA section to assess FSA methods as appropriate.
REC-R16.2	REGULATORY TEXT: The FAA should replace each reference to § 450.115(c) in the application requirements of the FSA sections (§§ 450.117 – 450.139) with three simplified criteria.

INTENT:

The intent is to remove undue burden caused by the second sentence of § 450.101(g) and eliminate redundancy within § 450.115 by moving the requirement for analytical validity to application criteria throughout part 450, including those replacing § 450.115(c)

Additionally, the intent is to expedite the FAA's tedious process for FSA methodology review by striking some of the overbroad and subjective criteria in § 450.115(c) and moving the rest, in simplified versions, as applicable, to the application requirements for each FSA section (§§ 450.117-139).

RATIONALE:

The FSA methodology criteria in § 450.115(c) and the requirement in § 450.101(g) for analytical validity are two requirements upon which the FAA has relied to significantly protract pre-application consultation and its overly intensive review of FSA methods. The recommendations in this section are aimed at relieving the pre-application bottleneck discussed throughout this report by forcing FSA methodology review to take place during the FAA's 180-day application review, removing redundancies between §§ 450.101 and 450.115, and simplifying the methodology criteria to prevent the FAA from levying these provisions to require boundless volumes of data with no discernable impact to public safety.

Section 450.101 (g)

Section 450.101(g) requires that any analysis used to demonstrate compliance with § 450.101 use accurate data and scientific principles, be "statistically valid," and "produce results consistent with or more conservative than" previous mishaps, tests, or other valid benchmarks, such as higher-fidelity methods. SpARC members report inconsistent application of this provision, particularly the second sentence of § 450.101(g), even among different FAA reviewers of the same document. The requirement to produce results consistent with or more conservative than valid benchmarks is subjective in nature, inconsistently applied at FAA, and represents a costly addition from the prior licensing regime in terms of time and resources with no measurable benefit to public safety. Moreover, the benchmarking requirement lacks any justification and inhibits innovation for operations that have no precedent or comparable benchmarks. Even established operators have found it challenging to obtain benchmarking data satisfactory to the FAA. The FAA frequently levies § 450.101(g) to require excessively detailed information to validate application data

and analyses. The requirement to be consistent with or more conservative than benchmarks also stymies novel operations where little or no benchmark data exists.

The requirement for statistical validity and accurate data and scientific principles is duplicative in many ways of the FSA methodology criteria in § 450.115(c) and the application criteria for some FSA and system safety regulations (*see*, e.g. the vehicle data requirements for flight abort rules and flight safety limits in § 450.108; the requirements of § 450.121(b) and § 450.135(b)(2) for "statistically valid" debris impact probability distributions; or the requirement of § 450.145(d)(4) to validate the accuracy of any vehicle tracking data used by an FSS).

Because the FAA principally assesses validity under § 450.101(g) during pre-application consultation and application review, the FAA should remove § 450.101(g) and instead relocate the requirements for statistical validity and accurate data and scientific principles to the relevant application requirements within part 450. Doing so would require no further change to § 450.101 because the application criteria remain in effect post-licensure pursuant to the FAA's continuing accuracy requirements (§ 450.211). Removing § 450.101(g) would improve consistency in FAA implementation and relieve applicants of endless data requests and iterative reviews, particularly when trying to move past the months-or-years-long pre-application consultation process. Eliminating § 450.101(g) would also remove an undue burden on operators by allowing them to prepare regulatorily compliant analyses even if their operation lacks precedent or comparable benchmarks. In concert with the changes recommended to § 450.115(c), removal of § 450.101(g) does not impact overall quality of an FSA nor impact public safety.

Section 450.115(c)

FAA's process to approve FSA methods under § 450.115 is a far cry from the streamlining intended by part 450. Although § 450.35(a) only calls for a description of FSA methods in accordance with § 450.115(b)(1), the FAA requires applicants to satisfy each of the application requirements in § 450.115(c) for each FSA method before submitting a license application, which defies the text of the regulation. The FAA has interpreted the criteria in § 450.115(c) to allow boundless data requests—often academic in nature—and this process keeps applicants in pre-application consultation for months to years as they complete innumerable paperwork exercises that have no bearing on the safety of the resultant operation. Both the industry and FAA struggle to articulate what the FAA is looking for with "fidelity," "benchmark conditions," and "risk mitigations" in the § 450.115(c)(5) context; the FAA's answer is almost always a paperwork exercise instead of useful justification. In many cases, particularly for new operators or those with novel operations, no data are available to benchmark their methodology. The FAA has also acknowledged that it is difficult to present all elements of § 450.115(c) in all the FSA sections (§§ 450.117 to 450.139).

FAA's implementation of § 450.115(c) is also a procedural nightmare, which compounds the hardship for applicants. Three years after promulgating part 450, FAA's FSA team (ASA-210) has begun reviewing FSA methods in 2 phases (a screening phase, followed by subject matter expert (SME) review), which has elongated the FSA review process because it takes months to receive input from ASA-210 screeners or SMEs on each FSA document. The extent of information needed to get an FSA method past ASA-210 depends on the analyst assigned. If a methodology document must be revised and resubmitted, it is all but certain that ASA-210 will raise new issues on re-review, especially if the secondary reviewer is different from the first. The FAA can never commit to any timelines for their reviews, communication of status is sparse, even for basic questions that the applicant could quickly address to keep review moving. The FAA

also recently began categorizing its comments on FSA products as "critical," "substantive," "administrative," and "ambiguous." – with no explanation for the basis or effect to guide applicants in preparing submittals. SpARC members attest, however, that the FAA has withheld approval for methods with outstanding "administrative" comments.

The SpARC recognizes that the demand from industry for launch and reentry licenses from FAA is ever growing, while FAA resources are generally stagnant. Given these conditions, it is imperative that the FAA maximize efficiency and transparency, taking care to regulate only as necessary for public safety by eliminating academic expositions having no impact on how operators fly their vehicles.

To expedite FAA's tedious process for FSA methodology review, the FAA should delete § 450.115(c) entirely and replace references to § 450.115(c) in the rest of the FSA sections (§§ 450.117-139) with baseline methodology criteria that address accuracy and fidelity without overprescription or subjectivity. The three application requirements for FSA methods would include demonstration of: (1) a scientifically valid approach, (2) assumptions, and (3) validation and verification (or some equivalent). Note that the SpARC's recommended substitutions of § 450.115(c) across FSA sections (§§ 450.117-139) appear in the accompanying redline text of part 450 but are not called out as individual recommendations for each FSA section in this report.

The SpARC urges the FAA to stop requiring FSA methodology approval as a prerequisite to application submission, as it defies the 180-day limitation that Congress instituted for reviewing license applications. As discussed in this report, the SpARC recommends that the FAA remove the barriers to application submittal presented by § 450.35(a). Doing so would remove the requirement that applicants receive FAA concurrence on each of their FSA methods under § 450.115(b) (and effectively §450.115(c) per FAA's implementation of § 450.35(a)(1)), which functionally requires a complete FSA at the outset of application review. Distilling and relocating the criteria in § 450.115(c) to FSA information requirements would mean that the bar for FAA acceptance of a license application is high-level concurrence with an approach, while in-depth review of FSA methods and details would take place during application review.

APPROACH:

Section 450.101(g): The FAA should remove § 450.101(g) and relocate the requirements for statistical validity and accurate data and scientific principles to the application requirements for FSA or other sections requiring compliance with § 450.101.

Alternatively, should the FAA retain all or part of § 450.101(g), the SpARC urges the FAA to publish clear standards for staff implementation of § 450.101(g) to avoid inconsistent implementation, boundless data requests, and general regulation beyond that which is necessary to protect public safety.

Section 450.115(c): To expedite FAA's tedious FSA methodology review, the FAA should delete § 450.115(c) entirely and instead review the application requirements for each FSA method when reviewing each FSA section (§§ 450.117-139) during the 180-day application review period. The FAA should replace all references to § 450.115(c) in the FSA sections (§§ 450.117-139) with baseline methodology criteria that address accuracy and fidelity without overprescription or subjectivity. The three application criteria for FSA methods would include: (1) evidence of a scientifically and statistically valid approach, (2) documentation of assumptions, and (3) validation and verification evidence (or equivalent). The SpARC's

recommendations for the rest of the FSA sections include in-line edits reflecting the replacement of § 450.115(c) with these criteria.

FAA analysts should take care to ensure consistent and practical implementation of these criteria, including, for example, refraining from asking applicants to justify or validate tools that are well known to the FAA, such as AVRA. The FAA should also bound the scope of evidence that may be required for verification and validation to include only such information as is necessary to determine the safety of the proposed operation.

IX. Recommendations - Safety Regulations – System Safety Program

REC-R17/REC-G08/REC-P12 System Safety Program Generally

REC-R17	REGULATORY TEXT: The FAA should clarify and restructure § 450.103(a) to ensure safety organization requirements apply only during licensed activities.
REC-R17.1	REGULATORY TEXT: The FAA should require operators to also account for ground safety hazards in § 450.103(b) "when applicable."
REC-R17.2	REGULATORY TEXT: The FAA should update § 450.103(b)(2) to require communication of hazard management updates only when an update is "material to public safety."
REC-R17.3	REGULATORY TEXT: The FAA should update language in § 450.103(c) to clarify non-applicability to exempt systems (like a highly reliable flight safety system, or systems adequately mitigated by hazard control strategies).
REC-G08	GUIDANCE: The FAA should update its guidance in AC 450.103-1 to clarify whether *any* change to a safety critical system would trigger documentation requirements in § 450.103(c)(2), (3).
REC-G09	GUIDANCE: In implementing REC-G08, the FAA should ensure the System Safety Program is included as an early requirement in licensing compliance.
REC-P12	PROCESS: In reviewing compliance with § 450.103, the FAA should apply differing levels of scrutiny based on the complexity of the system involved.

INTENT:

The intent is to clarify the scope, applicability, and foundational importance of a system safety program in the life cycle of vehicle and site development. Here, the regulation should be re-written/re-organized to clarify what is a persistent requirement of the regulation and what is just a day-of-launch requirement. Moreover, the regulation should be re-written to expand the scope of ground safety (when applicable) while simultaneously reducing unnecessary burdens on operators who rely heavily on exempted safety critical systems for hazard control strategies during flight. Finally, the intent also is to encourage the FAA to change its process and publish guidance, fostering greater clarity of what is considered a material change; and recognizing systems under part 450 vary widely in complexity and should be reviewed with differing levels of scrutiny, especially new systems.[33]

[33] This recognizes the commercial industry's general shift to a "fail fast, fail forward" development philosophy, which relies far less on historical development models, which required extensive, time-consuming analyses.

RATIONALE:

Section 450.103(a)

A system safety plan governs the lifecycle of a vehicle, but the safety organization (mission director and safety official) exists only for licensed activities. Listing the safety organization as the first subsection to § 450.103 creates ambiguity that these roles must exist throughout development cycle of the systems, when that is not the FAA's intent. Accordingly, industry seeks clarification that these positions are required only for licensed activities, not across the vehicle lifecycle by re-wording the regulation. Moreover, the subsection should be moved further down in the § 450.103 regulation to not place artificial importance on the regulation. The SpARC recommends it be moved after § 450.103(c) but before § 450.103(d), as currently written.

Section 450.103(b)

Hazard management, as written in § 450.103, only applies to flight safety, which is inconsistent with the desire for a semi-agnostic system safety and licensing process. While most applicants are exempt from ground safety requirements by launching from a federal or foreign launch or reentry site, it would "future proof" part 450 to include ground safety in § 450.103(b)(1) "when applicable."

Additionally, requiring applicants to communicate "any update … throughout the organization" in § 450.103(b)(2) is overbroad and the FAA's intent is unclear. As written, the regulation can be read to require an applicant to update its entire company about changes to the hazard management process, even if portions of the company are not involved in the license. The reference to an "organization" in the regulation is also ambiguous.

Accordingly, the SpARC recommends the FAA specifically bound communication of "any update" to the hazard management process to the safety organization required in § 450.103(b)(1). Moreover, "any update" should be replaced by "material update" because requiring communication of every change—even formatting—is over broad.

Section 450.103(c)

The current format of § 450.103(c) is vague, overbroad, and does not provide clear requirements for when a change to a safety-critical system rises to the level of a configuration change, prompting new documentation. For instance, § 450.103(c)(1) requires a system safety plan to "track configurations of all safety-critical systems." This scope should be reduced to only require configuration tracking of "non-exempt safety-critical systems." As written, this requirement mandates duplicative configuration management and control of a highly reliable flight safety system, which is already managed by Range Commanders Council 319 and 324.

Finally, it is unclear whether any change would require an update to configuration documentation. As written, § 450.103(c) only requires an operator to "document" configurations but provides no qualifying language for when a system change rises to the level of creating a new configuration. Accordingly, the SpARC recommends the FAA include clarifying language in the regulation to identify whether there is a change threshold the FAA is willing to accept before a new configuration needs to be documented.

Early Test Flights

In implementing the recommendations above, the FAA should change its internal application review processes to give grace to programs in early developmental stages if public safety and safety of property are adequately maintained. The documentation burden of part 450 is significant.[34] This burden is compounded for new programs, which often experience significant, rapid, and system-wide changes early in the development cycle of the vehicle.

Accordingly, the FAA should not hold new systems that can demonstrate protection of public safety and safety of property via a specific concept of operation to the same documentation fidelity as fully operational, commercial systems. For example, an expendable launch vehicle could have a low-fidelity system safety program if it launches from a coast, does not overfly land downrange, and incorporates a highly reliable flight safety system as its sole hazard control strategy.

While this approach will not always bear fruit for applicants, especially for highly complex or novel systems requiring flight hazard analyses to meet public safety standards, it will help new vehicles literally get off the ground and obtain real-world test data.[35] This data will inform system development down the road and lead to a high-fidelity system safety process later as the operator gains experience and systems mature. This is also consistent with seeking expansion of the experimental permit regime.

Pre-Application Sequencing (Interaction with § 450.35)

As mentioned above, a system safety plan is a foundational part of a vehicle development cycle. However, this foundational importance is lost in the current structure of part 450. As written, the FAA encourages applicants to focus on several means of compliance first, especially the various part 450 "methodologies" in § 450.35, but it leaves out the system safety plan. Because a system safety plan is foundational to a vehicle's compliance, the FAA should convey its importance through regulatory structure and guidance.

APPROACH:

Section 450.103(a)

The FAA can specify in regulation or AC that the Mission Director and Safety Official apply only during licensed activities and are not static positions that must be involved in the entire System Safety lifecycle. Specifically, it is more fitting for the prescriptive requirement of a Safety Official and Mission Director to be added to § 450.149—Safety-critical Personnel Qualifications.

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[34] *Commercial Space Launch and Reentry Regulations: Overview and Select Issues*, CRS Report R48582, at 14 (June 23, 2025).

[35] *See* Charles Perrow, *Normal Accidents: Living with High-Risk Technologies* 82 (Basic Books 1984) (stating—in the context of nuclear powerplants—risk prediction of new, complex systems is very uncertain without real-world experience across time).

Section 450.103(b)

The FAA can implement the recommended changes by modifying § 450.103(b)(1) to require an applicant to "ensure the validity of the … [ground safety analysis, when applicable]" as well. As written, ground safety obligations are excluded from the holistic system safety approach the FAA is trying to achieve with § 450.103. Requested changes to § 450.103(b)(2) can be implemented by narrowing the scope of updates required only to those that are material to public safety. The FAA should couple this change with the publication of an AC on the difference between changes that are material to public safety or changes that simply require a continuing accuracy update.

Section 450.103(c)

The FAA can implement the recommendations of § 450.103(c) by publishing/revising ACs and regulatory text. Here, the FAA should provide examples in AC 450.103-1 on when configuration changes require FAA approval. If the FAA decides not to reduce the scope of the definition of "safety-critical" and retains § 450.143, it should explicitly revise the text of § 450.103(c) to exclude "exempted" safety-critical systems under § 450.143.

Early Test Flights

The FAA can account for early test-flights by applying a phased regulatory approach to system safety, aligned with concept of operations and risk exposure. In doing so, the FAA will need to define what it considers to be an "early test flight," as well as developing an internal process for what level of system safety rigor will be applied to a program.

Pre-Application Sequencing (Interaction with § 450.35)

If the FAA decides to retain the pre-application phase of part 450 licensing, the FAA should update its existing 413.13-1 AC and provide a regulatory sequencing tool (flowchart/hierarchy) as guidance to operators.

X. Recommendations - Safety Regulations - Hazard Controls

REC-G10 System Safety for Reentry Vehicles

REC-G10	GUIDANCE: The FAA should update AC 450.107 to clarify and further define the functional hazard analysis process so it may be applied equitably to both launch and reentry vehicles.

INTENT:

The intent is to implement changes so that reentry vehicle functional risks and mitigations are treated similarly as those for controlled disposal of launch vehicle stages. This would significantly reduce the scope of systems defined as safety-critical, resulting in significant reduction of work and FAA documentation review that do not contribute to public safety.

RATIONALE:

As part of the functional hazard analysis (FuHA) process, operators identify subsystem functions and the consequences of credible failures that could impact public safety. Since initial publication of AC 450.107- 1, the recommended FuHA format was updated to include the consequences of successful subsystem performance. Once consequences have been identified, failure end-effects are then evaluated prior to mitigation to determine the extent of public safety impact. This process creates disparity between launch and reentry vehicle outcomes that have significant ramifications in terms of downstream work scope including safety-critical system design, test, and verification data; software verification level of rigor; and flight hazard analysis.

For launch, the FuHA treats normal flight as "No Safety Impact," with hazard evaluation based solely on subsystem functions, without regard to compliance with the risk criteria, which is determined by the FSA. Hazards resulting from planned debris impacts (i.e., component jettisons and stage disposals) are not considered in the scope of the FuHA. AC 450.107-1 states that risk mitigations cannot be used in the FuHA.[36] Unlike the corresponding outcome for a successful launch, this implies that the public risk consequence of a successful reentry vehicle landing (landing or splashdown) is hazardous; indeed, it has been treated as such in FAA review of reentry FuHAs, with the consequences of successful reentry considered of catastrophic severity as hazard area notifications were assumed to be less than 100% effective. If no conditions exist in which a successful reentry can be considered safe, then every reentry vehicle subsystem is safety-critical without mitigation.

Both launch and reentry require risk mitigation for planned impacts, assumed through hazard area clearance consistent with public notifications. It should not be within the scope of system safety analysis to consider the public risk impact of actively surveilled and controlled vs. uncontrolled public access. That is a function of the FSA.

[36] Federal Aviation Administration, Advisory Circular, *Trajectory Analysis for Normal Flight*, AC No. 450.117-1, Aug. 19, 2021.

Thus, a reentry within the bounds of published hazard areas, while it could be casualty producing if the area was not cleared, should be considered “No Safety Impact” for FuHA purposes, offering consistency with controlled launch vehicle stage disposal.

APPROACH:

FAA should provide additional detail in AC 450-107 explicitly addressing normal reentry and controlled stage disposal/impact, applying equitable treatment to both such that normal flight is considered “No Safety Impact” for system safety evaluation, and the FuHA is limited to assessment of subsystem malfunctions. The FSA will continue to ensure that public risk criteria are satisfied for a normal flight.

REC-R18 Restructure Systems Safety Analysis & Results

REC-R18	REGULATORY TEXT: The FAA should revise § 450.107 to require a performance-based system safety analysis that identifies critical systems and provide evidence of their qualification. Functionally, this combines the existing text from §§ 450.107 and 450.143.

INTENT:

The intent is to remove prescription from the part 450 system safety requirements to allow for variable approaches to system safety analysis, including system safety approaches accepted by the FAA under the legacy requirements.

RATIONALE:

Descope Redundancy:

Combining the scope of parts 431 and 417, part 450 now requires operators to undertake multiple risk assessments independently, the connectivity or benefit of which is not apparent to operators. This is exacerbated by the structure of FAA review of submissions under these regulations. Operators are left to justify their risk analysis to both ASA-220 and ASA-210 independently, often receiving differing feedback. Further, the FAA claims significant interconnectivity between FSA and system safety requirements that simply does not exist in the text of the regulations. New operators, therefore, contend with a ballooning scope of submissions without a clear improvement to public safety, while existing operators attempting to transition their previous compliance documentation to the new rule have found methods previously accepted are now questioned under compliance, not safety, concerns.

When the Part 450 rule was published, this dichotomy was pointed out by numerous commenters from the industry, drawing on their existing experiences. With multiple licenses complete or in process, the SpARC believes that resolving this issue is one of the primary methods the FAA has to reduce complexity, increase focus, and ultimately provide a better safety environment for the public.

Part 431 – System Safety Foundation: Part 431, specifically § 431.35(c) *Acceptable reusable launch vehicle mission risk*, leverages system safety processes to demonstrate compliance with the risk criteria equivalent to those found in part 450's § 450.101:

> To demonstrate compliance with acceptable risk criteria in this section, an applicant shall employ a system safety process to identify the hazards and assess the risks to public health and safety and the safety of property associated with the mission, including nominal and non-nominal operation and flight of the vehicle and payload, if any. An acceptable system safety analysis identifies and assesses the probability and consequences of any reasonably foreseeable hazardous event, and safety-critical system failures during launch flight or reentry that could result in a casualty to the public.

In satisfying this high-level regulation, operators must demonstrate and defend their qualitative and quantitative methods used to assess risk but does not prescribe the specific set of analyses required.

Part 417 – Prescriptive Flight Safety Analysis: The Part 417 regulations take a prescriptive analytical approach, defining input (data generation) and output (risk assessment) processes to follow. The requirements in § 417.205(a) *General* closely follow legacy Range requirements for launch operators with expendable vehicles.

> Public risk management. A flight safety analysis must demonstrate that a 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, hazard isolation, or a combination of risk assessment and partial isolation of the hazards, to demonstrate control of the risk to the public.

Part 450 = Part 431 + Part 417: The final part 450 rule directly acknowledges the contradiction that concerns the SpARC in its description of the relevant sections stating:

> In the final rule, the FAA concludes that an operator must use one or more of the hazard control strategies defined in §§ 450.108 through 450.111 to meet the safety criteria. The FAA also adds a new paragraph to this section to address how an operator determines its hazard control strategy or strategies for any phase of flight during a launch or reentry… Regardless of the hazard control strategy chosen or mandated an operator must conduct an FSA to demonstrate quantitatively that a launch or reentry meets the safety criteria for debris, far-field overpressure, and toxic hazards.[37]

Without careful coordination and clear ties between the two analyses, it is easy to see how this work can require largely redundant efforts by FAA review teams. It is logical to assume that to perform a sufficient FSA, an appropriate set of failure modes are defined and analyzed to meet safety criteria.

Reduce Safety-Critical Systems Scope (including § 450.143)

The SpARC does not question the value of performing systems safety work but rather, for FAA to stay within its statutory bounds, aims to eliminate the application of system safety requirements to systems that cannot impact public safety.

A concern levied early and often in the SpARC included the extraordinarily broad definition of safety-critical that drives additional compliance documentation under §§ 450.107, 450.109, and 450.143. A lack of clarity in application and implementation was cited, but the regulations themselves drive circular logic. "Safety critical systems" are defined under § 401.7, and preamble text clarifies[38] FAA's intent for this catalog to be defined without considering mitigations such as a Flight Safety System or operational controls like hazard areas. In § 450.107(b)(2), safety critical systems are arguably written as an input to the mandated functional hazard analysis, rather than a likely product of the exercise. Anecdotally, some operators have found that the FAA review teams rely on previous experience to determine their expectations of systems to be labeled as safety-critical systems, undermining the analytical process required by the regulations.

The concern regarding an overly long list of safety critical systems is based on the enormous compliance burden associated with the § 450.143 regulation and the qualification and lifecycle management artifacts required to be reviewed and approved. Section 450.143(a)(2) provides a carve-out for certain systems,

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[37] Federal Aviation Administration, Final Rule, Streamlined Launch and Reentry License Requirements, 85 FR 79566 (Dec. 10, 2020) at 79570.

[38] Federal Aviation Administration, Final Rule, Streamlined Launch and Reentry License Requirements, 85 FR 79566 (Dec. 10, 2020).

descoping this paperwork, only if an operator demonstrates a low enough likelihood of public risk, a metric qualitatively described as "extremely remote." While this regulation has been helpful in reducing scope, the requirement to perform a flight hazard analysis per § 450.109 can add unnecessary compliance documentation with no benefit to public safety. An example of this is any system that relies on the use of a Flight Safety System (FSS) for hazard mitigation. If the failures of a component or system would result in activation of an FSS, then, from a public safety perspective, a fulsome flight hazard analysis for this failure is moot yet is currently required by part 450. Where systems for which an FSS may not be fully responsive to a public risk, a flight hazard analysis may indeed be appropriate. If an FHA can satisfactorily demonstrate acceptably low risk to the public, then the § 450.143 requirements are unnecessary; however, the work associated with this approach may be more than direct compliance to § 450.143.

For systems that present a risk unmitigated by an FSS, and not able to demonstrate acceptable risk, the provision of qualification plans is a reasonable expectation. The SpARC notes however, that demonstration of best practices for qualification is not a pathway towards approval of Flight Safety Analysis results that exceed risk criteria. Under current regulations, no systems safety analysis methodology can impact the derivation or allocation of probability of failure (PoF) inputs to the FSA in a way that might demonstrate a reduced risk value. Therefore, no amount of data provided under § 450.143, unless used as part of an approved MOC for flight safety analysis, can change the outcome of a license application under the current regulations.

Five years into the implementation of part 450, the FAA remains inconsistent with its approach to compliance causing significant confusion to operators, and simultaneously inheriting the worst aspects of the legacy regulations with duplicative and prescriptive system safety work while providing optionality for operators to show quantitative risk reductions using system safety products.

Descope Computing Systems Analysis and Move to § 450.107

The computing systems safety requirements in § 450.141 call for far more analysis and documentation than justified by public safety in most instances. Rather than subjecting applicants to fulsome review of all computing systems safety items, the SpARC recommends the FAA narrow the scope of its review to computing systems that perform a safety function on safety-critical systems. This is consistent with the SpARC's recommendation that FAA narrow its definition of safety-critical systems to include only those that either ensure compliance with the risk criteria in § 450.101 or whose malfunction could cause an exceedance of those risk criteria.

The regulatory text redlines included in Appendix A reflect descope and relocation of § 450.141 to § 450.107, as paragraph (d). The SpARC recommends the FAA examine only the criticality and software development plans for computing systems performing safety functions on safety-critical systems. The SpARC recommends further that the FAA exempt from such review any safety-critical systems covered under § 450.145 and any systems whose associated hazards are mitigated through a hazard control strategy or are shown to meet § 450.101 through a flight hazard analysis under § 450.109. Reducing the evidentiary burden on applicants in this way will refocus FAA review on systems that actually impact safety—determined through the lens of § 450.101 compliance—and ensuring the FAA regulates no more than necessary to fulfil its statutory duty.

APPROACH:

The SpARC's recommended changes to §§ 450.107, 450.141, and 450.143 appear in Appendix A. The SpARC requests that the FAA closely consider how its systems safety analysis and flight safety analysis regulations do or do not interact, and descope regulatory product generation that is duplicative, redundant, or cannot impact decision-making on behalf of public safety. Alternatively, if the FAA believes that strong systems safety fundamentals increase the safety of the system, then this impact should be demonstrated in quantitative results of an FSA, leading to more permissive licensing for applications with particularly strong systems safety processes. The SpARC supports this pathway, which will be discussed in recommendations alongside § 450.131 commentary.

The redlines are offered to implement some of the necessary descoping to redirect focus on system safety reviews. Functionally, a combination between the current §§ 450.107 and 450.143 provides a more direct connection between these two regulations to prevent misapplication of the requirements. The redlines offered in Appendix intend to:

1. Remove the prescriptive requirement for a functional hazard analysis, allowing for any appropriate systems safety process to be leveraged by operators to identify safety critical systems, hazards, and their mitigations.
2. Allow use of any hazard control strategy as a hazard mitigation for a system previously identified as safety critical to descope the system from requiring additional qualification documentation.
3. Minimize additional documentation for safety critical systems with excess residual risk to include only that necessary to qualify a system to its expected environment and demonstrate validation of those expectations. Design and acceptance test data may be captured under this defense but may not be required depending on an operator's strategy for qualification.

The SpARC strongly recommends that the improvements to § 450.107 include the assumption that software is similarly accounted for under hazard identification and evaluation. Therefore, § 450.141 is unnecessary and should be struck in full.

REC-R19 Accounting for computing system mitigations, should FAA keep § 450.141

REC-R19	REGULATORY TEXT: Should the FAA retain all or part of § 450.141, the FAA should allow operators to assign criticality of computing system safety items (CSSIs) in light of mitigations and align with DoD and industry interpretations of "mitigations."

INTENT:

Should the FAA retain all or part of § 450.141, the intent is to remove inconsistency between FAA's interpretation of "mitigation" and current DoD and industry practice by allowing operators to assign CSSI criticality in light of mitigations.

RATIONALE:

The SpARC recommends that the FAA limit its review of computing systems to those which perform a safety function in safety-critical systems and collocate this review with hazard control strategy review under § 450.107. If the FAA accepts this recommendation, then the FAA should delete § 450.141 as moot.

If, however, the FAA retains all or part of § 450.141, the SpARC recommends FAA adjust its approach to comport with current DoD and industry practice. Although § 450.141 purports to afford applicants flexibility in developing a means of determining the criticality of each CSSI identified in accordance with § 450.141(a), in practice, the FAA requires applicants to assign criticality for each CSSI in the absence of any mitigations. FAA regulations do not define "mitigation," but the ACs published on §§ 450.107 and 450.141 indicate that software design itself and independent features like hardware watchdogs constitute mitigations. This means that applicants must assess the criticality, including likelihood and severity of any hazards posed to the public, under the assumption that the built-in or wholly independent mitigation structure does not exist. For system failures that would be wholly prevented by design features or independent hardware, the FAA essentially requires the applicant to assess the impact of a risk that does not exist. This creates undue burden and overhead on applicants to demonstrate that risks that will realistically be mitigated by external factors, like a flight termination system, will fall below the regulatory threshold, despite their nonexistence.

APPROACH:

The FAA should revise § 450.141 to allow assessments of CSSIs with mitigations, particularly if they are built-in an inextricable from the CSSI, by amending § 450.141(a)(2) to read as follows:

> (2) The level of criticality of each computing system safety item identified in paragraph (a)(1) of this section, commensurate with its degree of control over hazards to the public and the severity of those hazards, and accounting for any relevant mitigations.

The FAA should also clarify in guidance the meaning of "mitigation" for the purposes of analyzing potential hazards to the public, avoiding above all any insinuation that applicants should imagine that measures built into their system design simply do not exist when assessing credible risks.

Note that the SpARC recommends the FAA revise § 450.107 to incorporate hazards from software or other CSSIs into the FuHA. If the FAA accepts this recommendation, then it should remove § 450.141 entirely, as these requirements would be obsolete.

REC-P13 Streamline and clarify procedures for use of RCC documents to meet § 450.145.

REC-P13	PROCESS: Consistent with the FAA's decision to accept tailored versions of RCC 319-19 and 324-11 as accepted means of compliance with § 450.145, the FAA should extricate itself from RCC tailoring process if administered by DoD or NASA and clarify precedence of FAA review if applicants use RCC documents without RCC tailoring for operations from commercial spaceports.

INTENT:

The intent is to relieve applicants using tailored RCC documents (i.e. RCC 319-19 and 324-11) to meet § 450.145 from duplicative federal reviews, in alignment with FAA's determination that tailored versions of these documents satisfy § 450.145, and to clarify the FAA process if an applicant elects to use RCC materials but is not using a federal site.

RATIONALE:

From the outset of part 450's publication, the FAA has identified tailored versions of RCC 319-19 and 324-11 as an acceptable means of demonstrating compliance with § 450.145. RCC 319-19 and 324-11 contain requirements for flight termination systems applicable to operators conducting launch or reentry operations from a federal range. These requirements may be tailored to suit individual operations through iterative discussions with federal range safety staff, generally at the base/center level.

Although the FAA has accepted this tailoring process and its byproducts—tailored versions of RCC 319-19 and 324-11—as satisfying § 450.145, the FAA continues to insert itself into the approval process by co-reviewing tailoring proposals and attaching its signature to final tailoring approvals given by the federal range to the Range user. The FAA's involvement in this process drastically protracts the tailoring process that would otherwise occur between the Range user and federal range safety, as applicants circulate multiple iterations of tailoring proposals through both entities and adjudicate sometimes conflicting comments. If FAA feedback on RCC materials postdates range approvals, it adds undue delay to both the 450 application process and the range safety tailoring process.

Consistent with the FAA's own acceptance of RCC 319-19 and 324-11 as accepted means of compliance with § 450.145, the FAA should extricate itself from the tailoring process, if already required for Range oversight, and instead require only that applicants submit finalized tailored versions of these documents as compliance evidence. The FAA should only participate in tailoring discussions if the Range materially departs from the tailoring processes or requirements upon which the FAA's acceptance of the MOC is based.

Nothing in this recommendation is intended to limit the ability of an applicant to tailor an RCC document directly with the FAA if the applicant chooses. In cases where an applicant elects to develop RCC documents independent of any Range, the FAA should clarify its procedures for reviewing and approving such documents under § 450.145 and refrain from engaging any Range entities when reviewing those RCC materials. A goal for U.S. government oversight should be to allow either qualified agency to approve these documents and ensure that their partner organizations are poised to accept this approval. Although Range

oversight mechanisms necessitate RCC documentation approvals, interagency negotiation should pave the way for SLD45 or SLD30 to accept FAA tailoring as readily as FAA should accept theirs.

APPROACH:

Consistent with FAA's decision to accept tailored versions of RCC 319-19 and 324-11 as accepted means of compliance with § 450.145, the FAA should extricate itself from the RCC tailoring process if already administered by DoD and/or NASA. The FAA should instead rely on its pre-determined acceptance of the Range's tailoring process as meeting § 450.145. To relieve applicants of duplicative federal reviews, the FAA should only review material deviations by Ranges from its own processes and requirements, consistent with the way the FAA handles delegation of ground safety oversight to Federal Ranges for commercial launches or reentries taking place on DoD or NASA sites.

The FAA should only review and substantively comment on RCC materials if generated by an applicant proposing to use a commercial launch or reentry site, independent of any Range entity.

Conversely, but outside of the sole authority of the FAA, the Common Standards Working Group (FAA DoD, and NASA) should move towards a future where FAA tailoring can be accepted without duplicative review by a federal range.

XI. Recommendations - Safety Regulations – Flight Safety Analysis

REC-R20 Eliminate or lighten Disposal FSA requirements

REC-R20	REGULATORY TEXT: To encourage removal of vehicle debris from orbit, the FAA should eliminate or alleviate the requirement for a disposal FSA in § 450.113.

INTENT:

The intent is to facilitate the removal of vehicle debris from orbit by either relieving operators of the requirement to prepare an FSA for disposal under § 450.113 or greatly reducing the FSA requirements applicable to disposal.

RATIONALE:

In promulgating part 450, FAA not only introduced risk criteria for disposals, but also included a requirement that operators conduct an FSA for disposals. Section 450.113(a)(3) requires an FSA "[for] disposal, from initiation of the deorbit through final impact."

The requirements for an FSA are contained in §§ 450.115 through 450.139, but the word, "disposal" does not appear in any of these FSA requirements after § 450.113(a). Nor is it clear from the regulatory text how §§ 450.115 - 450.139 should be applied to disposals. For instance, although § 450.117(a) calls for a trajectory analysis for any phase of flight within the scope of § 450.113(a) (including disposals), the stated purpose of the § 450.117 analysis is "to establish the limits of a launch or reentry vehicle's normal flight," as defined by the nominal trajectory and sets of trajectories sufficient to characterize variability and uncertainty. The definitions of "normal flight," "nominal," and "normal trajectory" in § 401.7 refer exclusively to flights of launch or reentry vehicles, as opposed to disposals of stages or components. Similarly, § 450.115(a) calls for an FSA method accounting for reasonably foreseeable events and failures of safety-critical systems during nominal and non-nominal launch or reentry. SpARC members report that the FAA reads this provision to include disposal, such that applicants must prepare methodology descriptions for each segment of a disposal FSA—a steep evidentiary burden that is not justified by associated risk.

Notwithstanding the omission of "disposal" from §§ 450.115-450.139, the FAA has required applicants seeking to perform controlled disposals to cobble together pieces of these FSA requirements to produce a satisfactory disposal FSA. SpARC members noted that the information required for a satisfactory disposal FSA and the applicable regulations has differed among licensing teams. Without written guidance from the FAA on disposal FSAs, it is impossible to discern the agency's intent or approval for criteria.

By requiring operators to comply with an assortment of FSA requirements that clearly do not contemplate disposal, according to unwritten rules or procedures, the FAA has introduced a tremendous and disproportionate burden for operators seeking to remove vehicle debris from orbit safely. The addition has had an undeniably chilling effect. Although controlled disposals occurred frequently under the legacy regulations, as of the date of this report, not one disposal has occurred under a part 450 license. Because it takes the FAA many months to approve FSA methods (including methodology improvements submitted as

license modifications under part 450), operators are instead electing to leave vehicle stages and components in orbit for at least their early flights under a part 450 license, even though uncontrolled disposals pose significantly more risk to the public than controlled deorbits.

In the interest of public safety and space sustainability, the FAA should relieve operators of the burden of preparing an FSA for disposals under § 450.113 and instead rely on debris hazard analyses to identify any debris impact areas, including vehicle stages or components to be deorbited in a controlled manner. At a minimum, the FAA should ensure that the regulatory path for conducting a controlled disposal—unquestionably the safer alternative—is no more onerous than it would be to simply leave vehicle debris in orbit.

APPROACH:

The FAA should immediately remove the perverse incentive to leave vehicle debris in orbit by eliminating the requirement in § 450.113(a)(3) to prepare an FSA for disposals. Removing § 450.113(a)(3) would require no further revisions to the FSA requirements in §§ 450.115 - 450.139, as the text of these regulations apply only to launch and reentry.

Alternatively, if the FAA does not remove § 450.113(a)(3), then the FAA should greatly reduce the burden on operators so that it is no easier under part 450 to leave vehicle debris in orbit than it is to deorbit debris in a controlled manner—unquestionably the safer alternative. The FAA should create a separate subset of FSA requirements for disposals, limited to normal trajectory analysis (with revisions as applicable to the launch-and-reentry-specific definitions of "normal flight," "nominal," and "normal trajectory" in § 401.7), debris catalog, and tailored debris hazard analysis. Any FSA requirements for disposal should be streamlined to the maximum extent if the applicant will target a broad ocean area, which poses the least risk to public safety.

REC-R21 Clarify Use of Reliability in lieu of FSA

REC-R21	REGULATORY TEXT: The FAA should clarify its intent and provide a path to utilizing the FSA exception in § 450.113(b).

INTENT:

The intent is to facilitate use of the FSA exception in § 450.113(b) by clarifying intent and a practical means of availing oneself of the option.

RATIONALE:

Section 450.113(b) provides that an operator need not perform and document an FSA for a phase of flight "if agreed to by the Administrator based on demonstrated reliability [by] using operational and flight history to show compliance with the risk criteria in § 450.101(a) and (b)." Neither the regulation, nor its associated preamble or ACs shed light on the intent of this provision and how an operator may, as a practical matter, demonstrate reliability to a degree that obviates the need for FSA for one or more flight phases.

APPROACH:

The FAA should either amend § 450.113(b) to clarify the meaning of this provision or publish guidance that outlines how an operator may make use of this provision in seeking a part 450 license. Such guidance should identify the information that the FAA would expect to receive from the applicant, and the approximate timeline for the FAA to review such a request.

REC-P14/REC-P15 Streamline FSA Method Approval, Expedite Legacy FSA Approval

REC-P14	PROCESS: The FAA should amend § 450.115 and the FSA method approval process by any means necessary to remove unjustified roadblock to licensure.
REC-P15	PROCESS: The FAA should streamline approval under § 450.115 for FSA methods used under legacy licenses.

INTENT:

The intent is to encourage immediate relief of a procedure that has become a bottleneck to application submission and a drain on FAA resources and the launch and reentry industry. To support ongoing operations by removing administrative burden for legacy operators that has no bearing on public safety.

RATIONALE:

Part 450 introduced a requirement that operators describe the methodologies used to prepare their FSAs, which the FAA has interpreted to mean highly detailed volumes of information. Although the FAA touted methodology approval as a key to streamlined review—a feature that would unlock multi-flight approvals under part 450—in practice, this process keeps applicants in pre-application consultation for months to years and very rarely results in a multi-flight approval from the FAA. Implementation of § 450.115 varies among FSA analysts and has become a vehicle for boundless information requests.

Five years after the promulgation of part 450, there remain no published means of compliance with the most crucial element of the safety approval and prerequisite to applying: the FSA methods. Neither of the ACs that FAA published on § 450.115 has shortened the review time for FSA methods or provided off-the-shelf methods that operators could use for a streamlined review. The FAA has postulated that FSA methods would be readily available to applicants if part 450 licensees would authorize FAA to publish their accepted means of compliance, but this is simply not true. SpARC members licensed under part 450 noted that when they sought to use FSA methods that the FAA previously accepted under part 450 (for either a new license or a license modification), FAA analysts raised new issues with those accepted methods, endlessly moving the goalpost for regulatory compliance.

The SpARC urges the FAA to immediately revise by any means necessary § 450.115, or at least the process it employs to approve FSA methods, to (1) remove the bottleneck preventing applicants from being able to submit their applications due to § 450.35; (2) enable the FAA to better meet licensing demand with its already constrained resources; (3) adhere to the requirement of federal law that the FAA take no more than 180 days to review a license application; (4) avoid imposition of extra-regulatory requirements in contravention of the Administrative Procedure Act; and (5) ensure consistency in FAA's treatment of all part 450 applications.

Additionally, the FAA should immediately take steps to expedite review of FSA methods successfully used by legacy operators under FAA's prior licensing regime. The FSA documentation that the FAA requires under part 450 has increased at least five-fold compared to the legacy rules. Although the FAA touted methodology approval as a key to streamlined review—a feature that would unlock multi-flight approvals under part 450—in practice, this process keeps applicants in pre-application consultation for months to

years, in some cases slowing or halting legacy operations seeking a 450 license. The FAA has provided no rationale for why compliance strategies accepted under parts 417, 415, 431, 435 are no longer valid under part 450.

Importantly, although the FAA raised the evidentiary burden for FSA methods under part 450 from the legacy requirements, the change has no impact on public safety. SpARC members who have or are seeking part 450 licenses to continue legacy operations are spending invaluable time and resources to generate volumes of information that justify the very methods they have employed under legacy licenses for years. The FAA, in turn, takes an inordinately long time to review and approve these descriptions of already-proven methods, which prevents FAA staff from reviewing application material from new applicants.

To avoid further hindrances to legacy launch and reentry operations and better allocate FAA resources according to licensing demand, the FAA should immediately fast-track or streamline FSA methodology approval for methods employed by operators under legacy licenses.

APPROACH:

The SpARC encourages the FAA to revise § 450.115, or at least its FSA method approval process, by any means necessary to achieve the objectives outlined above. Recommended means include, but are not limited to:

- Remove the requirement in § 450.35(a) that prevents applicants from submitting their applications before FAA approves each of their FSA methods. For details, see the discussion of § 450.35 in this report.
- Alternatively, or while processing a revision to § 450.35, implement § 450.35(a)(1) exactly as it is written by requiring only that applicants demonstrate compliance with § 450.115(b)(1) as a prerequisite to submitting an application. Section 450.35(a)(1) requires only a description of the level of fidelity of the applicant's FSA method. Per § 450.115(b)(1), the level of fidelity must be sufficient to satisfy the risk criteria in § 450.101, but the regulation plainly does not require satisfaction of the application requirements in § 450.115(c). The FAA has misapplied this regulation since its promulgation by refusing to allow applicants to submit applications until FAA finds that each of the FSA methods meets each of the application requirements in § 450.115(c).
- Immediately publish any internal guidance or checklists that FAA staff use to evaluate FSA methods or other application materials. This will address the concerns raised by all SpARC members about the lack of transparency and consistency in FAA's implementation of part 450 among all applicants.
- Where FAA reviews an application document and deems it regulatorily deficient such that the applicant must revise and resubmit the document, limit the scope of FAA's re-review to only those issues raised during the initial FAA review, unless the first review was egregiously erroneous. In such cases, the FAA should provide the applicant with a written explanation for expanding the scope of its re-review of a document beyond the initial comments, and if the FAA will require the applicant to prepare an additional revision for FAA review, expedite the third review to avoid further hardship to the applicant due to FAA's error.
- Cease the practice observed by some of FAA's FSA analysts that subjects individual components of an applicant's FSA method to analysis under § 450.115(c). Section 450.115 calls for an evaluation of an applicant's singular FSA methodology, with additional reviews under § 450.115(c) for the methods used for each subsequent FSA section (§§ 450.117-139). Requiring operators to

provide § 450.115(c)-compliant descriptions of the individual pieces of their methods (e.g., COTS software used to validate data or government developed and maintained tools well known to FAA), generating duplicated volumes of additional data without any implication for public safety, is a plain misreading of the regulation and amounts to imposing an extra-regulatory requirement without the notice and comment rulemaking required by the Administrative Procedures Act.

- Publish in an AC or other FAA guidance providing FSA methods that applicants could use to demonstrate compliance with § 450.115 and the FSA requirements in §§ 450.117-139. FSA methods should be written such that an applicant precisely following FAA's guidance need not provide any further compliance evidence to FAA to receive approval for that FSA method.
- The FAA should either revise § 450.115 to expressly accept legacy FSA methods as compliant with § 450.115 or adjust its implementation of the current regulation, with explanation in published guidance, to streamline approval of FSA methods previously accepted under legacy requirements to the greatest extent possible. Approval of legacy FSA methods should be particularly expedient if the operator can validate the results of its FSA using the approaches that the FAA accepted under the legacy regulations.

REC-R22 Use achievable standard for uncertainty in FSA Methods

REC-R22	REGULATORY TEXT: The FAA should revise § 450.115(b)(1) to require only "reasonably likely" sources of uncertainty.

INTENT:

The intent is to remove unnecessary burden in § 450.115(b)(1) to account for "all known sources of uncertainty" for each FSA method, instead of those that are reasonably likely.

RATIONALE:

Section 450.115(b)(1) requires that each FSA method account for "all known sources of uncertainty." The scope of this requirement is impractically broad and may be read to include uncertainties that are either speculative or irrelevant. This overbroad requirement compounds the already slow process for FSA methodology approval by introducing unnecessary burdens of proof for applicants.

The FAA should revise § 450.115(b)(1) to instead require "all reasonably known sources of uncertainty." Doing so would ensure a more practical scope in line with accepted engineering and risk management principles The phrase "reasonably known" introduces a standard based on what a competent analyst, using current tools, methods, and industry knowledge, can be expected to identify. This change maintains rigor in the analysis process while avoiding consideration of every theoretical or obscure uncertainty.

APPROACH:

The FAA should replace "all known sources of uncertainty" in § 450.115(b)(1) with "reasonably likely sources of uncertainty."

REC-R23 Codify streamlined FSA review for initial flights

REC-R23	REGULATORY TEXT: The FAA should codify into the regulation the streamlined means of compliance for FSA outlined in AC 413.13.

INTENT:

The intent is to clarify and formalize the streamlined option that the FAA allows for FSA review for initial flights, currently outlined in AC 413.13.

RATIONALE:

The FAA has internally developed a procedure in which it will perform a narrower, more expeditious FSA review applicable only to an applicant's initial flights, which carries a lighter evidentiary burden and saves the applicant time in iterating with the FAA during pre-application consultation. However, the details of this process, its scope, and the application requirements for an applicant seeking to avail themselves of this option for early flights in their program are not clear. Some SpARC representatives had never heard of this alternative, underscoring the need for greater amplification by the FAA. The streamlined FSA alternative does not appear in the regulation or the guidance published on FSA methods, but is instead referenced in AC 413.13, *Guidance for a Complete Application*.[39]

Codification of this approach in the regulation, along with supplemental guidance that explains the FAA's procedures and expectations for applicants choosing this alternative, would afford applicants (and FAA reviewers) quicker FSA reviews in such cases, thereby freeing up resources in ASA-210 to review other applicants' materials. In codifying this alternative, the FAA should specify the application material that would need to be submitted to use this approach. For instance, the FAA has indicated that applicants should use actual mission data as representative data, and applicants should explicitly state that the FSA methods for which they seek expedited review would only apply to specific missions with limited variability—ideally generating a single set of hazard areas.

APPROACH:

The FAA should codify into part 450 the alternative outlined in AC 413.13 for streamlined FSA review under § 450.115, including specifications of scope, eligibility, and application requirements. The SpARC expects that such requirements would include use of actual mission data as representative data, specification of the missions to which the FSA methods would apply, and limited variability in chosen missions to limit the range of hazard areas generated.

[39] Federal Aviation Administration, Advisory Circular, *Guidance for a Complete Application*, AC No. 413.13, Dec. 18, 2023.

REC-R24 450.117 – Eliminate Prescription in Trajectory Modeling

REC-R24	REGULATORY TEXT: The FAA should replace six-degree of freedom requirement with performance-based metric(s) in § 450.117(b).

INTENT:

The intent is to afford greater flexibility in modeling trajectories to meet § 450.117(b).

RATIONALE:

Section 450.117(b) requires that all trajectory analyses use a six-degree of freedom (6DOF) trajectory model to satisfy § 450.117(a). Although it is possible for operators to obtain equivalent levels of safety (ELOS) to allow alternative means of trajectory modeling under § 450.117(b), the FAA should replace the prescriptive requirement in § 450.117(b) to model in 6DOF with a performance-based metric. This would allow operators greater flexibility to use innovative modeling without the administrative burden of seeking an ELOS. The SpARC recommends that the performance standard should merely link the FAA's need for accurate modeling to the substantive requirement § 450.117(a).

APPROACH:

The FAA should revise § 450.117(b) to require compliance with a performance standard instead of prescribing 6DOF modeling. The FAA should also replace "uncertainty" with "incertitude" throughout § 450.117. The SpARC recommends the FAA revise § 450.117(b) to read:

> *(b) Trajectory model.* A final trajectory analysis must use a trajectory model that demonstrates sufficient accuracy in predicting the vehicle's trajectory to meet the requirements of paragraph (a) of this section.

Consistent with this revision, the FAA should then remove the reference to 6DOF from § 450.117(d)(2), so that this criterion reads simply:

> (d)(2) The quantitative input data, including <u>incertitude</u>, used to model the vehicle's normal flight in six degrees of freedom.

REC-R25 450.117 – Increase Clarity

REC-R25	REGULATORY TEXT: The FAA should replace “uncertainty” with “incertitude” throughout § 450.117.

INTENT:

The intent is to enhance clarity by referring to “incertitude” instead of “uncertainty” in § 450.117.

RATIONALE:

Section 450.117 uses the term “uncertainty” throughout the regulation, when “incertitude” would be more accurate in the analytical context. This change is necessary because currently, the FAA distinguishes “variability” and “uncertainty” within § 450.117 when in fact, variability is an example of uncertainty within trajectory modeling.

Uncertainty is a broader term than “incertitude” and as such is a less defined requirement against which operators can demonstrate compliance to certain parts of § 450.117. The use of “incertitude” more specifically targets what the FAA intends within § 450.117(a)(2), which requires a description of random uncertainties and their impacts on a vehicle’s trajectory.

One exception to this approach may be retaining the term “uncertainty” within § 450.117(d)(3) which discusses atmospheric conditions.

APPROACH:

The FAA should replace “uncertainty” with “incertitude” in all places in which it is used in § 450.117, except in § 450.117(d)(3).

REC-P16 450.117 & 450.119 – Set Reasonable Limits for Methods Documentation

REC-P16	PROCESS: The FAA should require no more than a description of tools and components of trajectory methods under §§ 450.117 and 450.119.

INTENT:

The intent is to relieve operators of undue burden and to align FAA practice with the text and stated intent of §§ 450.115(c), 450.117 and 450.119 by requiring no more than a description of the tools or components comprising an applicant's method for normal or malfunction trajectory, respectively.

RATIONALE:

SpARC members report that some FAA analysts have required applicants to show that each facet of their trajectory method satisfies §§ 450.115(c), contrary to the plain text of this regulation and §§ 450.117 and 450.119, which call for a singular review of an FSA method for compliance with §§ 450.115(c). For example, SpARC members have been asked to show their trajectory modeling capabilities under § 450.117(d)(1) to meet § 450.115(c), which are typically software-based analytical tools. In some cases, the FAA has requested delivery of the trajectory modeling software itself, often an intractable request, to accept a method for trajectory analysis under §§ 450.115(c), 450.117 or 450.119. The FAA used to require a simple description of vehicle simulation tools under the legacy regulations. The FAA has expanded these requirements under part 450 to include a full software review of vehicle simulation tools, which is burdensome to both the FAA and applicants and not required to ensure public safety is protected. Further, often these tools are internally housed and not off-the-shelf; this makes sharing of the trajectory tool cumbersome at best and likely infeasible especially if the FAA's goal is to run the software independently of operators.

The SpARC recommends the FAA remove § 450.115(c) entirely, but even if the FAA retains some version of this requirement in part 450, the FAA should immediately direct all FSA analysts to evaluate trajectory analyses methods as a single unit, requiring no more than a description of the components or tools that comprise the applicant's methodology under §§ 450.117 or 450.119. Evaluating each such tool or element for compliance with § 450.115 amounts to nothing more than a paperwork exercise, as it has no bearing on public safety or the way that the operator conducts its operation. Targeted reviews of trajectory data outputs or verification evidence, such as plots, are generally sufficient to ensure trajectory modeling is accurate.

APPROACH:

The FAA should, as a matter of policy, streamline acceptance of all means of compliance previously accepted under the legacy requirements (i.e. parts 415, 417, 431, and 435), especially as it relates to trajectory modeling. The FAA should require no more than a description of the components comprising a trajectory analysis method or tools under §§ 450.117 or 450.119 such that each method receives one comprehensive review under § 450.115 and the application requirements of §§ 450.117 and 450.119, respectively.

REC-R26/REC-R27 Restructure and refine §§ 450.119-122

REC-R26	REGULATORY TEXT: The FAA should restructure malfunction, breakup, and debris impact hazard analyses across §§ 450.119-122 to reflect order of operations and simplify as well as clarify requirements.
REC-R27	REGULATORY TEXT: The FAA should relocate the LUM trajectory requirements that apply solely to operators using flight abort (§ 450.108) as their hazard control strategy from § 450.119(a)(3) to a new regulatory section dedicated to LUM, § 450.124.

INTENT:

The intent is to simplify and clarify FAA requirements to analyze malfunction trajectories, breakup scenarios, and debris impacts in a manner reflective of the order in which applicants should logically perform such tasks. These revisions encompass §§ 450.19-121, with a proposed addition of § 450.122.

RATIONALE:

Having recommended relocating §§ 450.119(a)(3) and (c)(2) to § 450.124, the SpARC recommends the FAA restructure the requirements to analyze malfunction trajectories, impact and breakup scenarios, debris hazards, and debris propagation to simplify and clarify FAA's requirements for these components of the FSA. This can be accomplished by reorganizing the current requirements into the proposed §§ 450.119-121 including a proposed new addition §§ 450.120 and 122 in a manner reflective of the order in which applicants should complete each analysis. These streamlined requirements would help clarify, particularly for new part 450 applicants, FAA's expectations for these products based on operators' experiences since 2020.

For § 450.119, the FAA should streamline malfunction trajectory analysis in several ways. First, the FAA should relocate the limits of a useful mission (LUM) trajectory requirements that apply solely to operators using flight abort (§ 450.108) as their hazard control strategy from § 450.119(a)(3) to a new regulatory section dedicated to LUM, § 450.124. This is because LUM development is exclusive to operators that use flight safety systems and flight abort but have no use for operations that utilize a different hazard control strategy. This recommendation maintains a wholly separate section to allow operators to cleanly identify an input while citing range services for wholesale compliance with other FSA related regulations. Further, while LUM development may be consistent with most operators' development process, it is questionably necessary for FAA review under public-safety grounds. While consideration of the inputs to these limits is necessary, so long as public safety criteria are met, there is no public safety justification for requiring that the modeled trajectories represent useful missions.

Next, the FAA should move the requirement to account for potential FSS failure from § 450.119(a)(3) to a new regulatory section dedicated to Impact and Breakup Analysis (§ 450.120). Both these proposed revisions would help to modularize and clarify the material that the FAA expects from applicants and the order in which applicants should tackle those deliverables, based on current practice.

To simplify trajectory analysis procedures, the FAA should move the requirement to analyze probability distribution of the vehicle's position and velocity in § 450.119(b)(2) to a new section focused on "Impact

and breakup analysis," § 450.120. The FAA should similarly remove the reference to "vehicle breakup" from § 450.119(b)(3). This would refocus § 450.119 on trajectory modeling, while § 450.120 would focus on analysis of vehicle impact and breakup.

The FAA should also explicitly allow enveloping failure mode effects within malfunction trajectory analysis to prevent ballooning computational requirements for FSAs by allowing reasonable enveloping within analytical solutions, particularly as additional data is available from initial flights. Where there is enough data to conservatively envelope certain failure modes, operators may desire to reduce their necessary computational resources by doing so.

The SpARC proposes the FAA require applicants to analyze vehicle impact and breakup risk in a new section, § 450.120, *Impact and breakup analysis*, in which applicants would document their causes of vehicle breakup and process for determining vehicle breakup states. Isolating these requirements would clarify FAA's intent that all applicants document vehicle breakup possibilities and their process to determine vehicle breakup states, regardless of whether the applicant chooses to use flight abort under § 450.108 or another hazard control strategy. Section 450.120(a) would include elements currently found in §§ 450.119 and 450.121, such as reasonably foreseeable causes of breakup and intact impact, and the probability distribution of vehicle position and velocity. Section 450.120(b) would exempt operators using a highly reliable flight safety system (FSS) under § 450.145 from having to simulate and analyze potential failures of their FSS because such failures are not foreseeable and, even if they arise, should not present risk to the public in excess of § 450.101.

The SpARC proposes the FAA revise § 450.121 to require an Impact and Debris Hazard Analysis. This regulation would retain many of the impact and breakup requirements currently found in § 450.121, but extract for placement in other regulations the requirements to identify reasonably foreseeable causes of breakup and intact impact (would appear in § 450.120(a)(1)), describe scenarios leading to hazardous debris (would appear in § 450.120(c)(1)), and describe atmospheric data used as inputs to debris analysis (to appear in new § 450.122, *Propagation of debris*). Revising § 450.121 to focus on analysis of hazardous debris in light of vehicle characteristics would align with current practice in which operators typically submit debris catalogs, debris hazard areas, and breakup criteria as separate products.

Lastly, the SpARC recommends the FAA move the debris propagation requirements from § 450.121 to a new section, § 450.122, *Propagation of debris*. This section would continue to provide distinguishing steps between phases of FSA with the remaining baseline FSA requirement of debris propagation prior to risk analysis.

APPROACH:

See redlines in Appendix A.

REC-G11/REC-R28 Improve efficacy and consistency of § 450.123

REC-G11	PROCESS/GUIDANCE: The FAA should make available a population database that applicants may use when overflying DoD sites in lieu of hiring USSF or using overly conservative modeling.
REC-R28	REGULATORY TEXT: The FAA should revise § 450.123(c)(2) to require a "representative analysis."

INTENT:

The intent is to remove inequity posed by § 450.123(b)(3) for applicants who are not using USSF services to satisfy § 450.123 through option of FAA-provided database for overflights of DoD sites, and to align the application requirements with the overall intent of § 450.123.

RATIONALE:

Operators proposing to overfly land owned or operated by the DoD have gleaned that the only population database that FAA will accept in satisfaction of § 450.123(b)(3)'s requirement for "reliable, accurate, and timely source data" is the database maintained by DoD. For applicants relying on USSF services to satisfy § 450.123, this does not pose an issue. Applicants who endeavor to perform their own population exposure analysis, however, are faced with the inequitable dilemma of either expending additional funds to hire USSF to perform their § 450.123 analysis (regardless of any in-house capability developed by the applicant) or using an overly conservative population model. If the applicant elects to use overly conservative modeling, this opens the door to inconsistent implementation of § 450.123(b)(3) because the applicant has no way of knowing whether its overestimate is on par with or exceeds (and if so, by how much) any overestimates that the FAA has accepted for other applicants. In other words, applicants using overly conservative modeling in lieu of Range services for § 450.123 are held to different safety standards because they cannot be sure that their model is consistent with those accepted by the FAA for other applicants generating their own compliance evidence for § 450.123.

This dilemma particularly affects reentry operators, who are generally less reliant on Federal Range sites and services than launch operators.

Unless the FAA makes available a population database for areas owned or operated by DoD that all license applicants may use, any applicant who proposes to overfly DoD sites, but does not rely on USSF services to meet § 450.123, will continue to be at an unfair disadvantage. The SpARC recognizes that publication of DoD's population database is infeasible given the sensitive data contained therein. The FAA could, however, extract a copy of the database—even a redacted or obfuscated version, if necessary—that applicants could elect to use instead of developing their own overly-conservative model. The FAA could even offer this option without disclosing the database itself to applicants such that applicants need only plug in their relevant mission details.

Lastly, the SpARC recommends the FAA insert "for a representative analysis" after "complete population exposure data" in § 450.123(c)(2) to align this requirement with the overall intent of § 450.123.

APPROACH:

The FAA should add "for a representative analysis" to § 450.123(c)(2).

The FAA should make a population database available for DoD sites that satisfies § 450.123(b)(3) that any part 450 applicant may use if they are overflying the DoD site and generating their own population exposure analysis, rather than relying on USSF services. Applicants who do not rely on Range services could still elect to use an overly conservative model if suitable to their operations; the goal is to provide an equitable alternative to avoid reliance on USSF services not otherwise needed and inflated analysis due to overrepresented population exposure. This would require no change to the regulatory text, but the FAA should outline these three MOC (Range services, FAA database, or applicant-developed model) in an AC or other guidance.

REC-R29 Rework Probability of failure analysis (§ 450.131) to reflect practice

REC-R29	REGULATORY TEXT: The FAA should streamline and rework the probability of failure analysis requirement in § 450.131 to reflect expected practice.

INTENT:

The intent is to restructure the probability of failure analysis requirements in § 450.131 based on expected practice and better streamline this regulation to remove undue burden to applicants.

RATIONALE:

Probability of failure (PoF) analysis has presented significant challenges to part 450 applicants due in part to ambiguities in the current text, and in part to inconsistent implementation by the FAA. The SpARC recommends the FAA rework § 450.131 entirely to (1) reflect the four main steps of PoF analysis; (2) remove language that is ambiguous, overbroad, or redundant; and (3) align with the SpARC's recommended removal of § 450.115(c) and revisions to reentry scope (*see* discussion of § 450.3 in this report) and mishap definition.

The SpARC recommends the FAA reorganize paragraphs (b) through (e) of § 450.131 to reflect the four steps FAA expects applicants to take when analyzing PoF: (1) determine phases of flight; (2) estimate failure probabilities; (3) calculate failure rate; and (4) determine failure mode allocations. This will help applicants prepare better application material and evidence a fulsome analysis.

The meaning of "failure" for PoF purposes is also unclear from the text of the regulation. The SpARC recommends the FAA add greater clarity to this definition, included as paragraph (a) in proposed rework of § 450.131 in Appendix A.

Consistent with the SpARC's recommendation to descope the FAA's definition of mishap to exclude events having no impact on public safety, the SpARC recommends the FAA limit the scope of failures relevant to PoF to only events capable of presenting risk to the public (*see* proposed § 450.131(c) in Appendix A). To this end, the FAA should also strike "as planned" when describing failure to "complete any phase of normal flight," as this phrase renders a range of events that have no impact on safety or mission success within the scope of failures relevant to PoF. Under the current regulation, successful completion of a landing burn using nine engines instead of 10 would constitute a failure, which poses an unreasonable burden on applicants with no safety benefit. The SpARC notes further that in cases where an applicant identifies corrective actions taken to prevent recurrence of a mishap or anomaly when calculating failure probability in accordance with § 450.131(c), those corrective actions should decrease the resultant PoF in many cases because the corrective actions would ultimately improve the overall reliability of the vehicle. The SpARC encourages the FAA to provide guidance on factors such as this which may decrease PoF.

The SpARC recommends the FAA codify as § 450.131(b) the process that the FAA has only encouraged through guidance for identifying flight phases for PoF purposes. The language proposed as paragraph (b) in proposed § 450.131 below draws heavily from AC 450.101-1 and would provide clear requirements for ensuring continuous PoF distribution for each failure mode.

APPROACH:

See redlines in Appendix A. The recommended redlines are intended to provide clear segmentation of PoF methods, allowing additional certainty for applicants. In reviewing the recommended redlines, the FAA should evaluate the catalog of currently approved PoF analyses and identify if any of the content borrowed from the AC is too prescriptive or may unnecessarily complicate compliance.

The SpARC also encourages the FAA to publish guidance on factors that may drive down a PoF calculation, including corrective actions that are implemented to prevent recurrence of a mishap or anomaly and, as such, improve the overall reliability of the vehicle.

REC-R30 Improve flexibility in Flight hazard area analysis (§ 450.133)

REC-R30	REGULATORY TEXT: As with § 450.101(f), the FAA should revise § 450.133 to allow operators to develop risk contours based on probability of casualty as an alternative to the existing requirements for 97% probability of containment.

INTENT:

The intent is to allow operators to develop risk contours based on probability of casualty, in lieu of the more conservative requirement to establish contours with 97% probability of containment.

RATIONALE:

Consistent with proposed revision to § 450.101(f), the FAA should amend each requirement for 97% probability of containment in § 450.133 to allow operators to identify hazard areas based either on the existing requirement (97% probability of containment) or a numeric threshold for probability of casualty. The 97% containment requirement is overly conservative in some cases. The current regulation for hazard area analysis associated with normal flight events requires defining areas large enough to contain, with 97% probability, all debris capable of causing a casualty—even when disposal is targeted over broad ocean regions. A recent FAA paper notes that substantial uncertainty is already applied in debris catalog development; this conservatism can lead to debris footprints that are unrealistically large.[40] For disposal and reentry missions, although the debris footprint itself may be extensive, the corresponding 1E-6 risk contours to aircraft and 1E-5 risk contours to waterborne vessels are typically very small. Publishing hazard areas that reflect the actual incremental risk to aircraft and vessels is sufficient to protect public safety. This approach was employed under the legacy part 417 regulations and continues to be utilized by DoD and NASA today, where it has been shown to effectively safeguard the public. Conversely, publishing excessively conservative hazard areas can create unnecessary disruption to maritime and air traffic operations.

Rather than requiring all license applicants to adhere to this more cumbersome requirement, the FAA should include an option in § 450.133 to develop risk contours based on probability of casualty. Applicants could still choose to use the 97% containment requirement if suitable or simpler for their operations, but the recommended revision would allow an alternate route without having to seek a waiver or ELOS.

APPROACH:

The FAA should revise §§ 450.133(b)(1), (c)(1), (d)(1), and (e)(2)(ii) to give applicants the option to define hazard areas based on probability of casualty, as an alternative to the existing requirement to develop contours based on 97% probability of containment. To define actual risk, the SpARC recommends retaining the existing probability of casualty or probability of impact thresholds currently found in § 450.133. To

[40] Federal Aviation Administration, *A Critical Analysis of Reentry Debris Uncertainty and International Coordination Efforts*, Submittal to the 75th International Astronautical Congress 2024, https://iafastro.directory/iac/archive/browse/IAC-24/D6/1/89694/.

enhance clarity in § 450.133(b), the SpARC recommends FAA adopt language indicating the inclusion of "normal flight events."

The FAA should also replace the reference to § 450.121 in § 450.133(a) with a reference to § 450.122, consistent with the SpARC's proposed rework of §§ 450.119-122.

REC-R31 Debris risk analysis (§ 450.135)

REC-R31	REGULATORY TEXT: The FAA should parse the two analyses described in § 450.135 into two separate requirements, consistent with actual practice.

INTENT:

The intent is to align § 450.135 with actual practice by moving the requirement to perform a casualty area and consequence analysis to a separate section (§ 450.132), while debris risk would continue to be analyzed under § 450.135.

RATIONALE:

Both §§ 450.133 and 450.135 require vulnerability modeling to buildings, aircraft, and ships. Even though it is not explicitly stated in § 450.133, an operator cannot determine debris capable of causing a casualty without modeling vulnerability. Thus, having vulnerability modeling requirements only in § 450.135 means generating repetitive or confusing compliance evidence between these two regulations. Moving vulnerability modeling to its own regulation would streamline MOC generation, making it less burdensome on operators and avoiding duplicative content for FAA reviewers.

APPROACH:

The FAA should move § 450.135(b) and the corresponding application requirements (§ 450.135(c)(2)-(4)) to a new section, § 450.132, focused on casualty area and consequence analysis. The proposed redlines accompanying this report in Appendix A reflect how § 450.135 would continue to require only the debris risk analysis per paragraph (a), along with the relevant, renumbered application criteria.

REC-R32 Clarify requirements of Far Field Overpressure Analysis

REC-R32	REGULATORY TEXT: The FAA should clarify far-field overpressure requirements in § 450.137 and align the regulation with industry and USSF practice.

INTENT:

The intent is to enhance clarity of far-field overpressure blast effects analysis requirements, thereby alleviating evidentiary burden on applicants, and align regulation with industry and USSF practice.

RATIONALE:

The FAA should clarify the requirements in § 450.137 in several ways. First, the FAA should replace the phrase "at altitude" in current § 450.137(b)(1) with a quantitative threshold above which at-altitude explosions would cease to matter. This would ensure the FAA regulation goes no further than the degree needed to protect public safety, while providing clarity to both applicants and FAA evaluators as to the substantive requirement. The SpARC recommends "below 1 km altitude" as the quantitative threshold.

The SpARC recommends the FAA add "building" before "windows" in §§ 450.137(b)(3) and (c)(4) to avoid any insinuation that the applicant should also account for windows attached to vehicles or other non-structures. The FAA could further clarify this caveat in guidance. As with § 450.137(b)(1), the SpARC recommends the FAA establish a numerical threshold in § 450.137(b)(3) below which risk would be negligible and, as such, excluded from evaluation. The SpARC recommends "between 69 Pa and 6,900 Pa" as the numeric threshold, consistent with industry standard and USSF practice. The 69 Pa threshold is where overpressure modeling begins under RCC requirements and 6,900 Pa represents near-field overpressures, which is outside of the scope of far-field blast overpressure requirements.

In § 450.137(c), the SpARC recommends restructuring of some application criteria to reflect analytical sequence and greater fidelity to risk criteria in § 450.101. Specifically, the FAA should revise §§ 450.137(c)(7) and (c)(8) to align with analytical ordering (i.e. concluding the regulation with risk results) and § 450.101. Specifically, § 450.137(c)(8) seeks to replace the confusing requirement in the current § 450.137(c)(6), as it does not make sense to provide hypothetical individual risk contours for a hazard that requires people to be inside static structures. The SpARC recommends the FAA align the risk results requirement with language that is consistent with debris risk.

APPROACH:

See proposed redlines in Appendix A.

REC-R33 Align FAA implementation of § 450.139 with regulatory text

REC-R33	REGULATORY TEXT: The FAA should stop levying § 450.35(a) to require toxic release hazard analysis and/or toxics catalog outside of the 180-day review period, in clear contravention of the regulatory text.

INTENT:

The intent is to align FAA practice with regulatory text in §§ 450.139 and 450.35 should the FAA retain this provision.

RATIONALE:

If the FAA retains all or part of § 450.35, or during the interim between such time as FAA may amend § 450.35, the FAA should immediately revise its practice to align with the plain text in §§ 450.35(a)(2) and 450.35(a)(5). Both sections call for FAA acceptance of a means of compliance *should the applicant elect* to perform a toxic risk assessment in accordance with §§ 450.139(e)(1) and/or 450.187(e)(1). Specifically, an applicant must receive FAA approval of their means of accounting "for airborne concentration and duration thresholds of toxic propellants or other chemicals." If an applicant does not intend to perform a toxic risk assessment, and would instead perform toxic containment (per §§ 450.139(d) and/or 450.187(d)) to manage risk after conducting a toxic release hazard analysis (TRHA), then there is no need to submit a means of complying with §§ 450.139(e)(1) and/or 450.187(e)(1) to FAA before submitting a license application.

Contrary to the foregoing, FAA practice has been to require applicants to certify to the FAA prior to submitting their license application that either a) their proposed operation will not involve toxics, which requires a fulsome account of all materials proposed to be built into or carried on the vehicle; or b) if toxics will be present, the results of the TRHA, before getting to the proposed MOC with §§ 450.139(e)(1) and/or 450.187(e)(1). As with FAA's frontloading of FSA approvals prior to application evaluation, this forces applicants to undergo significant analytical work wholly outside the 180-day statutory clock and, in many cases, at a time when final materials are not yet known (e.g. for manifested payloads). The FAA's practice in this regard plainly contradicts the text of §§ 450.35(a)(2) and 450.35(a)(5), which should apply only when applicants elect to perform toxic risk assessment and require only review of the applicant's means of accounting for airborne concentration and duration thresholds.

APPROACH:

The FAA should stop levying § 450.35(a) to require TRHA evidence and/or catalogs of vehicle materials outside of the 180-day application review period, in clear violation of the regulatory text. The FAA should instead apply §§ 450.35(a)(2) and 450.35(a)(5) as written, requiring only that applicants perform a toxic risk assessment (following TRHA completion) and submit their means of accounting for airborne concentration and duration thresholds per §§ 450.139(e)(1) and/or 450.187(e)(1).

REC-R34 FSA inputs in pre-flight report (§ 450.213)

REC-R34	REGULATORY TEXT: The FAA should revise § 450.213(b)(2) to require only vacuum instantaneous impact points for planned impact points.

INTENT:

To alleviate undue burden on applicants and align § 450.213(b) with the purpose of pre-flight reporting, which is to notify the FAA of upcoming licensed operations.

RATIONALE:

Pre-flight reports generated in accordance with § 450.213 serve to notify the FAA of upcoming licensed operations and confirm compliance with license parameters. These reports are not used to evaluate FSA methods or the outputs generated using FAA-approved FSA methods. The mission information required for pre-flight reports under § 450.213(b)(2) is reflective of this reality, save for the requirement for "staging and impact locations." The FAA has interpreted this language to call for drag-corrected impact points for staging and reentry location, which is inconsistent with the purpose of pre-flight reports and unduly burdensome for applicants. Licensees are required to establish and publish hazard areas generated in accordance with § 450.133 *Hazard Area Analysis* to provide notice so that members of the public, including mariners and airmen, can avoid the designated area. It is therefore unnecessary for the FAA to also require that licensees provide the FAA with drag-corrected impact points for staging and reentry locations. Instead, the FAA should require only vacuum instantaneous impact points (IIPs) in pre-flight reports.

APPROACH:

The FAA should revise § 450.213(b)(2) to call for only vacuum IIPs. See proposed revision in Appendix A.

REC-R35 Clarify Surveillance Requirements in § 450.161

REC-R35	REGULATORY TEXT: The FAA should update § 450.161 to clarify hazard area control and surveillance requirements and constrain applicability to hazard areas surrounding the launch and/or landing area. Additionally, corresponding updates and details should be implemented in AC 450.161-1 and coordinated with USCG.

INTENT:

The intent is to implement changes to surveillance requirements that recognize practical operations considerations, such as timing of go/no-go decisions, inaccuracies of downrange surveillance status assessed an hour or more in advance of the hazard, available surveillance methods and data, and excessive obstruction of public movement especially as it relates to down-range launch vehicle stage disposals and reentry vehicle landing/splashdowns.

RATIONALE:

Spaceflight operators are responsible for executing or procuring services to exercise control over hazard areas through one or several of the means listed in § 450.161(a). In practice, operators licensed under part 450 may be required to expend significant resources to demonstrate compliance with § 450.161 requirements that greatly differ from federal range practices. This is impactful to operations at non-federal ranges who are precluded from using federal range practices as well as surveillance strategies for operations in remote locations such as disposals in ocean areas and reentry operations.

The FAA's application of requirements in § 450.161 have deviated from past practices so significantly that once acceptable maritime surveillance practices are no longer satisfactory, and operations now require more assets physically on location in order to conduct operations even in remote locations. This is impactful because unlike aviation operations where a U.S. government organization is responsible for routing traffic, maritime traffic is not as predictable, has no central management for routing, and vessels typically do not obey hazard area publications with the same reliability as aircraft. This requires launch and reentry operators either inject significant conservatism into their analysis, have limiting flight rules, lower flight availability, expend significant resources to analyze maritime patterns, and/or conduct on-site surveillance. Furthermore, reentry go/no-go decisions are commonly on the order of an hour or more prior to landing, making ocean surveillance data perishable and related forecasts of negligible value. While operators entirely understand the motivations to protect the public via control of hazard areas, AST's current enforcement of § 450.161 can require extremely draconian approaches that vastly outweigh the likelihood of hazards or consequences to the public.

Further, the application of § 450.161(a) in operators' experience is inconsistent with the language:

> The operator must publicize, survey, control, or evacuate each flight hazard area identified in accordance with § 450.133 prior to initiating flight of a launch vehicle or the reentry of a reentry vehicle to the extent necessary to ensure compliance with § 450.101.

The list "publicize, survey, control, or evacuate" grammatically implies a choice between four options. In reality, publicity is not optional, and surveillance, control, or evacuation may be necessary to assure prerequisite conditions for flight in accordance with § 450.161(b):

> The launch or reentry operator must perform surveillance sufficient to verify or update the assumptions, input data, and results of the flight safety analyses.

Operators complying with this requirement have historically been asked by the FAA to provide rationale for each of the methods despite the inherent flexibility of the requirements, which is written to allow operators to select their control strategy from the list.

These requirements, similar to other features of part 450, also do not adequately consider reentry or disposal operations. In many scenarios, stage disposal area or reentry area surveillance may be cost prohibitive, unsafe for personnel, and complex to execute. Because disposal sequences are usually automated and reentry operations do not hazard the landing location until several minutes or hours after initiation, there is often significant conservatism needed to bound where aircraft, vessels, or land-based populations may be when the disposal or reentry actually hazard the landing or splashdown location. Given the extended duration between launch and disposal impact, predicted vessel locations in or near the 97% containment area are so uncertain that the level of risk is not discernable when the go/no-go decision occurs. The same holds true for reentry, with go/no-go decisions typically occurring around an hour prior to impact/landing.

APPROACH:

The FAA should clarify definitions to distinguish between flight hazard and debris containment areas such that the former is defined by risk and the latter reflects an area of uncertainty. See redlines in Appendix A.

XII. Recommendations: Additional Terms & Conditions

REC-R36 Increase Utilization of Process Approvals to Minimize Ongoing Compliance Reviews

REC-R36	REGULATORY TEXT: The FAA should narrow the scope of application changes requiring license modification under § 450.211 and discontinue practice of reviewing compliance products generated under continuing accuracy requirements when the underlying process remains static and outcomes remain acceptable.

INTENT:

The intent is to appropriately reduce FAA scope of review for continuing accuracy and modifications and allow the FAA to focus limited resources on changes affecting safety-critical matters or means of compliance used to meet safety regulations.

RATIONALE:

The scope of application updates requiring modification to a license under § 450.211 functionally includes all changes to compliance documentation associated with safety requirements. This can be an incredibly burdensome review process for both the FAA and the licensee even when changes are minor. A shift towards process-based approvals is the only way to enable high cadence, low overhead launch and reentry operations while supporting changes in design or operations that have no bearing on safety results.

The FAA often re-reviews all updated application material for safety impacts under § 450.211. For documentation, such as systems safety products, this can generate a high number of comments and requests for clarification even if no downstream impacts or potential non-compliances are identified. Similarly, new trajectories, even when determined from approved MOCs, can require fulsome re-review of the FSA method and output generated therewith. The lack of clear prioritization can mean that FAA personnel must equally weight changes that generate a new risk to the public, with changes that do not impact safety, but merely generate new content in an existing submission.

APPROACH:

The FAA should eliminate from the scope of changes requiring license modification or re-review under § 450.211 all changes that do not have significant impact on public safety. For example, systems safety products can be readily divorced from the approved processes that generate them. The SpARC has not identified a statutory or regulatory limitation on this type of review. Regulatory changes can be made to solidify the scope of modifications and allow a closer connection to the concept of Means of Compliance. Please see the recommended redlines to § 450.211 in Appendix A.

REC-R37 De-scope Post-flight Reporting (§ 450.215)

REC-R37	REGULATORY TEXT: The FAA should reduce scope of post-flight reporting under § 450.215.

INTENT:

The intent is to relieve operators of reporting requirements that are redundant of pre-flight and/or mishap reporting under part 450, and to exempt operators flying under single-flight authorizations from post-flight reporting altogether.

RATIONALE:

The post-flight reporting requirements in § 450.215(b) are duplicative of other part 450 reporting requirements in two ways. First, § 450.215(b)(2)'s requirement to identify corrective actions implemented or to-be-implemented in future flights after an anomaly or mishap is redundant of the mishap reporting requirements in §§ 450.173(e) and (f), which call for identification of root causes and preventive measures. For vehicles completing their second or greater flight, this requirement is also duplicative of the requirement to identify outcomes of past mishaps or anomalies when calculating PoF under § 450.131. Second, § 450.215(b)(3) is duplicative of the pre-flight reporting requirements in § 450.213, the safety approval under § 450.45 (specifically, § 450.45(e)(5)), and § 450.207's requirement to demonstrate compliance with part 460 – as demonstrations of compliance with each of these requirements would entail a description of the human spaceflight mission and number of persons to be carried on the vehicle.

The SpARC also notes that while part 450 was intended to authorize multiple flights under a single vehicle operator license, in practice the FAA seldom authorizes multiple flights under part 450—at least not initially. Rather, the FAA's practice is to issue single-flight authorizations and require licensees to submit additional compliance evidence for re-review to modify their license to include additional flights. Given the high likelihood that new part 450 licensees will be required to submit additional evidence to modify their license for continued flights—including details far beyond those solicited by § 450.215—the FAA should exempt licensees flying under single-flight authorizations from the post-flight reporting requirements altogether. Requiring single-flight licensees to produce post-flight reports under § 450.215 adds undue burden to an operator working toward their next flight, with no measurable benefit to public safety.

APPROACH:

The FAA should strike § 450.215(b)(2) and (3) as redundant of existing part 450 reporting requirements.

The FAA should exempt launches or reentries conducted under a part 450 license authorizing only one flight from § 450.215 entirely. Recommended redlines appear in Appendix A.

REC-P17 Expansion of Experimental Permits

REC-P17	PROCESS: The FAA should expand eligibility for experimental permits under part 437 to include all types of new vehicles.

INTENT:

The intent is to allow newer operators and operators of newer vehicles to test and qualify vehicles under a simpler process, yielding data to support a future part 450 application. The FAA should expand the eligibility of experimental permits under part 437 to include all types of launch and reentry vehicles.

RATIONALE:

The SpARC finds that the vehicle licensing process under part 450 is unduly burdensome for development and test flights of a new vehicle. Such flights are conducted for the purpose of technology proof of concept or demonstration, involve as little as a single flight of a particular configuration, and often provide no commercial revenue. The FAA should expand eligibility for experimental permits under part 437 to include development and test flights of all new vehicles, whether expendable or reusable, suborbital or orbital. This would not only level the regulatory scope for all types of experimental vehicles, but it would also clearly distinguish experimental (i.e. test) vehicles, which may carry a higher probability of failure, and operational vehicles, which meet risk criteria for licensing. Such a distinction would offer learning opportunities in a risk-limited environment while furthering public confidence in the safety of licensed vehicles. Furthermore, for licensed vehicles that have completed a successful test program, a reduced probability of failure on operational flights may correspond to an increase in mission success by virtue of expanded flight limits.

To implement experimental permits on such a wide range of vehicles requires a robust, qualitative risk assessment so that the FAA may identify appropriate flight constraints necessary to contain risk. The hazard analysis described under part 437 (Experimental Permits) is analogous to the Functional Hazard Analysis (FuHA) under part 450 but could be enhanced with elements of Flight Hazard Analysis (FHA) to more thoroughly evaluate public risk. Additionally, a system maturity metric could be applied to further enhance risk assessment, whether in the experimental phase or carried through to licensed operations, and could help determine what changes are substantive in terms of license modifications.

The FuHA (§ 450.107) currently identifies failure and response modes for casualty-causing events, where a flight hazard analysis evaluates the associated risks. Expanding the FuHA to include likelihood and consequence for casualty-causing events (much like an abbreviated FHA, per § 450.109) can provide additional context to qualitatively assess risk, not only for each hazardous event, but also collectively. As currently employed in the FAA's FHA template, each likelihood/consequence is assigned a numerical risk value that can be plotted on a risk acceptability matrix. While all plotted risks may be considered acceptable, accumulated risk should be considered in determining what risk mitigation measures (i.e., remote launch/landing, overflight constraints) are appropriate. Accumulated risk levels could be defined by the FAA based on the sum of the risk numbers, thereby considering not only the largest risk but the cumulative effect of numerous lower level risks. As necessary to show acceptable overall risk, this assessment could be performed separately for each phase of flight to show that risk is not concentrated but spread across multiple populations.

In addition, or alternatively, a system maturity metric could be used as a scaling factor that represents the extent to which a configuration has been proven. This could be structured like the Technology Readiness Levels (for both hardware and software) used by DoD and NASA, though perhaps at a lower fidelity (e.g., 5 levels vs. 9). A level would be assigned based on the extent and fidelity of testing, and the number/magnitude of configuration changes. The level would then determine a factor applied to overall probability of success (POS). Such an evaluation could also be applied to operational flights to determine whether a change is significant enough to warrant a license modification.

As an example, the first flight of a new vehicle may warrant a maturity level 3 based on rigorous testing and proven components, resulting in being assigned a POS factor of .5 (50% likelihood of normal flight). After the first successful flight, it could rise to a maturity level of 4, increasing POS to 75%. A vehicle having achieved two consecutive successful flights in similar configuration could be assigned a 5 (indicative of an operational vehicle) with a 90% POS. If a major change, or multiple lesser changes, are made prior to a subsequent flight, the maturity level would be reduced accordingly. Such use of POS would effectively scale the size of hazard areas and associated flight limits.

APPROACH:

To allow newer operators and operators of newer vehicles to test and qualify vehicles under a simpler process, yielding data to support a future part 450 application, the FAA should expand the eligibility of experimental permits under part 437 to include all types of launch and reentry vehicles, whether expendable or reusable, suborbital or orbital. The FAA should employ a qualitative risk assessment under part 437, so that the FAA may identify any flight constraints necessary to contain risk.

XIII. Appendices

Appendix A – Redlines

Appendix A provides the redlined edits referenced within the report to the current regulatory text, showing all recommended revisions in context. It presents proposed changes alongside the existing language, allowing to easily compare, evaluate, and understand the specific modifications proposed throughout the report.

§ 401.7 Definitions.

For the purposes of this chapter unless otherwise excepted, the following definitions apply:

Act means 51 U.S.C Subtitle V, Programs Targeting Commercial Opportunities, chapter 509—Commercial Space Launch Activities, 51 U.S.C. 50901-50923.

Anomaly means any condition during licensed or permitted activity that deviates from what is standard, normal, or expected, during the verification or operation of a system, subsystem, process, facility, or support equipment.

Associate Administrator means the Associate Administrator for Commercial Space Transportation, Federal Aviation Administration, or any person designated by the Associate Administrator to exercise the authority or discharge the responsibilities of the Associate Administrator.

Casualty means serious injury or death.

Casualty area means the area surrounding each potential debris or vehicle impact point where serious injuries, or worse, can occur.

Command control system means the portion of a flight safety system that includes all components needed to send a flight abort control signal to the on-board portion of a flight safety system.

Contingency abort means a flight abort with a landing at a planned location that has been designated in advance of vehicle flight.

Countdown means the timed sequence of events that must take place to initiate flight of a launch vehicle or reentry of a reentry vehicle.

Crew means any employee or independent contractor of a licensee, transferee, or permittee, or of a contractor or subcontractor of a licensee, transferee, or permittee, who performs activities in the course of that employment or contract directly relating to the launch, reentry, or other operation of or in a launch vehicle or reentry vehicle that carries human beings. A crew consists of flight crew and any remote operator.

Critical asset means an asset that is essential to the national interests of the United States. Critical assets include property, facilities, or infrastructure necessary for national security purposes, high priority civil space purposes, or assured access to space for national priority missions.

Critical payload means a payload and essential infrastructure directly supporting such a payload that is a critical asset that:

(1) Is so costly or unique that it cannot be readily replaced; or

(2) The time frame for its replacement would adversely affect the national interests of the United States.

Crossrange means the distance measured along a line whose direction is either 90 degrees clockwise (right crossrange) or counter-clockwise (left crossrange) to the projection of a vehicle's planned nominal velocity vector azimuth onto a horizontal plane tangent to the ellipsoidal Earth model at the vehicle's sub-vehicle point. The terms right crossrange and left crossrange may also be used to indicate direction.

Deorbit means the flight of a vehicle that begins with the final command to commit to a perigee below 70 nautical miles (approximately 130 kilometers), and ends when all vehicle components come to rest on the Earth.

Disposal means the return or attempt to return, purposefully, a ~~launch~~ vehicle stage or component~~, not including a reentry vehicle,~~ from Earth orbit to Earth in a controlled manner.

Downrange means the distance measured along a line whose direction is parallel to the projection of a vehicle's planned nominal velocity vector azimuth into a horizontal plane tangent to the ellipsoidal Earth model at the vehicle sub-vehicle point. The term downrange may also be used to indicate direction.

Effective casualty area means the aggregate casualty area of each piece of debris created by a vehicle failure at a particular point on its trajectory. The effective casualty area for each piece of debris is a modeling construct in which the area within which 100 percent of the population are assumed to be a casualty, and outside of which 100 percent of the population are assumed not to be a casualty.

Equivalent level of safety means an approximately equal level of safety as determined by qualitative or quantitative means.

Expected casualty means the mean number of casualties predicted to occur per flight operation if the operation were repeated many times.

Expendable launch vehicle means a launch vehicle whose propulsive stages are flown only once.

Experimental permit or *permit* means an authorization by the FAA to a person to launch or reenter a reusable suborbital rocket.

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

Federal launch or reentry site means a launch or reentry site, from which launches routinely take place, that is owned and operated by the government of the United States.

Flight abort means the process to limit or restrict the hazards to public safety, and the safety of property, presented by a launch vehicle or reentry vehicle, including any payload, while in flight by initiating and accomplishing a controlled ending to vehicle flight.

Flight abort rules means the conditions under which a flight safety system must abort the flight to ensure compliance with the safety criteria in § 450.101.

Flight crew means crew that is on board a vehicle during a launch or reentry.

Flight hazard area means any region of land, sea, or air that must be surveyed, publicized, controlled, or evacuated to ensure compliance with the safety criteria in § 450.101.

Flight safety limit means criteria to ensure that public safety and critical assets are protected from the flight of a vehicle when a flight safety system functions properly.

Flight safety system means a system used to implement flight abort. A flight safety system includes any flight safety system located on board a launch or reentry vehicle; any ground based command control system; any support system, including telemetry subsystems and tracking subsystems, necessary to support a flight abort decision; and the functions of any personnel who operate the flight safety system hardware or software.

Government astronaut means an individual who—

(1) Is designated by the National Aeronautics and Space Administration under Title 51, United States Code, Section 20113(n);

(2) Is carried within a launch vehicle or reentry vehicle in the course of their employment, which may include performance of activities directly relating to the launch, reentry, or other operation of the launch vehicle or reentry vehicle; and

(3) Is either—

(i) An employee of the United States Government, including the uniformed services, engaged in the performance of a Federal function under authority of law or an Executive act; or

(ii) An international partner astronaut.

Hazard control means a preventative measure or mitigation put in place for systems or operations to reduce the severity of a hazard or the likelihood of the hazard occurring.

Hazardous debris means any object or substance capable of causing a casualty or loss of functionality to a critical asset. Hazardous debris includes inert debris and explosive debris such as an intact vehicle, vehicle fragments, any detached vehicle component whether intact or in fragments, payload, and any planned jettison bodies.

Hazardous materials means hazardous materials as defined in 49 CFR 172.101.

Instantaneous impact point means a predicted impact point, following thrust termination of a vehicle.

International partner astronaut means an individual designated under Article 11 of the International Space Station Intergovernmental Agreement, by a partner to that agreement other than the United States, as qualified to serve as an International Space Station crew member.

International Space Station Intergovernmental Agreement means the Agreement Concerning Cooperation on the International Space Station, signed in Washington, DC, on January 29, 1998 (TIAS 12927).

Key flight safety event means a flight activity that has an increased likelihood of causing a failure compared with other portions of flight.

Launch means to place or try to place a launch vehicle or reentry vehicle and any payload or human being from Earth in a suborbital trajectory, in Earth orbit in outer space, or otherwise in outer space, including activities involved in the preparation of a launch vehicle or payload for launch, when those activities take place at a launch site in the United States.

Launch operator means a person who conducts or who will conduct the launch of a launch vehicle and any payload.

Launch or reentry system means the integrated set of subsystems, personnel, products, and processes that, when combined, carries out a launch or reentry.

Launch site means the location on Earth from which a launch takes place (as defined in a license the Secretary issues or transfers under this chapter) and necessary facilities at that location.

Launch vehicle means a vehicle built to operate in, or place a payload in, outer space or a suborbital rocket.

Launch window means an approved period of time during which the flight of a launch vehicle may be initiated.

Liftoff means any motion of the launch vehicle with intention to initiate flight.

Limits of a useful mission means the trajectory data or other parameters that bound the performance of a useful mission, including flight azimuth limits.

Means of Compliance means an approach used to satisfy one or more sections or subsections of the regulations

Mishap means any event, or series of events associated with a licensed or permitted activity resulting in any of the following:

(1) A fatality or serious injury (as defined in 49 CFR 830.2);

(2) A malfunction of a safety-critical system;

(3) A failure of the licensee~~'s~~ or permittee~~'s~~ to follow safety processes ~~safety organization, safety~~ operations, ~~safety~~ or procedures represented in its application material;

(4) High risk,~~ as determined by the FAA,~~ of causing a serious or fatal injury to any space flight participant, crew, government astronaut, or member of the public;

(5) ~~Substantial d~~Damage~~, as determined by the FAA,~~ to property not associated with licensed or permitted activity resulting in a claim against an operator's financial responsibility required under Part 440;

~~(6) Unplanned substantial damage, as determined by the FAA, to property associated with licensed or permitted activity;~~

~~(7) Unplanned permanent loss of a launch or reentry vehicle during licensed activity or permitted activity;~~

(~~8~~6) The impact of hazardous debris outside the planned landing site or designated hazard area; or

(~~9~~7) Failure to complete a launch or reentry ~~as planned~~ as reported in § 450.213(b).

Neighboring operations personnel means those members of the public located within a launch or reentry site, or an adjacent launch or reentry site, who are not associated with a specific hazardous licensed or permitted operation currently being conducted, but are required to perform safety, security, or critical tasks at the site and are notified of the operation.

Nominal means, in reference to launch vehicle performance, trajectory, or stage impact point, a launch vehicle flight where all vehicle aerodynamic parameters are as expected, all vehicle internal and external systems perform exactly as planned, and there are no external perturbing influences other than atmospheric drag and gravity.

Normal flight means the flight of a properly performing vehicle whose real-time vacuum instantaneous impact point does not deviate from the nominal vacuum 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.

Operating environment means an environment that a launch or reentry vehicle component will experience during its lifecycle. Operating environments include shock, vibration, thermal cycle, acceleration, humidity, thermal vacuum, or other environments relevant to system or material degradation.

Operation hazard means a hazard created by an operating environment or by an unsafe act.

Operation of a launch site means the conduct of approved safety operations at a permanent site to support the launching of vehicles and payloads.

Operation of a reentry site means the conduct of safety operations at a permanent site on Earth at which a reentry vehicle and its payload, if any, is intended to land.

Operator means a holder of a license or permit under 51 U.S.C. Subtitle V, chapter 509.

Orbital extraction means the point at which a vehicle's orbit descends below a maximum 70-nautical mile perigee.

Orbital insertion means the point at which a vehicle achieves a minimum 70-nautical mile perigee based on a computation that accounts for drag.

Payload means an object that a person undertakes to place in outer space by means of a launch vehicle, including components of the vehicle specifically designed or adapted for that object.

Person means an individual or an entity organized or existing under the laws of a State or country.

Physical containment means a launch vehicle does not have sufficient energy for any hazards associated with its flight to reach the public or critical assets.

Physical electronic storage means a physical device that can store electronic documents and files including but not limited to an optical disc, a memory card, a USB flash drive, or an external hard drive.

Pilot means a flight crew member who has the ability to control, in real time, a launch or reentry vehicle's flight path.

Populated area means—

(1) An outdoor location, structure, or cluster of structures that may be occupied by people;

(2) Sections of roadways and waterways that are frequented by automobile and boat traffic; or

(3) Agricultural lands, if routinely occupied by field workers.

Probability of casualty means the likelihood that a person will suffer a serious injury or worse, including a fatal injury, due to all hazards from an operation at a specific location.

Public means, for a particular licensed or permitted launch or reentry, people that are not involved in supporting the launch or reentry and includes those people who may be located within the launch or reentry site, such as visitors, individuals providing goods or services not related to launch or reentry processing or flight, and any other operator and its personnel.

Reenter; reentry means to return or attempt to return, purposefully, a reentry vehicle and its payload or human being, if any, from Earth orbit or from outer space to Earth.

Return means the controlled flight of a suborbital launch vehicle stage to a landing location at or in the vicinity of the launch site.

Reentry operator means a person responsible for conducting the reentry of a reentry vehicle as specified in a license issued by the FAA.

Reentry site means the location on Earth where a reentry vehicle is intended to return. It includes the area within three standard deviations of the intended landing point (the predicted three-sigma footprint).

Reentry vehicle means a vehicle designed to return from Earth orbit or outer space to Earth substantially intact. A reusable launch vehicle that is designed to return from Earth orbit or outer space to Earth substantially intact is a reentry vehicle.

Reentry window means an approved period of time during which the reentry of a reentry vehicle may be initiated.

Remote operator means a crew member who—

(1) Has the ability to control, in real time, a launch or reentry vehicle's flight path; and

(2) Is not on board the controlled vehicle.

Reusable launch vehicle (RLV) means a launch vehicle that is designed to return to Earth substantially intact and therefore may be launched more than one time or that contains vehicle stages that may be recovered by a launch operator for future use in the operation of a substantially similar launch vehicle.

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.

Safety critical ~~means essential to safe performance or operation.~~ A safety-critical system, subsystem, component, ~~condition~~, function, event, operation, process, or item, is one: ~~whose proper recognition, control, performance, or tolerance, is essential to ensuring public safety and the safety of property.~~

(a) whose malfunction may result in a catastrophic hazard that cannot be sufficiently mitigated to meet the risk criteria in § 450.101; or

(b) that is necessary to mitigate a catastrophic hazard to ensure compliance with the risk criteria in § 450.101.

For human spaceflight vehicles, this includes systems necessary for crew to exercise safety-critical control.

Service life means, for a safety-critical system component, the sum total of the component's storage life and operating life.

Sigma means a single standard deviation from a fixed value, such as a mean.

Software function means a collection of computer code that implements a requirement or performs an action. This includes firmware and operating systems.

Space flight participant means an individual, who is not crew or a government astronaut, carried on board a launch vehicle or reentry vehicle.

State and United States means, when used in a geographical sense, the several States, the District of Columbia, the Commonwealth of Puerto Rico, American Samoa, the United States Virgin Islands, Guam, and any other commonwealth, territory, or possession of the United States.

Suborbital rocket means a vehicle, rocket-propelled in whole or in part, intended for flight on a suborbital trajectory, and the thrust of which is greater than its lift for the majority of the rocket-powered portion of its ascent.

Suborbital trajectory means the intentional flight path of a launch vehicle, reentry vehicle, or any portion thereof, whose vacuum instantaneous impact point does not leave the surface of the Earth.

Sub-vehicle point means the location on an ellipsoidal Earth model where the normal to the ellipsoid passes through the vehicle's center of gravity.

System hazard means a hazard associated with a system and generally exists even when no operation is occurring.

Tether system means a device that contains launch vehicle hazards by physically constraining a launch vehicle in flight to a specified range from its launch point. A tether system includes all components, from

the tether's point of attachment to the vehicle to a solid base, that experience load during a tethered launch.

Toxic hazard area means a region on the Earth's surface where toxic concentrations and durations may be greater than accepted toxic thresholds for acute casualty, in the event of a worst case release or maximum credible release scenario during launch or reentry.

Uncontrolled area is an area of land not controlled by a launch or reentry operator, a launch or reentry site operator, an adjacent site operator, or other entity by agreement.

Unguided suborbital launch vehicle means a suborbital rocket that does not contain active guidance or a directional control system.

United States citizen means:

(1) Any individual who is a citizen of the United States;

(2) Any corporation, partnership, joint venture, association, or other entity organized or existing under the laws of the United States or any State; and

(3) Any corporation, partnership, joint venture, association, or other entity which is organized or exists under the laws of a foreign nation, if the controlling interest in such entity is held by an individual or entity described in paragraph (1) or (2) of this definition. Controlling interest means ownership of an amount of equity in such entity sufficient to direct management of the entity or to void transactions entered into by management. Ownership of at least fifty-one percent of the equity in an entity by persons described in paragraph (1) or (2) of this definition creates a rebuttable presumption that such interest is controlling.

Uprange means the distance measured along a line that is 180 degrees to the downrange direction.

Useful mission means a mission that can attain one or more objectives.

Validation means an evaluation to determine that each safety measure derived from a system safety process is correct, complete, consistent, unambiguous, verifiable, and technically feasible. Validation ensures that the right safety measure is implemented, and that the safety measure is well understood.

Verification means an evaluation to determine that safety measures derived from a system safety process are effective and have been properly implemented. Verification provides measurable evidence that a safety measure reduces risk to acceptable levels.

Wind weighting safety system means equipment, procedures, analysis and personnel functions used to determine the launcher elevation and azimuth settings that correct for wind effects that an unguided suborbital launch vehicle will experience during flight.

Window closure means a period of time when launch or reentry is not permitted in order to avoid a collision with an object in orbit. A window closure may occur within a launch or reentry window, may delay the start of a window, or terminate a window early.

§ 413.5 Pre-application consultation.

A prospective applicant may consult with the FAA before submitting an application to discuss the application process and possible issues relevant to the FAA's licensing or permitting decision. Early consultation helps an applicant to identify possible regulatory issues at the planning stage when changes to an application or to proposed licensed or permitted activities are less likely to result in significant delay or costs to the applicant.

Subpart A—General Information

§ 450.1 Applicability.

(a) **General.** This part prescribes requirements for obtaining and maintaining a license to launch, reenter, or both launch and reenter, a launch or reentry vehicle.

(b) **Exception.** Activities listed in § 450.1(a), which the U.S. Government carries out for the U.S. Government, are not required to obtain or maintain a license under this part.

(1) An activity listed in § 450.1(a) is considered to be carried out by the U.S. Government for the U.S. Government when:

(i) The government is responsible for authorization of launch and/or reentry activities through approvals and/or contractual requirements; and

(ii) The government exercises final flight decision authority.

(2) The following activities are not considered activities carried out by the U.S. Government for the U.S. Government under paragraph 450.1(b):

(i) A government astronaut being carried on or within a launch vehicle or within a reentry vehicle under this chapter.

(ii) A government astronaut performing activities relating to the launch, reentry, or other operation of the launch or reentry vehicle under this chapter.

§ 450.3 Scope of a vehicle operator license.

(a) ***General.*** A vehicle operator license authorizes a licensee to conduct one or more launches or reentries using the same vehicle or family of vehicles. A vehicle operator license identifies the scope of authorization as defined in paragraphs (b) and (c) of this section or as agreed to by the Administrator.

(b) ***Scope of launch.*** A vehicle operator license authorizes launch, which includes the flight of a launch vehicle and pre- and post-flight ground operations as follows:

(1) Launch begins when hazardous pre-flight operations commence at a U.S. launch site that may pose a threat to the public. Hazardous pre-flight operations that may pose a threat to the public include pressurizing or loading of propellants into the vehicle, operations involving a fueled launch vehicle, the transfer of energy necessary to initiate flight, or any hazardous activity preparing the vehicle for flight. Hazardous pre-flight operations do not include the period between the end of the previous launch and launch vehicle reuse, when the vehicle is in a safe and dormant state.

(2) At a non-U.S. launch site, launch begins at ignition or at the first movement that initiates flight, whichever occurs earlier.

(3) Launch ends when any of the following events occur:

(i) For an orbital launch of a vehicle without a reentry of the vehicle, launch ends after the licensee's last exercise of control over its vehicle on orbit, after vehicle component impact or landing on Earth, after activities necessary to return the vehicle or component to a safe condition on the ground after impact or landing, or after activities necessary to return the site to a safe condition, whichever occurs latest;

(ii) For an orbital launch of a vehicle with a reentry of the vehicle, launch ends after deployment of all payloads, upon completion of the vehicle's first steady-state orbit if there is no payload deployment, after vehicle component impact or landing on Earth, after activities necessary to return the vehicle or component to a safe condition on the ground after impact or landing, or after activities necessary to return the site to a safe condition, whichever occurs latest;

~~(iii) For a suborbital launch that includes a reentry, launch ends after reaching apogee;~~

(iii~~v~~) For a suborbital launch that does not include a reentry, launch ends after vehicle or vehicle component impact or landing on Earth, after activities necessary to return the vehicle or vehicle component to a safe condition on the ground after impact or landing, or after activities necessary to return the site to a safe condition, whichever occurs latest.

(c) ***Scope of reentry***. A vehicle operator license authorizes reentry~~. Reentry includes activities conducted in Earth orbit or outer space to determine reentry readiness and that are critical to ensuring public health and safety and the safety of property during reentry flight. Reentry also includes activities necessary to return the reentry vehicle, or vehicle component, to a safe condition on the ground after impact or landing.~~ which includes the flight of a reentry vehicle, and pre- and post-reentry operations as follows:

(1) Reentry begins with initiation of the maneuver sequence intended to result in impact on Earth.

(2) Reentry ends when any of the following occurs:

(i) After completion of post-landing and/or impact activities necessary to place the reentry vehicle in a safe condition, after impact of any expended vehicle components or debris, or after activities necessary to return the reentry site to a safe condition, whichever occurs latest;

(ii) After activities necessary to return the vehicle to a safe condition on orbit prior to another deorbit attempt; or

(iii) If deorbit is unsuccessful and will not be reattempted, after activities necessary to safe the vehicle on-orbit such as depletion of residual fuel, venting pressurized systems, leaving batteries in a permanent discharge state, or removing any remaining sources of stored energy.

(~~d~~e) ***Application requirements.*** An applicant must identify pre- and post-flight ground operations at a U.S. launch site sufficient for the Administrator to determine the scope of activities authorized under the license.

§ 450.5 Issuance of a vehicle operator license.

(a) The FAA issues a vehicle operator license to an applicant who has obtained all approvals and determinations required under this part for a license.

(b) A vehicle operator license authorizes a licensee to conduct launches or reentries, in accordance with the representations contained in the licensee's application, with subparts C and D of this part, and subject to the licensee's compliance with terms and conditions contained in license orders accompanying the license, including financial responsibility requirements.

§ 450.7 Duration of a vehicle operator license.

A vehicle operator license is valid for the period of time determined by the Administrator as necessary to conduct the licensed activity but may not exceed 5 years from the issuance date.

§ 450.9 Additional license terms and conditions.

The FAA may modify a vehicle operator license at any time by modifying or adding license terms and conditions to ensure compliance with the Act and regulations.

§ 450.11 Transfer of a vehicle operator license.

(a) Only the FAA may transfer a vehicle operator license.

(b) Either the holder of a vehicle operator license or the prospective transferee may request a vehicle operator license transfer.

(c) Both the holder and prospective transferee must agree to the transfer.

(d) An applicant for transfer of a vehicle operator license must submit a license application in accordance with part 413 of this chapter and must meet the requirements of part 450 of this chapter.

(e) The FAA will transfer a license to an applicant that has obtained all of the approvals and determinations required under this part for a license. In conducting its reviews and issuing approvals and determinations, the FAA may incorporate by reference any findings made part of the record to support the initial licensing determination. The FAA may modify a license to reflect any changes necessary as a result of a license transfer.

(f) The FAA will provide written notice of its determination to the person requesting the vehicle operator license transfer.

§ 450.13 Rights not conferred by a vehicle operator license.

Issuance of a vehicle operator license does not relieve a licensee of its obligation to comply with all applicable requirements of law or regulation that may apply to its activities, nor does issuance confer any proprietary, property, or exclusive right in the use of any Federal launch or reentry site or related facilities, airspace, or outer space.

Subpart B—Requirements to Obtain a Vehicle Operator License

§ 450.31 General.

(a) To obtain a vehicle operator license, an applicant must—

(1) Submit a license application in accordance with the procedures in part 413 of this chapter;

(2) Obtain a policy approval from the Administrator in accordance with § 450.41;

(3) Obtain a favorable payload determination from the Administrator in accordance with § 450.43, if applicable;

(4) Obtain a safety approval from the Administrator in accordance with § 450.45;

(5) Satisfy the environmental review requirements of § 450.47; and

(6) Provide the information required by appendix A of part 440 for the Administrator to conduct a maximum probable loss analysis for the applicable licensed operation.

(b) An applicant may apply for the approvals and determinations in paragraphs (a)(2) through (6) of this section separately or all together in one complete application, using the application procedures contained in part 413 of this chapter.

(c) An applicant may also apply for a safety approval in an incremental manner, in accordance with § 450.33.

(d) An applicant may reference materials previously provided as part of a license application in order to meet the application requirements of this part.

§ 450.33 Incremental review and determinations.

An applicant may submit its application for a safety review in modules using an incremental approach approved by the Administrator.

(a) An applicant must identify to the Administrator, prior to submitting an application, whether it will submit a modular application for any approval or determination.

(b) An applicant using an incremental approach must have the approach approved by the Administrator prior to submitting an application. In reviewing a proposed approach, the Administrator will consider the following:

(1) Whether the modules can be reviewed independently; and

(2) Whether the modules will be submitted in a workable chronological order.

(c) The Administrator may make incremental determinations as part of this review process.

§ 450.35 Means of compliance.

~~(a) Prior to application acceptance, a means of compliance must be accepted by the Administrator for the following:~~

~~(1) Section 450.115(b)(1) regarding flight safety analyses;~~

~~(2) Section 450.139(e)(1) regarding toxic hazards for flight;~~

~~(3) Section 450.145(b) regarding highly reliable flight safety system;~~

~~(4) Section 450.163(a)(1) regarding lightning hazard mitigation; and~~

~~(5) Section 450.187(e)(1) regarding toxic hazards mitigation for ground operations.~~

~~(b)~~ A person requesting acceptance of a proposed means of compliance outside a license application must submit the proposed means of compliance to the FAA in a form and manner acceptable to the Administrator.

§ 450.37 Equivalent level of safety.

(a) An applicant must demonstrate compliance with each requirement of this part, unless the applicant clearly and convincingly demonstrates that an alternative approach provides an equivalent level of safety to the requirement of this part.

(b) Paragraph (a) of this section does not apply to § 450.101(a), (b), (c)(1) and (3), (d), (e)(1), and (g).

(c) FAA shall provide the applicant with written notice and justification for its decision whenever the FAA grants or denies an equivalent level of safety.

§ 450.39 Use of safety element approval.

If an applicant proposes to use any vehicle, safety system, process, service, or personnel for which the FAA has issued a safety element approval under part 414 of this chapter, the FAA will not reevaluate that safety element during a license application evaluation to the extent its use is within its approved scope.

§ 450.41 Policy review and approval.

(a) ***General.*** The FAA issues a policy approval to an applicant unless the FAA determines that a proposed launch or reentry would jeopardize U.S. national security or foreign policy interests, or international obligations of the United States.

(b) ***Interagency consultation.***

(1) The FAA consults with the Department of Defense to determine whether a license application presents any issues affecting U.S. national security.

(2) The FAA consults with the Department of State to determine whether a license application presents any issues affecting U.S. foreign policy interests or international obligations.

(3) The FAA consults with other Federal agencies, including the National Aeronautics and Space Administration, authorized to address issues identified under paragraph (a) of this section, associated with an applicant's proposal.

(c) ***Issues during policy review.*** The FAA will advise an applicant, in writing, of any issue raised during a policy review that would impede issuance of a policy approval. The applicant may respond, in writing, or amend its license application as required by § 413.17 of this chapter.

(d) ***Denial of policy approval.*** The FAA notifies an applicant, in writing, if it has denied policy approval for a license application. The notice states the reasons for the FAA's determination. The applicant may seek further review of the determination in accordance with § 413.21 of this chapter.

(e) ***Application requirements for policy review***. In its license application, an applicant must—

(1) Identify the model, type, and configuration of any vehicle proposed for launch or reentry by the applicant;

(2) Describe the vehicle by characteristics that include individual stages, their dimensions, type and amounts of all propellants, and maximum thrust;

(3) Identify foreign ownership of the applicant as follows:

(i) For a sole proprietorship or partnership, identify all foreign ownership;

(ii) For a corporation, identify any foreign ownership interests of 10 percent or more; and

(iii) For a joint venture, association, or other entity, identify any participating foreign entities; and

(4) Identify the proposed vehicle flight profile, including:

(i) Launch or reentry site, including any contingency abort locations;

(ii) Flight azimuths, trajectories, and associated ground tracks and instantaneous impact points for the duration of the licensed activity, including any contingency abort profiles;

(iii) Sequence of planned events or maneuvers during flight;

(iv) Normal impact or landing areas for all mission hardware; and

(v) For each orbital mission, the range of intermediate and final orbits of each vehicle upper stage and their estimated orbital lifetimes.

§ 450.43 Payload review and determination.

(a) ***General.*** If applicable, the FAA issues a favorable payload determination for a launch or reentry to a license applicant or payload owner or operator if—

(1) The applicant, payload owner, or payload operator has obtained all required licenses, authorizations, and permits; and

(2) Its launch or reentry would not jeopardize public health and safety, safety of property, U.S. national security or foreign policy interests, or international obligations of the United States.

(b) ***Relationship to other executive agencies.*** The FAA does not make a determination under paragraph (a)(2) of this section for—

(1) Those aspects of payloads that are subject to regulation by the Federal Communications Commission or the Department of Commerce; or

(2) Payloads owned or operated by the U.S. Government.

(c) ***Classes of payloads.*** The FAA may review and issue findings regarding a proposed class of payload, including communications, remote sensing, or navigation. However, prior to a launch or reentry, each payload is subject to verification by the FAA that its launch or reentry would not jeopardize public health and safety, safety of property, U.S. national security or foreign policy interests, or international obligations of the United States.

(d) ***Payload owner or payload operator may apply***. In addition to a launch or reentry operator, a payload owner or payload operator may request a payload review and determination.

(e) ***Interagency consultation.*** The FAA consults with other agencies as follows:

(1) The Department of Defense to determine whether launch or reentry of a proposed payload or payload class would present any issues affecting U.S. national security;

(2) The Department of State to determine whether launch or reentry of a proposed payload or payload class would present any issues affecting U.S. foreign policy interests or international obligations; or

(3) Other Federal agencies, including the National Aeronautics and Space Administration, authorized to address issues of public health and safety, safety of property, U.S. national security or foreign policy interests, or international obligations of the United States, associated with the launch or reentry of a proposed payload or payload class.

(f) ***Issues during payload review.*** The FAA will advise a person requesting a payload determination, in writing, of any issue raised during a payload review that would impede issuance of a license to launch or reenter that payload or payload class. The person requesting payload review may respond, in writing, or amend its application as required by § 413.17 of this chapter.

(g) ***Denial of a payload determination.*** The FAA notifies an applicant, in writing, if it has denied a favorable payload determination. The notice states the reasons for the FAA's determination. The applicant may seek further review of the determination in accordance with § 413.21 of this chapter.

(h) ***Incorporation of payload determination in license application.*** A favorable payload determination issued for a payload or class of payload may be included by a license applicant as part of its application. However, any change in information provided under paragraph (i) of this section must be reported in accordance with § 413.17 of this chapter. The FAA determines whether a favorable payload determination remains valid in light of reported changes and may conduct an additional payload review.

(i) ***Application requirements.*** A person requesting review of a particular payload or payload class must identify the following:

(1) For launch of a payload:

(i) Payload name or class of payload, and function;

(ii) Description, including physical dimensions, weight, composition, and any hosted payloads;

(iii) Payload owner and payload operator, if different from the person requesting payload review and determination;

(iv) Any foreign ownership of the payload or payload operator, as specified in § 450.41(e)(3);

(v) Hazardous materials as defined in § 401.7 of this chapter, radioactive materials, and the amounts of each;

(vi) Explosive potential of payload materials, alone and in combination with other materials found on the payload;

(vii) For orbital launches, parameters for parking, transfer and final orbits, and approximate transit times to final orbit;

(viii) Delivery point in flight at which the payload will no longer be under the licensee's control;

(ix) Intended operations during the lifetime of the payload, including anticipated life span and any planned disposal;

(x) Any encryption associated with data storage on the payload and transmissions to or from the payload; and

(xi) Any other information necessary to make a determination based on public health and safety, safety of property, U.S. national security or foreign policy interests, or international obligations of the United States.

(2) For reentry of a payload:

(i) Payload name or class of payload, and function;

(ii) Physical characteristics, dimensions, and weight of the payload;

(iii) Payload owner and payload operator, if different from the person requesting the payload review and determination;

(iv) Type, amount, and container of hazardous materials and radioactive materials in the payload;

(v) Explosive potential of payload materials, alone and in combination with other materials found on the payload or reentry vehicle during reentry; and

(vi) Designated reentry site.

§ 450.45 Safety review and approval.

(a) ***General.*** The FAA issues a safety approval to an applicant if it determines that an applicant can conduct launch or reentry without jeopardizing public health and safety and safety of property. A license applicant must satisfy the application requirements in this section and subpart C of this part.

(b) ***Services or property provided by a Federal ~~launch or reentry site~~ Agency.*** The FAA will ~~accept~~ evaluate any safety-related launch or reentry service or property provided by a Federal launch or reentry site or other Federal entity by contract~~, as long as the FAA determines that the launch or reentry services or property provided satisfy this part~~. The FAA will consult with entities providing such services or property as needed to ensure compliance or equivalence with applicable requirements under this part, or to negotiate a waiver with the Federal entity until equivalence can be achieved.

(c) ***Reliance on other FAA approvals.*** The Office of Commercial Space Transportation shall accept, without further showing, any current airworthiness and operational approvals from the Office of Aviation Safety and the Air Traffic Organization for use in launch licensing determinations and subsequent operations under this part.

(~~c~~d) ***Issues during safety review.*** The FAA will advise an applicant, in writing, of any issues raised during a safety review that would impede issuance of a safety approval. The applicant may respond, in writing, or amend its license application as required by § 413.17 of this chapter.

(~~d~~e) ***Denial of a safety approval.*** The FAA notifies an applicant, in writing, if it has denied a safety approval for a license application. The notice states the reasons for the FAA's determination. The applicant may seek further review of the determination in accordance with § 413.21 of this chapter.

(~~e~~f) ***Application requirements.*** An applicant must submit the information required in the "Application requirements" paragraphs in individual sections in subpart C of this part, as well as the following:

(1) *General.* An application must—

(i) Contain a glossary of unique terms and acronyms used in alphabetical order;

(ii) Contain a listing of all referenced material;

(iii) Use equations and mathematical relationships derived from or referenced to a recognized standard or text, and define all algebraic parameters;

(iv) Include the units of all numerical values provided; and

(v) Include a legend or key that identifies all symbols used for any schematic diagrams.

(2) *Site description.* An applicant must identify the proposed launch or reentry site, including contingency abort locations, and submit the following:

(i) Boundaries of the site;

(ii) Launch or landing point locations, including latitude and longitude;

(iii) Identity of any site operator; and

(iv) Identity of any facilities at the site that will be used for pre- or post-flight ground operations.

(3) *Vehicle description.* An applicant must submit the following:

(i) A written description of the vehicle or family of vehicles, including structural, thermal, pneumatic, propulsion, electrical, and avionics and guidance systems used in each vehicle, and all propellants. The description must include a table specifying the type and quantities of all hazardous materials on each vehicle and must include propellants, explosives, and toxic materials; and

(ii) A drawing of each vehicle that identifies:

(A) Each stage, including strap-on motors;

(B) Physical dimensions and weight;

(C) Location of all safety-critical systems;

(D) Location of all major vehicle control systems, propulsion systems, pressure vessels, and any other hardware that contains potential hazardous energy or hazardous material; and

(E) For an unguided suborbital launch vehicle, the location of the vehicle's center of pressure in relation to its center of gravity for the entire flight profile.

(4) *Mission schedule.* An applicant must submit a generic launch or reentry processing schedule that identifies any readiness activities, such as reviews and rehearsals, and each safety-critical pre-flight operation to be conducted. The mission schedule must also identify day of flight activities.

(5) *Human space flight.* For a proposed launch or reentry with a space flight participant, crew, or government astronaut on board a vehicle, an applicant must demonstrate compliance with §§ 460.5, 460.7, 460.11, 460.13, 460.15, 460.17, 460.51, 460.53, 460.59, 460.61, and 460.67 of this chapter.

(6) *Radionuclides.* The FAA will evaluate the launch or reentry of any radionuclide on a case-by-case basis, and issue an approval if the FAA finds that the launch or reentry is consistent with public health and safety, safety of property, and national security and foreign policy interests of the United States. For any radionuclide on a launch or reentry vehicle, an applicant must—

(i) Identify the type and quantity;

(ii) Include a reference list of all documentation addressing the safety of its intended use; and

(iii) Describe all approvals by the Nuclear Regulatory Commission for pre-flight ground operations.

(7) *Additional material.* The FAA may also request—

(i) Any information incorporated by reference in the license application; and

(ii) Additional products that allow the FAA to conduct an independent safety analysis.

§ 450.47 Environmental review.

(a) ***General.*** The FAA is responsible for complying with the procedures and policies of the National Environmental Policy Act (NEPA) and other applicable environmental laws, regulations, and Executive Orders prior to issuing a launch or reentry license. An applicant must provide the FAA with information needed to comply with such requirements. The FAA will consider and document the potential environmental effects associated with issuing a launch or reentry license consistent with paragraph (b) of this section.

(b) ***Environmental Impact Statement or Environmental Assessment***. When directed by the FAA, an applicant must—

(1) Prepare an Environmental Assessment with FAA oversight;

(2) Assume financial responsibility for preparation of an Environmental Impact Statement by an FAA-selected and -managed consultant contractor; or

(3) Submit information to support a written re-evaluation of a previously submitted Environmental Assessment or Environmental Impact Statement.

(c) ***Categorical exclusion.*** The FAA may determine that a categorical exclusion is appropriate upon receipt of supporting information from an applicant. The FAA may adopt categorical exclusions from other Federal agencies for similar major federal actions according to the requirements of NEPA Section 109. The FAA may determine that a categorical exclusion is appropriate for major federal actions similar to previous major federal actions for which FAA has issued a Finding of No Significant Impact (FONSI).

(d) ***Application requirements.*** An application must include an approved ~~FAA~~ Environmental Assessment, Environmental Impact Statement, categorical exclusion determination, or written re-evaluation, which should address compliance with any ~~other~~ applicable environmental laws ~~, regulations,~~ and Executive Orders covering all planned licensed activities in compliance with NEPA ~~and the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA.~~

Subpart C—Safety Requirements

Safety Criteria

§ 450.101 Safety criteria.

(a) ***Launch risk criteria.*** For any launch, an operator may initiate the flight of a launch vehicle only if all risks to the public satisfy the criteria in this paragraph (a). For an orbital launch, the criteria in this paragraph apply from liftoff through orbital insertion. For a suborbital launch, or a suborbital launch and reentry, the criteria in this paragraph apply from liftoff through final impact or landing.

(1) ***Collective risk.*** The collective risk, measured as expected number of casualties (E_C), consists of risk posed by impacting inert and explosive debris, toxic release, and far field blast overpressure. Public risk due to any other hazard associated with the proposed flight of a launch vehicle will be determined by the Administrator on a case-by-case basis.

(i) The risk to all members of the public, excluding persons in aircraft and neighboring operations personnel, must not exceed an expected number of 1×10^{-4} casualties.

(ii) The risk to all neighboring operations personnel must not exceed an expected number of 2×10^{-4} casualties.

(2) ***Individual risk.*** The individual risk, measured as probability of casualty (P_C), consists of risk posed by impacting inert and explosive debris, toxic release, and far field blast overpressure. The FAA will determine whether to approve public risk due to any other hazard associated with the proposed flight of a launch vehicle on a case-by-case basis.

(i) The risk to any individual member of the public, excluding neighboring operations personnel, must not exceed a probability of casualty of 1×10^{-6} per launch.

(ii) The risk to any individual neighboring operations personnel must not exceed a probability of casualty of 1×10^{-5} per launch.

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

(4) ***Risk to critical assets.***

(i) The risk to critical assets, measured as the probability of loss of functionality, must not exceed the following probabilities:

(A) For each critical asset, except for a critical payload, 1×10^{-3} ; and

(B) For each critical payload, 1×10^{-4}.

(ii) The Administrator will consult with relevant Federal agencies, and each agency will identify, for purposes of this part, any critical assets that the agency owns or otherwise depends on. ~~For purposes of this part, the Administrator will accept any identification by the Secretary of Defense that an asset is critical to national security.~~

(iii) The Administrator or Federal site operator will notify the licensee of any risk to critical assets above the risk criteria in paragraph (a)(4)(i) of this section.

(iv) The Administrator may determine, in consultation with relevant Federal agencies, that an ~~more stringent~~ alternate probability is ~~necessary~~ acceptable to protect the national interests of the United States.

(v) The risk criteria in paragraph (a)(4)(i) of this section do not apply to property, facilities, or infrastructure supporting the launch that are within the public area distance, as defined in part 420, appendix E, tables E1 and E2 or associated formulae, of the vehicle's launch point.

(b) ***Reentry risk criteria.*** For any reentry, an operator may initiate the deorbit of a vehicle only if all risks to the public satisfy the criteria in this paragraph (b). The following criteria apply to each reentry, other than a suborbital reentry, from the final health check prior to initiating deorbit through final impact or landing:

(1) ***Collective risk.*** The collective risk, measured as expected number of casualties (E_C), consists of risk posed by impacting inert and explosive debris, toxic release, and far field blast overpressure. Public risk due to any other hazard associated with the proposed deorbit of a reentry vehicle will be determined by the Administrator on a case-by-case basis.

(i) The risk to all members of the public, excluding persons in aircraft and neighboring operations personnel, must not exceed an expected number of 1×10^{-4} casualties.

(ii) The risk to all neighboring operations personnel must not exceed an expected number of 2×10^{-4} casualties.

(2) ***Individual risk.*** The individual risk, measured as probability of casualty (P_C), consists of risk posed by impacting inert and explosive debris, toxic release, and far field blast overpressure. Public risk due to any other hazard associated with the proposed flight of a launch vehicle will be determined on a case-by-case basis.

(i) The risk to any individual member of the public, excluding neighboring operations personnel, must not exceed a probability of casualty of 1×10^{-6} per reentry.

(ii) The risk to any individual neighboring operations personnel must not exceed a probability of casualty of 1×10^{-5} per reentry.

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

(4) ***Risk to critical assets.***

(i) The risk to critical assets, measured as the probability of loss of functionality, must not exceed the following probabilities:

(A) For each critical asset, except for a critical payload, 1×10^{-3} ; and

(B) For each critical payload, 1×10^{-4}.

(ii) The Administrator will consult with relevant Federal agencies, and each agency will identify, for purposes of this part, any critical assets that the agency owns or otherwise depends on. ~~For purposes of this part, the Administrator will accept any identification by the Secretary of Defense that an asset is critical to national security.~~

(iii) The Administrator or Federal site operator will notify the licensee of any risk to critical assets above the risk criteria in paragraph (b)(4)(i) of this section.

(iv) The Administrator may determine, in consultation with relevant Federal agencies, that an ~~more stringent~~ alternate probability is ~~necessary~~ acceptable to protect the national interests of the United States.

(c) ***High consequence event protection.*** For all phases of flight capable of resulting in a high consequence event in uncontrolled areas, the operator must demonstrate that the likelihood of a high consequence event occurring is extremely remote using a mitigation commensurate with the magnitude of the event.

~~An operator must protect against a high consequence event in uncontrolled areas for each phase of flight by:~~

~~(1) Using flight abort as a hazard control strategy in accordance with the requirements of~~ § 450.108~~;~~

~~(2) Ensuring the consequence of any reasonably foreseeable failure mode, in any significant period of flight, is no greater than 1×10^{-3} conditional expected casualties; or~~

~~(3) Establishing the launch or reentry vehicle has sufficient demonstrated reliability as agreed to by the Administrator based on conditional expected casualties criteria during that phase of flight.~~

(d) ***Disposal safety criteria.*** A launch operator must ensure that any disposal meets the criteria of paragraphs (b)(1) through (3) of this section, or targets a broad ocean area.

(e) ***Protection of people and property on orbit.***

(1) A launch or reentry operator must prevent the collision between a launch or reentry vehicle stage or component and people or property on orbit, in accordance with the requirements in § 450.169(a).

(2) For any launch vehicle stage or component that reaches Earth orbit, a launch operator must prevent the creation of debris through the conversion of energy sources into energy that fragments the stage or component, in accordance with the requirements in § 450.171.

(f) ***Notification of planned impacts.*** For any launch, reentry, or disposal, an operator must notify the public of any region of land, sea, or air that either—

(1) exceeds a probability of casualty of 1x10-7 for all debris resulting from normal flight events capable of causing a casualty; or

(2) that is contained within a 97 percent probability of containment contour of all debris resulting from normal flight events capable of causing a casualty.

~~(g) ***Validity of the analysis.*** For any analysis used to demonstrate compliance with this section, an operator must use accurate data and scientific principles and the analysis must be statistically valid. The method must produce results consistent with or more conservative than the results available from previous mishaps, tests, or other valid benchmarks, such as higher-fidelity methods.~~

System Safety Program

§ 450.103 System safety program.

An operator must implement and document a system safety program throughout the lifecycle of a launch or reentry system that includes the following:

(a) ***Hazard management.*** For hazard management:
- (1) An operator must implement methods to assess the system to ensure the validity of the hazard control strategy determination, any flight hazard or flight safety analysis, and any ground safety analysis (when applicable), throughout the lifecycle of the launch or reentry system;
- (2) An operator must implement methods for communicating and implementing any updates throughout the organization that is material to public safety and the safety of property; and
- (3) Additionally, an operator required to conduct a flight hazard analysis must implement a process for tracking hazards, risks, mitigation measures, and verification activities.

(b) ***Configuration management and control.*** An operator must—
- (1) Employ a process that tracks configurations of all safety-critical systems and documentation related to the operation;
- (2) Ensure the use of correct and appropriate versions of systems and documentation tracked in paragraph (b)(1) of this section; and
- (3) Document the configurations and versions identified in paragraph (b)(2) of this section for each licensed activity.

(c) ***Post-flight data review.*** An operator must employ a process for evaluating post-flight data to—
- (1) Ensure consistency between the assumptions used for the hazard control strategy determination, any flight hazard or flight safety analyses, and associated mitigation and hazard control measures;
- (2) Resolve any inconsistencies identified in paragraph (c)(1) of this section prior to the next flight of the vehicle;
- (3) Identify any anomaly that may impact any flight hazard analysis, flight safety analysis, or safety-critical system, or is otherwise material to public safety; and
- (4) Address any anomaly identified in paragraph (c)(3) of this section prior to the next flight as necessary to ensure public safety, including updates to any flight hazard analysis, flight safety analysis, or safety-critical system.

(d) ***Application requirements.*** An applicant must submit in its application the following:
- (1) A description of the applicant's safety organization as required by paragraph (a) of this section, identifying the applicant's lines of communication and approval authority, both internally and externally, for all public safety decisions and the provision of public safety services; and
- (2) A summary of the processes and products identified in the system safety program requirements in paragraphs (a), (b), and (c) of this section.

Hazard Control Strategies

§ 450.107 Hazard control strategies and safety-critical systems.

(a) ***General.*** To meet the safety criteria of § 450.101(a), (b), or (c) for the flight, or any phase of flight, of a launch or reentry vehicle, an operator must use one or more of the hazard control strategies identified in § 450.108 through § 450.111.

(b) **Hazard identification.** For each phase of flight during a launch or reentry, an operator must conduct a system safety analysis that identifies:

(1) all reasonably foreseeable hazards to the public; and

(2) all safety-critical systems.

(~~b~~c) ***Hazard control strategy determination.*** For each hazard identified within a phase of flight during a launch or reentry, an operator must ~~use a functional hazard analysis to determine~~ identify a hazard control strategy or strategies. ~~that account for~~ Any safety-critical system identified in accordance with § 450.107(b)(2) does not need to comply to § 450.107(d) if:

(1) the hazards associated with the safety-critical system are mitigated by use of a hazard control strategy under § 450.108 through § 450.111; or

(2) a flight hazard analysis performed under § 450.109 demonstrates that the risk associated with the safety-critical system can be controlled to meet the risk criteria in § 450.101.

~~(1) All functional failures associated with reasonably foreseeable hazardous events that have the capability to create a hazard to the public;~~

~~(2) Safety-critical systems; and~~

~~(3) A timeline of all safety-critical events.~~

~~(c) ***Flight hazard analysis.*** An operator must conduct a flight hazard analysis in accordance with § 450.109 of this part for the flight, or phase of flight, of a launch or reentry vehicle if the public safety hazards cannot be mitigated adequately to meet the public risk criteria of § 450.101(a), (b), and (c) using physical containment, wind weighting, or flight abort.~~

(d) **Safety-critical systems.** For each safety-critical system identified, except for highly reliable flight safety systems covered under § 450.145, operators must:

(1) Qualify the components of the safety-critical systems in environments exceeding the predicted environments.

(2) Show by test, demonstration, analysis, or other means accepted by the Administrator that any safety-critical system is capable of its service life based on conditions predicted to be encountered in all phases of flight.

(3) Monitor the flight environments experienced by safety-critical system components to the extent necessary to:

(i) Validate the predicted operating environments; and

(ii) Assess the actual component life remaining or adjust any inspection period.

(4) For safety-critical systems involving computing systems that perform a safety function, an operator must:

(i) Identify the level of criticality of each such computing system, commensurate with its degree of control over hazards to the public and the severity of those hazards; and

(ii) Implement a software development program commensurate with the criticality of the computing system identified in accordance subparagraph (4)(i).

(~~d~~e) ***Application requirements.*** An applicant must submit in its application—

(1) The results of the hazard control strategy determination, including—

~~(i) All functional failures identified under paragraph (b)(1) of this section;~~

~~(ii) The identification of all safety-critical systems; and~~

(i) Supporting system safety analysis under paragraph (b) of this section; and

(ii) A description of the hazard control strategy or strategies for each phase of flight.

~~(2) A description of its hazard control strategy or strategies for each phase of flight.~~

(2) A description of all safety-critical systems, including—

(i) Identification and rationale for any safety-critical systems exempt from paragraph (d) in accordance with subparagraphs (c)(1) and (c)(2); and

(ii) For each safety-critical system subject to paragraph (d), a description of the qualification, testing, analysis performed for each safety-critical system to satisfy paragraph (d).

§ 450.108 Flight abort.

(a) ***Applicability.*** This section applies to the use of flight abort as a hazard control strategy for the flight, or phase of flight, of a launch or reentry vehicle to meet the safety criteria of § 450.101.

(b) ***Flight safety system.*** An operator must use a flight safety system that:

(1) Meets the requirements of § 450.145 if the consequence of any reasonably foreseeable failure mode in any significant period of flight is greater than 1×10^{-2} conditional expected casualties in uncontrolled areas; or

(2) Meets the requirements of § 450.107(d)~~143~~ if the consequence of any reasonably foreseeable failure mode in any significant period of flight is between 1×10^{-2} and 1×10^{-3} conditional expected casualties for uncontrolled areas.

(c) ***Flight safety limits objectives.*** An operator must determine and use flight safety limits that define when an operator must initiate flight abort for each of the following—

(1) To ensure compliance with the safety criteria of § 450.101(a) and (b);

(2) To prevent continued flight from increasing risk in uncontrolled areas if the vehicle is unable to achieve a useful mission;

(3) To prevent the vehicle from entering a period of materially increased public exposure in uncontrolled areas, including before orbital insertion, if a critical vehicle parameter is outside its pre-established expected range or indicates an inability to complete flight within the limits of a useful mission;

(4) To prevent conditional expected casualties greater than 1×10^{-2} in uncontrolled areas due to flight abort or due to flight outside the limits of a useful mission from any reasonably foreseeable off-trajectory failure mode in any significant period of flight; and

(5) To prevent the vehicle state from reaching identified conditions that are anticipated to compromise the capability of the flight safety system if further flight has the potential to violate a flight safety limit.

(6) In lieu of paragraphs (c)(2) and (4) of this section, to prevent debris capable of causing a casualty due to any hazard from affecting uncontrolled areas using a flight safety system that complies with § 450.145.

(d) ***Flight safety limits constraints.*** An operator must determine flight safety limits that—

(1) Account for temporal and geometric extents on the Earth's surface of any reasonably foreseeable vehicle hazards under all reasonably foreseeable conditions during normal and malfunctioning flight;

(2) Account for physics of hazard generation and transport including uncertainty;

(3) Account for the potential to lose valid data necessary to evaluate the flight abort rules;

(4) Account for the time delay, including uncertainties, between the violation of a flight abort rule and the time when the flight safety system is expected to activate;

(5) Account in individual, collective, and conditional risk evaluations both for proper functioning of the flight safety system and failure of the flight safety system;

(6) Are designed to avoid flight abort that results in increased collective risk to the public in uncontrolled areas, compared to continued flight; and

(7) Ensure that any trajectory within the limits of a useful mission that is permitted to fly without abort would meet the collective risk criteria of § 450.101(a)(1) or (b)(1) when analyzed as if it were the planned mission in accordance with § 450.213(b)(2).

(e) ***End of flight abort.*** A flight does not need to be aborted to protect against high consequence events in uncontrolled areas beginning immediately after critical vehicle parameters are validated, if the vehicle is able to achieve a useful mission and the following conditions are met for the remainder of flight:

(1) Flight abort would not materially decrease the risk from a high consequence event; and

(2) There are no key flight safety events.

(f) ***Flight abort rules.*** For each launch or reentry, an operator must establish and observe flight abort rules that govern the conduct of the launch or reentry as follows.

(1) Vehicle data required to evaluate flight abort rules must be available to the flight safety system under all reasonably foreseeable conditions during normal and malfunctioning flight.

(2) The flight safety system must abort flight:

(i) When valid, real-time data indicate the vehicle has violated any flight safety limit developed in accordance with this section;

(ii) When the vehicle state approaches identified conditions that are anticipated to compromise the capability of the flight safety system and further flight has the potential to violate a flight safety limit; and

(iii) In accordance with methods used to satisfy (d)(3) of this section, if tracking data is invalid and further flight has the potential to violate a flight safety limit.

(g) ***Application requirements.*** An applicant must submit in its application the following:

(1) A description of the methods used to demonstrate compliance with paragraph (c) of this section, including descriptions of how each analysis constraint in paragraph (d) of this section is satisfied in accordance with § 450.115.

(2) A description of how each flight safety limit and flight abort rule is evaluated and implemented during vehicle flight, including the quantitative criteria that will be used, a description of any critical parameters, and how the values required in paragraphs (c)(3) and (e) of this section are identified;

(3) A graphic depiction or series of depictions of flight safety limits for a representative mission together with the launch or landing point, all uncontrolled area boundaries, the nominal trajectory, extents of normal flight, and limits of a useful mission trajectories, with all trajectories in the same projection as each of the flight safety limits; and

(4) A description of the vehicle data that will be available to evaluate flight abort rules under all reasonably foreseeable conditions during normal and malfunctioning flight.

§ 450.109 Flight hazard analysis.

(a) ***Applicability.*** This section applies to the use of a flight hazard analysis as a hazard control strategy to derive hazard controls for the flight, or phase of flight, of a launch or reentry vehicle.

(b) ***Analysis.*** A flight hazard analysis must identify, describe, and analyze all reasonably foreseeable hazards to public safety resulting from the flight of a launch or reentry vehicle. Each flight hazard analysis must—

(1) Identify all reasonably foreseeable hazards, and the corresponding failure mode for each hazard, associated with the launch or reentry system relevant to public safety, including those resulting from:

(i) Vehicle operation, including staging and release;

(ii) System, subsystem, and component failures or faults;

(iii) Software operations;

(iv) Environmental conditions;

(v) Human factors;

(vi) Design inadequacies;

(vii) Procedure deficiencies;

(viii) Functional and physical interfaces between subsystems, including any vehicle payload; and

(ix) Reuse of components or systems.~~; and~~

~~(x) Interactions of any of the above.~~

(2) Assess each hazard's likelihood and severity.

(3) Ensure that the likelihood of any hazardous condition that may cause death or serious injury to the public is extremely remote.

(4) Identify and describe the risk elimination and mitigation measures required to satisfy paragraph (b)(3) of this section.

(5) Document that the risk elimination and mitigation measures achieve the risk level of paragraph (b)(3) of this section through validation and verification. Verification includes:

(i) Analysis;

(ii) Test;

(iii) Demonstration; or

(iv) Inspection.

(c) ***New Hazards.*** An operator must establish and document the criteria and techniques for identifying new hazards throughout the lifecycle of the launch or reentry system.

(d) ***Completeness Prior to Flight.*** For every launch or reentry, the flight hazard analysis must be complete and all hazards must be mitigated to an acceptable level in accordance with paragraph (b)(3) of this section.

(e) ***Updates.*** An operator must continually update the flight hazard analysis throughout the lifecycle of the launch or reentry system.

(f) ***Application requirements.*** An applicant must submit in its application the following:

> (1) Flight hazard analysis products of paragraphs (b)(1) through (5) of this section, including data that verifies the risk elimination and mitigation measures resulting from the applicant's flight hazard analyses required by paragraph (b)(5) of this section; and
>
> (2) The criteria and techniques for identifying new hazards throughout the lifecycle of the launch or reentry system as required by paragraph (c) of this section.

§ 450.110 Physical containment.

(a) ***Applicability.*** This section applies to the use of physical containment as a hazard control strategy for the flight, or phase of flight, of a launch or reentry vehicle to meet the safety criteria of § 450.101(a), (b), and (c).

(b) ***Containment.*** To use physical containment as a hazard control strategy, an operator must—

(1) Develop the flight hazard area in accordance with § 450.133;

~~(2) Ensure that the launch vehicle does not have sufficient energy for any hazards associated with its flight to reach outside the flight hazard area;~~

(~~3~~2) Ensure the hazard area is clear of the public and critical assets; and

(~~4~~3) Apply other mitigation measures necessary to ensure no public or critical asset exposure to hazards, such as control of public access or wind placards.

(c) ***Application requirements.*** An applicant must submit in its application the following:

(1) A demonstration that the launch vehicle does not have sufficient energy for any hazards associated with its flight to reach outside the flight hazard area developed in accordance with § 450.133; and

(2) A description of the methods used to ensure that flight hazard areas are cleared of the public and critical assets.

§ 450.111 Wind weighting.

(a) ***Applicability.*** This section applies to the use of wind weighting as a hazard control strategy for the flight of an unguided suborbital launch vehicle to meet the safety criteria of § 450.101(a), (b), and (c).

(b) ***Wind weighting safety system.*** The flight of an unguided suborbital launch vehicle that uses a wind weighting safety system must meet the following:

(1) The launcher azimuth and elevation settings must be wind weighted to correct for the effects of wind conditions at the time of flight to provide impact locations that will ensure compliance with the safety criteria in § 450.101; and

(2) An operator must use launcher azimuth and elevation angle settings that ensures the rocket will not fly in an unintended direction accounting for uncertainties in vehicle and launcher design and manufacturing, and atmospheric uncertainties.

(c) ***Analysis.*** An operator must—

(1) Establish flight commit criteria and other flight safety rules that control the risk to the public from potential adverse effects resulting from normal and malfunctioning flight;

(2) Establish any wind constraints under which flight may occur; and

(3) Conduct 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 launch vehicle.

(d) ***Stability.*** An unguided suborbital launch vehicle, in all configurations, must be stable throughout each stage of powered flight.

(e) ***Application requirements.*** An applicant must submit in its application the following:

(1) A description of its wind weighting analysis methods, including its method and schedule of determining wind speed and wind direction for each altitude layer;

(2) A description of its wind weighting safety system including all equipment used to perform the wind weighting analysis; and

(3) A representative wind weighting analysis using actual or statistical winds for the launch area and samples of the output.

Flight Safety Analyses

§ 450.113 Flight safety analysis requirements—scope.

(a) An operator must perform and document a flight safety analysis for all phases of flight, except as specified in paragraph (b) of this section, as follows—

(1) For orbital launch, from liftoff through orbital insertion, and through all component impacts or landings;

(2) For suborbital launch, from liftoff through all component impacts or landings;

~~(3) For disposal, from the initiation of the deorbit through final impact; and~~

(4) For reentry, from ~~the initiation of the deorbit~~ orbital extraction through all component impacts or landing.

(b) An operator is not required to perform and document a flight safety analysis for a phase of flight if agreed to by the Administrator based on demonstrated reliability. An operator demonstrates reliability by using operational and flight history to show compliance with the risk criteria in § 450.101(a) and (b).

§ 450.115 Flight safety analysis methods.

(a) ***Scope of the analysis.*** An operator's flight safety analysis method must account for all reasonably foreseeable events and failures of safety-critical systems during nominal and non-nominal launch or reentry that could jeopardize public safety.

(b) ***Level of fidelity of the analysis.*** An operator's flight safety analysis method must have a level of fidelity sufficient to—

(1) Demonstrate that any risk to the public satisfies the safety criteria of § 450.101, including the use of mitigations, accounting for ~~all known~~ reasonably likely sources of uncertainty~~, using a means of compliance accepted by the Administrator~~; and

(2) Identify the dominant source of each type of public risk with a criterion in § 450.101(a) or (b) in terms of phase of flight, source of hazard (such as toxic exposure, inert, or explosive debris), and failure mode.

~~(c) ***Application requirements.*** An applicant must submit a description of the flight safety analysis methodology, including identification of:~~

~~(1) The scientific principles and statistical methods used;~~

~~(2) All assumptions and their justifications;~~

~~(3) The rationale for the level of fidelity;~~

~~(4) The evidence for validation and verification required by § 450.101(g);~~

~~(5) The extent to which the benchmark conditions are comparable to the foreseeable conditions of the intended operations; and~~

~~(6) The extent to which risk mitigations were accounted for in the analyses.~~

§ 450.117 Trajectory analysis for normal flight.

(a) ***General.*** A flight safety analysis must include a trajectory analysis that establishes, for any phase of flight within the scope as provided by § 450.113(a), the limits of a launch or reentry vehicle's normal flight as defined by the nominal trajectory, and the following sets of trajectories sufficient to characterize variability and ~~uncertainty~~ incertitude during normal flight:

(1) A set of trajectories to characterize variability. This set must describe how the intended trajectory could vary due to conditions known prior to initiation of flight; and

(2) A set of trajectories to characterize ~~uncertainty~~ incertitude. This set must describe how the actual trajectory could differ from the intended trajectory due to random ~~uncertainties~~ incertitude in all parameters with a significant influence on the vehicle's behavior throughout normal flight.

(b) ***Trajectory model.*** A final trajectory analysis must use a ~~six-degree-of-freedom trajectory~~ model that demonstrates sufficient accuracy in predicting the vehicle's trajectory to satisfy the requirements of paragraph (a) of this section.

(c) ***Atmospheric effects.*** A trajectory analysis must account for atmospheric conditions that have an effect on the trajectory, including atmospheric profiles that are no less severe than the worst conditions under which flight might be attempted, and for ~~uncertainty~~ incertitude in the atmospheric conditions.

(d) ***Application requirements.*** An applicant must submit the following:

(1) A description of the methods used to characterize the vehicle's flight behavior throughout normal flight, ~~in accordance with § 450.115(c)~~ to include:

(i) evidence of a scientifically and statistically valid approach;

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(2) The quantitative input data, including ~~uncertainties~~ incertitude, used to model the vehicle's normal flight ~~in six degrees of freedom~~.

(3) The worst atmospheric conditions under which flight might be attempted, and a description of how the operator will evaluate the atmospheric conditions and ~~uncertainty~~ incertitude in the atmospheric conditions prior to initiating the operation;

(4) Representative normal flight trajectory analysis outputs, including the position velocity, and orientation for each second of flight for—

(i) The nominal trajectory;

(ii) A set of trajectories that characterize variability in the intended trajectory based on conditions known prior to initiation of flight; and

(iii) A set of trajectories that characterize how the actual trajectory could differ from the intended trajectory due to random ~~uncertainty~~ incertitude.

§ 450.119 Trajectory analysis for malfunction flight.

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

(1) The vehicle's deviation capability in the event of a malfunction during flight,

(2) The trajectory dispersion resulting from reasonably foreseeable malfunctions, or a conservative envelope thereof.

~~(3) For vehicles using flight abort as a hazard control strategy under § 450.108, trajectory data or parameters that describe the limits of a useful mission. The FAA does not consider the collection of data related to a failure to be a useful mission.~~

(b) ***Analysis constraints.*** A malfunction trajectory analysis must account for each cause of a malfunction flight, including software and hardware failures, for every period of normal flight or a reasonably conservative subset which envelopes its effects. The analysis for each type of malfunction must have sufficient temporal and spatial resolution to establish flight safety limits, if any, and individual risk contours that are smooth and continuous. The analysis must account for—

(1) The relative probability of occurrence of each malfunction;

~~(2) The probability distribution of position and velocity of the vehicle when each malfunction trajectory will terminate due to vehicle breakup, ground impact, or orbital insertion along with the cause of termination and the state of the vehicle;~~

(3) The parameters with a significant influence on a vehicle's flight behavior from the time a malfunction begins to cause a flight deviation until the time each malfunction trajectory will terminate due to vehicle breakup, ground impact, or orbital insertion, or other flight-ending event other than flight abort under § 450.108.~~;~~ ~~and~~

~~(4) The potential for failure of the flight safety system, if any.~~

(c) ***Application requirements.*** An applicant must submit—

(1) A description of the methodology used to characterize the vehicle's flight behavior throughout malfunction flight, to include ~~in accordance with § 450.115(c).~~

(i) evidence of a scientifically and statistically valid approach

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

~~(2) A description of the methodology used to determine the limits of a useful mission, in accordance with § 450.115(c).~~

(3) A description of the input data used to characterize the vehicle's malfunction flight behavior, including:

(i) A list of each cause of malfunction flight considered;

(ii) A list of each type of malfunction flight for which malfunction flight behavior was characterized; and

(iii) A quantitative description of the parameters, including uncertainties, with a significant influence on the vehicle's malfunction behavior for each type of malfunction flight characterized.

(4) Representative malfunction flight trajectory analysis outputs, including the position and velocity as a function of flight time for—

(i) Each set of trajectories that characterizes a type of malfunction flight;

(ii) The probability of each set of trajectories that characterizes a type of malfunction flight; and

~~(iii) A set of trajectories that characterizes the limits of a useful mission as described in paragraph (a)(3) of this section.~~

450.120 Impact and breakup analysis.

(a) ***General***. A flight safety analysis must include impact and breakup analysis that documents—

(1) Each reasonably foreseeable cause of vehicle breakup and intact impact,

(2) A process for determining vehicle breakup states as a function of:

(i) Outside forces acting on the vehicle based on the vehicle's environment, and

(ii) Flight abort, if elected as the vehicle's hazard control strategy;

(3) The probability distribution of position and velocity of the vehicle when each malfunction trajectory will terminate due to vehicle breakup, ground impact, or orbital insertion along with the cause of termination and the state of the vehicle;

(b) ***Implementation of flight safety system.*** For operators that use flight abort as the vehicle's hazard control strategy, operators must account for potential failures of the flight safety system only if the flight safety system is not highly reliable per § 450.145.

(c) ***Application requirements.*** An applicant must submit:

(1) A description of all scenarios that can lead to hazardous debris;

(2) A description of methods used to determine breakup limits, to include:

(i) evidence of a scientifically and statistically valid approach

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(3) A description of methods used to implement breakup criteria, to include:

(i) evidence of a scientifically and statistically valid approach

(ii) documentation of all assumptions;

(iii) evidence of validation and verification; and

(iv) for operators utilizing the Flight Abort hazard control strategy, a description of how the flight safety system utilizes the breakup criteria.

(4) Representative breakup data outputs including position and velocity for each representative malfunction trajectory.

450.121 Impact and debris hazard analysis.

(a) ***General.*** A flight safety analysis must include an analysis characterizing the hazardous debris generated from ~~normal and malfunctioning vehicle flight as a function of vehicle flight sequence~~ each cause of impact or breakup.

(b) ~~***Vehicle***~~ ***Impact and breakup analysis.*** A debris analysis must account for:

~~(1) Each reasonably foreseeable cause of vehicle breakup and intact impact,~~

(2) Vehicle structural characteristics and materials, and

(3) Energetic effects during break-up or at impact.

~~(c) ***Propagation of debris.*** A debris analysis must compute statistically valid debris impact probability distributions. The propagation of debris from each predicted breakup location to impact must account for—~~

~~(1) All foreseeable forces that can influence any debris impact location; and~~

~~(2) All foreseeable sources of impact dispersion, including, at a minimum:~~

~~(i) The uncertainties in atmospheric conditions;~~

~~(ii) Debris aerodynamic parameters, including uncertainties;~~

~~(iii) Pre-breakup position and velocity, including uncertainties; and~~

~~(iv) Breakup-imparted velocities, including uncertainties.~~

(~~d~~c) ***Application requirements.*** An applicant must submit:

~~(1) A description of all scenarios that can lead to hazardous debris;~~

(~~2~~1) A description of the methods used to perform the vehicle impact ~~and breakup~~ analysis to include: ~~in accordance with § 450.115(c)~~

(i) evidence of a scientifically and statistically valid approach

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

~~(3) A description of the methods used to compute debris impact distributions, in accordance with § 450.115(c);~~

~~(4) A description of the atmospheric data used as input to the debris analysis; and~~

(~~5~~2) A quantitative description of the physical, aerodynamic, and harmful characteristics of hazardous debris.

450.122 Propagation of debris

(a) ~~***Propagation of debris.***~~ ***General***. A debris analysis must compute statistically valid debris impact probability distributions. The propagation of debris from each predicted breakup location to impact must account for—

(1) All foreseeable forces that can influence any debris impact location; and

(2) All foreseeable sources of impact dispersion, including, at a minimum:

(i) The uncertainties in atmospheric conditions;

(ii) Debris aerodynamic parameters, including uncertainties;

(iii) Pre-breakup position and velocity, including uncertainties; and

(iv) Breakup-imparted velocities, including uncertainties.

(d) ***Application requirements.*** An applicant must submit:

(1) A description of the methods used to compute debris impact distributions to include: ~~in accordance with § 450.115(c);~~

(i) evidence of a scientifically and statistically valid approach

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(2) A description of the atmospheric data used as input to the debris analysis; and

(3) Representative debris impact distributions sufficient to demonstrate the method described in paragraph (b)(1).

§ 450.123 Population exposure analysis.

(a) ***General.*** A flight safety analysis must account for the distribution of people for the entire region where there is a significant probability of impact of hazardous debris.

(b) ***Constraints.*** The exposure analysis must—

(1) Characterize the distribution of people both geographically and temporally;

(2) Account for the distribution of people among structures and vehicle types;

(3) Use reliable, accurate, and timely source data; and

(4) Account for vulnerability of people to hazardous debris effects.

(c) ***Application requirements.*** An applicant must submit:

(1) A description of the methods used to develop the exposure input data, to include: ~~in accordance with § 45~~

(i) evidence of a scientifically and statistically valid approach;

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(2) Complete population exposure data, for a representative analysis, in tabular form.

450.124 Limits of a useful mission

(a) ***General.*** For vehicles using flight abort as a hazard control strategy under § 450.108, an applicant must describe the limits of a useful mission. The FAA does not consider the collection of data related to a failure to be a useful mission.

(b) ***Application requirements.*** An applicant must submit in its application the following:

(1) Trajectory data or parameters that describe the limits of a useful mission.

(2) A description of the methodology used to determine the limits of a useful mission~~, in accordance with § 450.115(c)~~ including:

(i) evidence of a statistically and scientifically valid approach

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

§ 450.131 Probability of failure analysis.

(a) ***General.*** For each ~~hazard and~~ phase of flight and reasonably foreseeable failure mode, a flight safety analysis for a launch or reentry must account for vehicle failure probability. The probability of failure must be consistent for all ~~hazards~~ failure modes and phases of flight. For flight safety analysis purposes, a failure occurs when a vehicle or vehicle stage:

~~(1) For a vehicle or vehicle stage with fewer than two flights, the failure probability estimate must account for the outcome of all previous flights of vehicles developed and launched or reentered in similar circumstances.~~

~~(2) For a vehicle or vehicle stage with two or more flights, vehicle failure probability estimates must account for the outcomes of all previous flights of the vehicle or vehicle stage in a statistically valid manner. The outcomes of all previous flights of the vehicle or vehicle stage must account for data on any mishap and anomaly.~~

(1) Impacted the Earth outside of planned areas or reentered the atmosphere outside of the normal trajectory envelope;

(2) Broke up and had hazardous debris impact the Earth outside of planned areas;

(3) Did not complete any phase of normal flight with the potential to create a public safety hazard; or

(4) Experienced an anomalous condition with the potential to create a public safety hazard.

(b) ***Phase of Flight.*** The probability of failure analysis must identify phases of flight where the probability of failure distribution for each failure mode is continuous and defined by a single mathematical function. Phases of flight must:

(1) Use consistent phase transition criteria based on physically observable phenomena;

(2) Continuously cover the full duration of the scope of flight safety analysis defined in § 450.113(a) when combined;

(3) Not include more than one key flight safety event in each phase of flight; and

(4) Be long enough to allow for the implementation of a risk mitigation.

~~(b) ***Failure.*** For flight safety analysis purposes, a failure occurs when a vehicle does not complete any phase of normal flight or when any anomalous condition exhibits the potential for a stage or its debris to impact the Earth or reenter the atmosphere outside the normal trajectory envelope during the mission or any future mission of similar vehicle capability.~~

~~(c) ***Previous flight.*** For flight safety analysis purposes—~~

~~(1) The flight of a launch vehicle begins at a time in which a launch vehicle lifts off from the surface of the Earth; and~~

~~(2) The flight of a reentry vehicle or deorbiting upper stage begins at a time in which a vehicle attempts to initiate a reentry.~~

(c) Failure Probability. For each phase of flight, the failure probability estimate must account for:

(1) The outcomes of all previous flights of vehicles developed and launched or reentered in similar circumstances. Similar vehicles ~~must~~ should consider:

(i) Common physical design characteristics;

(ii) Common flight or operational environments;

(iii) Development and integration processes, including the extent of integrated system testing;

(iv) Level of experience of the vehicle operator and development team members; and

(v) Level of risk tolerance of the vehicle operator and customer, if applicable.

(2) The outcomes of all previous flights of the vehicle or vehicle stage, including data on any mishap and anomaly, if known; and

(3) Any significant differences in the observed failure probability and the conditional failure probability for a phase of flight.

(d) ***Failure Rate.*** For each phase of flight, the failure probability estimate must be distributed. The failure rate distribution must be:

(1) Defined by a single mathematical function; and

(2) Consistent across all phases of flight, unless there is clear and convincing evidence of a different distribution for a particular phase of flight.

(d) ***Failure Mode Allocation.*** For each phase of flight, the ~~vehicle~~ failure probability estimate must be distributed consistently. ~~across flight phases and failure modes~~. The distribution must ~~be consistent with~~ account for—

(1) The data available from all previous flights of vehicles developed and launched or reentered in similar circumstances; and

(2) Data from previous flights of vehicles, stages, or components developed and launched, reentered, flown, or tested by the subject vehicle developer or operator; and ~~Such data may include previous experience involving similar—~~

~~(i) Vehicle, stage, or component design characteristics;~~

~~(ii) Development and integration processes, including the extent of integrated system testing; and~~

~~(iii) Level of experience of the vehicle operation and development team members.~~

(3) The relative likelihood of each failure mode within the subject vehicle's functional hazard analysis developed in accordance with § 450.107(b) or other system safety analysis.

~~(e) ***Observed vs. conditional failure rate.*** Probability of failure allocation must account for significant differences in the observed failure rate and the conditional failure rate. A probability of failure analysis must use a constant conditional failure rate for each phase of flight, unless there is clear and convincing evidence of a different conditional failure rate for a particular vehicle, stage, or phase of flight.~~

(f) ***Application requirements.*** An applicant must submit both:

(1) A description of the methods used in probability of failure analysis, to include:~~, in accordance with § 450.115(c)including~~

(i) evidence of a scientifically and statistically valid approach;

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(2) A representative set of tabular data ~~and graphs~~ of the ~~predicted~~ estimated failure rate and cumulative failure probability for each foreseeable failure mode.

450.132 – Vulnerability Modeling

(a) ***General.*** An applicant must account for the casualty area for:

(1) All relevant debris fragment characteristics from § 450.121 and their impact or effects;

(2) All characteristics of a representative person exposed to any potential debris hazard;

(3) All hazardous debris by modeling the vulnerability of persons to debris impacts or blast hazards, including—

(i) Effects of buildings, ground vehicles, waterborne vessel, and aircraft upon the vulnerability of any occupants;

(ii) Effect of atmospheric conditions on debris impact and effects;

(iii) Impact speed and angle, accounting for motion of impacted vehicles;

(iv) Uncertainty in input data, such as fragment impact parameters; and

(v) Uncertainty in modeling methodology.

(b) ***Application requirements.*** An applicant must submit description of the scientific methods used to develop a vulnerability model to include:

(1) evidence of a scientifically and statistically valid approach;

(2) documentation of all assumptions; and

(3) evidence of validation and verification.

~~including assumptions and rationale.~~

~~(1) A The vulnerability analysis for a casualty area must account for —~~

~~(2) Statistically valid debris impact probability distributions;~~

~~(3) Any impact or effects of hazardous debris; and~~

~~(4) The vulnerability of people to debris impact or effects, including:~~

§ 450.133 Flight hazard area analysis.

(a) ***General.*** A flight safety analysis must include a flight hazard area analysis that identifies any region of land, sea, or air that must be surveyed, publicized, controlled, or evacuated in order to control the risk to the public. The analysis must account for, at a minimum—

(1) The regions of land, sea, and air potentially exposed to hazardous debris generated during normal flight events and all reasonably foreseeable failure modes;

(2) Any hazard controls implemented to control risk from any hazard;

(3) The limits of a launch or reentry vehicle's normal flight, including—

(i) Atmospheric conditions that are no less severe than the worst atmospheric conditions under which flight might be attempted; and

(ii) Uncertainty in the atmospheric conditions;

(4) All hazardous debris;

(5) Sources of debris dispersion in accordance with § 450.122~~1~~(~~e~~a); and

(6) A probability of one for any planned debris hazards or planned impacts.

(b) ***Waterborne vessel hazard areas.*** The flight hazard area analysis for waterborne vessels must determine the areas and durations for regions of water—

(1) That are necessary to contain either

(i) With 97 percent probability of containment, all debris resulting from normal flight events capable of causing a casualty to persons on waterborne vessels; or

(ii)~~(2) That are necessary to contain either~~ Where either the probability of debris capable of causing a casualty impacting on or near a vessel would exceed 1×10^{-5}, accounting for all relevant hazards, including normal flight events, or where the individual probability of casualty for any person on board a vessel would exceed the individual risk criteria in § 450.101(a)(2) or (b)(2); and

(2) Where reduced vessel traffic is necessary to meet the collective risk criteria in § 450.101(a)(1) or (b)(1).

(c) ***Land hazard areas.*** The flight hazard area analysis for land must determine the durations and areas regions of land—

(1) That are either

(i) Necessary to contain 97 percent probability of containment, all debris resulting from normal flight events capable of causing a casualty to any person on land; or

(2) Where the individual probability of casualty for any person on land would exceed the individual risk criteria in § 450.101(a)(2) or (b)(2); and

(2) Where reduced population is necessary to meet the collective risk criteria in § 450.101(a)(1) or (b)(1).

(d) ***Airspace hazard volumes.*** The flight hazard area analysis for airspace must determine the durations and volumes for regions of air to be submitted to the FAA for approval—

(1) That are necessary to contain, with 97 percent probability of containment, all debris resulting from normal flight events capable of causing a casualty to persons on an aircraft; or

(2) Where the probability of impact on an aircraft would exceed the aircraft risk criterion in § 450.101(a)(3) or (b)(3).

(e) ***Application requirements.*** An applicant must submit:

(1) A description of the methodology to be used in the flight hazard area analysis to include ~~in accordance with § 450.115(c),~~:

(i) evidence of a scientifically and statistically valid approach;

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(2) The classes of waterborne vessel and aircraft considered, and the vulnerability criteria employed; (3) Tabular data and graphs of the results of the flight hazard area analysis, including:

(i) Geographical coordinates of all hazard areas that are representative of those to be published, in accordance with § 450.161, prior to any proposed operation;

(ii) Representative contours showing either 97 percent probability of containment contours or actual risk contours based on probability of casualty for all debris resulting from normal flight events capable of causing a casualty for all locations specified in paragraph (a) of this section;

(iii) Representative individual probability of casualty contours for all locations specified in paragraph (a) of this section, including tabular data and graphs showing the hypothetical location of any member of the public that could be exposed to a probability of casualty of 1×10^{-5} or greater for neighboring operations personnel, and 1×10^{-6} or greater for other members of the public, given all foreseeable conditions within the flight commit criteria;

(iv) If applicable, representative 1×10^{-5} and 1×10^{-6} probability of impact contours for all debris capable of causing a casualty to persons on a waterborne vessel regardless of location; and

(v) Representative 1×10^{-6} and 1×10^{-7} probability of impact contours for all debris capable of causing a casualty to persons on an aircraft regardless of location.

§ 450.135 Debris risk analysis.

(a) ***General.*** A flight safety analysis must include a debris risk analysis that demonstrates compliance with safety criteria in § 450.101, either—

(1) Prior to the day of the operation, accounting for all foreseeable conditions within the flight commit criteria; or

(2) During the countdown using the best available input data, including flight commit criteria and flight abort rules.

(b) The debris risk analysis must—

(1) Include a description of the atmospheric data used as input to the debris risk analysis;

(2) Compute the predicted consequences of each reasonably foreseeable failure mode in any significant period of flight in terms of conditional expected casualties only if operators utilize § 450.101(c)(1) or § 450.101(c)(2).

~~(b) ***Casualty area and consequence analysis.*** A debris risk analysis must model the casualty area, and compute the predicted consequences of each reasonably foreseeable failure mode in any significant period of flight in terms of conditional expected casualties. The casualty area and consequence analysis must account for—~~

~~(1) All relevant debris fragment characteristics and the characteristics of a representative person exposed to any potential debris hazard;~~

~~(2) Statistically valid debris impact probability distributions;~~

~~(3) Any impact or effects of hazardous debris; and~~

~~(4) The vulnerability of people to debris impact or effects, including:~~

~~(i) Effects of buildings, ground vehicles, waterborne vessel, and aircraft upon the vulnerability of any occupants;~~

~~(ii) Effect of atmospheric conditions on debris impact and effects;~~

~~(iii) Impact speed and angle, accounting for motion of impacted vehicles;~~

~~(iv) Uncertainty in input data, such as fragment impact parameters; and~~

~~(v) Uncertainty in modeling methodology.~~

(c) ***Application requirements.*** An applicant must submit:

(1) A description of the methods used to demonstrate compliance with the safety criteria in § 450.101~~, in accordance with § 450.115(c)~~, to include:

(i) evidence of a scientifically and statistically valid approach;

(ii) documentation of all assumptions; and

(iii) evidence of validation and verification.

(2) A description of how the operator will account for the conditions immediately prior to enabling the flight of a launch vehicle or the reentry of a reentry vehicle, such as the final trajectory, atmospheric conditions, and the exposure of people;

~~(2) A description of the atmospheric data used as input to the debris risk analysis;~~

~~(3) The effective unsheltered casualty area for all fragment classes, assuming a representative impact vector;~~

~~(4) The effective casualty area for all fragment classes for a representative type of building, ground vehicle, waterborne vessel, and aircraft, assuming a representative impact vector;~~

(~~5~~3) Collective and individual debris risk analysis outputs under representative conditions and the worst foreseeable conditions, including:

(i) Total collective casualty expectation for the proposed operation;

(ii) A list of the collective risk contribution for ~~at least~~ the top ten population centers and all centers with collective risk exceeding 1 percent of the collective risk criteria in § 450.101(a)(1) or (b)(1);

(iii) A list of the maximum individual probability of casualty for the top ten population centers and all centers that exceed 10 percent of the individual risk criteria in § 450.101(a)(2) or (b)(2); and

(iv) A list of the conditional collective casualty expectation for each failure mode for each significant period of flight under representative conditions and the worst foreseeable conditions.

§ 450.137 Far-field overpressure blast effects analysis.

(a) ***General.*** A flight safety analysis must include a far-field overpressure blast effect analysis that demonstrates compliance with safety criteria in § 450.101, either—

(1) Prior to the day of the operation, accounting for all foreseeable conditions within the flight commit criteria; or

(2) During the countdown using the best available input data, including flight commit criteria and flight abort rules.

(b) ***Analysis constraints.*** The analysis must account for—

(1) The explosive capability of the vehicle and hazardous debris at impact and below 1km ~~at~~ altitude;

(2) The potential influence of meteorological conditions and terrain characteristics; and

(3) The potential for broken building windows due to peak incident overpressures ~~below 1.0 psi~~ between 690 Pa and 6,900 Pa and related casualties based on the characteristics of exposed windows and the population's susceptibility to injury, with considerations including, at a minimum, shelter types, window types, and the time of day of the proposed operation.

(c) ***Application requirements.*** An applicant must submit a description of the far-field overpressure analysis, including all assumptions and justifications for the assumptions, analysis methods, input data, and results. At a minimum, the application must include:

(1) A description of the population centers, terrain, building types, and window characteristics used as input to the far-field overpressure analysis;

(2) A description of the methods used to compute the foreseeable explosive yield probability pairs, and the complete set of yield-probability pairs, used as input to the far-field overpressure analysis;

(3) A description of the methods used to compute peak incident overpressures as a function of distance from the explosion and prevailing meteorological conditions, including sample calculations for a representative range of the foreseeable meteorological conditions, yields, and population center locations;

(4) A description of the methods used to compute the probability of building window breakage, including tabular data and graphs for the probability of breakage as a function of the peak incident overpressure for a representative range of window types, building types, and yields accounted for;

(5) A description of the methods used to compute the probability of casualty for a representative individual, including tabular data and graphs for the probability of casualty, as a function of location relative to the window and the peak incident overpressure for a representative range of window types, building types, and yields accounted for;

(6) A description of the meteorological measurements used as input to any real-time far-field overpressure analysis; and

(7) Collective and individual far-field overpressure risk analysis outputs under representative conditions and the worst foreseeable conditions, including:

(i) The total collective casualty expectation for the proposed operation;

(ii) A list of the collective risk contribution for at least the top ten population centers and all centers with collective risk exceeding 1 percent of the collective risk criteria in § 450.101(a)(1) or (b)(1); and

(iii) A list of the maximum individual probability of casualty for the top ten population centers and all centers that exceed 10 percent of the individual risk criteria in § 450.101(a)(2) or (b)(2).

~~(6) Tabular data and graphs showing the hypothetical location of any member of the public that could be exposed to a probability of casualty of 1×10^{-5} or greater for neighboring operations personnel, and 1×10^{-6} or greater for other members of the public, given foreseeable conditions~~;

~~(7) The maximum expected casualties that could result from far-field overpressure hazards given foreseeable conditions; and~~

~~(8) A description of the meteorological measurements used as input to any real-time far-field overpressure analysis.~~

§ 450.139 Toxic hazards for flight.

(a) ***Applicability.***

(1) Except as specified in paragraph (a)(2), this section applies to any launch or reentry vehicle, including all vehicle components and payloads, that use toxic propellants or other toxic chemicals.

(2) No toxic release hazard analysis is required for kerosene-based fuels, unless the Administrator determines that an analysis is required to protect public safety.

(b) ***General.*** An operator must—

(1) Conduct a toxic release hazard analysis in accordance with paragraph (c) of this section;

(2) Manage the risk of casualties that could arise from the exposure to toxic release through one of the following means:

(i) Contain hazards caused by toxic release in accordance with paragraph (d) of this section; or

(ii) Perform a toxic risk assessment, in accordance with paragraph (e) of this section, that protects the public in compliance with the safety criteria of § 450.101, including toxic release hazards.

(3) Establish flight commit criteria based on the results of its toxic release hazard analysis and toxic containment or toxic risk assessment for any necessary evacuation of the public from any toxic hazard area.

(c) ***Toxic release hazard analysis.*** A toxic release hazard analysis must—

(1) Account for any toxic release that could occur during nominal or non-nominal flight;

(2) Include a worst-case release scenario analysis or a maximum-credible release scenario analysis for each process that involves a toxic propellant or other chemical;

(3) Determine if toxic release can occur based on an evaluation of the chemical compositions and quantities of propellants, other chemicals, vehicle materials, and projected combustion products, and the possible toxic release scenarios;

(4) Account for both normal combustion products and any unreacted propellants and phase change or chemical derivatives of released substances; and

(5) Account for any operational constraints and emergency procedures that provide protection from toxic release.

(d) ***Toxic containment.*** An operator using toxic containment must manage the risk of any casualty from the exposure to toxic release either by—

(1) Evacuating, or being prepared to evacuate, the public from any toxic hazard area in the event of a worst-case release or maximum-credible release scenario; or

(2) Employing meteorological constraints to limit an operation to times during which prevailing winds and other conditions ensure that any member of the public would not be exposed to toxic concentrations and durations greater than accepted toxic thresholds for acute casualty in the event of a worst-case release or maximum-credible release scenario.

(e) ***Toxic risk assessment.*** An operator using toxic risk assessment must establish flight commit criteria that demonstrate compliance with the safety criteria of § 450.101. A toxic risk assessment must—

(1) Account for airborne concentration and duration thresholds of toxic propellants or other chemicals. For any toxic propellant, other chemicals, or combustion product, an operator must use airborne toxic concentration and duration thresholds identified in a means of compliance accepted by the Administrator;

(2) Account for physical phenomena expected to influence any toxic concentration and duration in the area surrounding the potential release site;

(3) Determine a toxic hazard area for the launch or reentry, surrounding the potential release site for each toxic propellant or other chemical based on the amount and toxicity of the propellant or other chemical, the exposure duration, and the meteorological conditions involved;

(4) 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, populated offshore structures, and aircraft that are not operated in direct support of the launch or reentry; and

(5) Account for any risk mitigation measures applied in the risk assessment.

(f) ***Application requirements.*** An applicant must submit:

(1) The identity of toxic propellant, chemical, or combustion products or derivatives in the possible toxic release;

(2) The applicant's selected airborne toxic concentration and duration thresholds;

(3) The meteorological conditions for the atmospheric transport and buoyant cloud rise of any toxic release from its source to downwind receptor locations;

(4) Characterization of the terrain, as input for modeling the atmospheric transport of a toxic release from its source to downwind receptor locations;

(5) The identity of the toxic dispersion model used, and any other input data;

(6) Representative results of an applicant's toxic dispersion modeling to predict concentrations and durations at selected downwind receptor locations, to determine the toxic hazard area for a released quantity of the toxic substance;

(7) A toxic release hazard analysis in accordance with paragraph (c) of this section:

(i) A description of the failure modes and associated relative probabilities for potential toxic release scenarios used in the risk evaluation; and

(ii) The methodology and representative results of an applicant's determination of the worst-case or maximum-credible quantity of any toxic release that might occur during the flight of a vehicle;

(8) In accordance with § 450.139(b)(2),

(i) A toxic containment in accordance with paragraph (d) of this section, identify the evacuation plans or meteorological constraints and associated launch commit criteria needed to ensure that the public will not be within a toxic hazard area in the event of a worst-case release or maximum-credible release scenario; or

(ii) A toxic risk assessment in accordance with paragraph (e) of this section:

(A) A demonstration that the safety criteria in § 450.101 will be met;

(B) The population characteristics in receptor locations that are identified by toxic dispersion modeling as toxic hazard areas;

(C) A description of any risk mitigations applied in the toxic risk assessment; and

(D) A description of the population exposure input data used in accordance with § 450.123.

Prescribed Hazard Controls for Safety-Critical Hardware and Computing Systems

§ 450.141 Computing systems.

(a) ***Identification of computing system safety items.*** An operator must identify:

(1) Any software or data that implements a capability that, by intended operation, unintended operation, or non-operation, can present a hazard to the public; and

(2) The level of criticality of each computing system safety item identified in paragraph (a)(1) of this section, commensurate with its degree of control over hazards to the public and the severity of those hazards.

(b) ***Safety requirements.*** An operator must develop safety requirements for each computing system safety item. In doing so, the operator must:

(1) Identify and evaluate safety requirements for each computing system safety item;

(2) Ensure the safety requirements are complete and correct;

(3) Implement each safety requirement; and

(4) Verify and validate the implementation of each safety requirement by using a method appropriate for the level of criticality of the computing system safety item. For each computing system safety item that is safety critical under § 401.7, verification and validation must include testing by a test team independent of the development division or organization.

(c) ***Development process.*** An operator must implement and document a development process for computing system safety items appropriate for the level of criticality of the computing system safety item. A development process must define:

(1) Responsibilities for each task associated with a computing system safety item;

(2) Processes for internal review and approval—including review that evaluates the implementation of all safety requirements—such that no person approves that person's own work;

(3) Processes to ensure development personnel are trained, qualified, and capable of performing their role;

(4) Processes that trace requirements to verification and validation evidence;

(5) Processes for configuration management that specify the content of each released version of a computing system safety item;

(6) Processes for testing that verify and validate all safety requirements to the extent required by paragraph (b)(4) of this section;

(7) Reuse policies that verify and validate the safety requirements for reused computing system safety items; and

(8) Third-party product use policies that verify and validate the safety requirements for any third-party product.

~~(d) ***Application requirements.*** An applicant must:~~

~~(1) Identify and describe all computing system safety items involved in the proposed operations;~~

~~(2) Provide the safety requirements for each computing system safety item;~~

~~(3) Provide documentation of the development processes that meets paragraph (c) of this section;~~

~~(4) Provide evidence of the execution of the appropriate development process for each computing system safety item; and~~

~~(5) Provide evidence of the implementation of each safety requirement.~~

§ 450.143 Safety-critical system design, test, and documentation.

(a) ***Applicability.*** This section applies to all safety-critical systems, except for—

(1) Highly reliable flight safety systems covered under § 450.145; or

(2) Safety-critical systems for which an operator demonstrates through its flight hazard analysis that the likelihood of any hazardous condition specifically associated with the system that may cause death or serious injury to the public is extremely remote, pursuant to § 450.109(b)(3).

(b) ***Design.*** An operator must design safety-critical systems such that no credible fault can lead to increased risk to the public beyond nominal safety-critical system operation.

(c) ***Qualification testing of design.*** An operator must functionally demonstrate the design of the vehicle's safety-critical systems at conditions beyond its predicted operating environments. The operator must select environmental test levels that ensure the design is sufficiently stressed to demonstrate that system performance is not degraded due to design tolerances, manufacturing variances, or uncertainties in the environment.

(d) ***Acceptance of hardware.*** An operator must—

(1) Functionally demonstrate any safety-critical system, while exposed to its predicted operating environments with margin, is free of defects, free of integration and workmanship errors, and ready for operational use; or

(2) Combine in-process controls and a quality assurance process to ensure functional capability of any safety-critical system during its service life.

(e) ***Lifecycle of safety-critical systems.***

(1) The predicted operating environments must be based on conditions predicted to be encountered in all phases of flight, recovery, and transportation.

(2) An operator must monitor the flight environments experienced by safety-critical system components to the extent necessary to—

(i) Validate the predicted operating environments; and

(ii) Assess the actual component life remaining or adjust any inspection period.

(f) ***Application requirements.*** An applicant must submit to the FAA the following as part of its application:

(1) A list and description of each safety-critical system;

(2) Drawings and schematics for each safety-critical system;

(3) A summary of the analysis to determine the predicted operating environments and duration to be applied to qualification and acceptance testing covering the service life of any safety-critical system;

(4) A description of any method used to validate the predicted operating environments;

~~(5) A description of any instrumentation or inspection processes to monitor aging of any safety-critical system;~~

~~(6) The criteria and procedures for disposal or refurbishment for service life extension of safety-critical system components; and~~

~~(7) A description of the standards used in all phases of the lifecycle of each safety-critical system.~~

§ 450.145 Highly reliable flight safety system.

(a) ***General.*** For each phase of flight for which an operator must implement flight abort to meet the requirement of § 450.108(b)(1), the operator must use a highly reliable flight safety system on the launch or reentry vehicle, vehicle component, or payload with a design reliability in accordance with this section.

(b) ***Reliability.*** A highly reliable flight safety system must, using a means of compliance accepted by the Administrator—

(1) Have a design reliability of 0.999 at 95 percent confidence and commensurate design, analysis, and testing for the portion of the flight safety system onboard the vehicle; and

(2) Have a design reliability of 0.999 at 95 percent confidence and commensurate design, analysis, and testing for the portion of the flight safety system not onboard the vehicle, if used.

(c) ***Monitoring.*** An operator must monitor the flight environments experienced by any flight safety system component to the extent necessary to—

(1) Validate the predicted operating environment; and

(2) Assess the actual component life remaining or adjust any inspection period.

(d) ***Application requirements.*** An applicant must submit the information identified below, for any highly reliable flight safety system:

(1) ***Flight safety system description.*** An applicant must describe the flight safety system and its operation in detail, including all components, component functions, and possible operational scenarios.

(2) ***Flight safety system diagram.*** An applicant must submit a diagram that identifies all flight safety system subsystems and shows the interconnection of all the elements of the flight safety system. The diagram must include any subsystems used to implement flight abort both on and off the vehicle, including any subsystems used to make the decision to abort flight.

(3) ***Flight safety system analyses.*** An applicant must submit any analyses and detailed analysis reports of all flight safety system subsystems necessary to calculate the reliability and confidence levels required by paragraph (a) of this section.

(4) ***Tracking validation procedures.*** An applicant must document and submit the procedures for validating the accuracy of any vehicle tracking data utilized by the flight safety system to make the decision to abort flight.

(5) ***Flight safety system test plans.*** An applicant must submit acceptance, qualification, and preflight test plans of any flight safety system, subsystems, and components. The test plans must include test procedures and test environments.

(6) ***Monitoring plan.*** An applicant must submit a description of any method used to validate the predicted operating environments.

Other Prescribed Hazard Controls

§ 450.147 Agreements.

(a) ***General.*** An operator must establish a written agreement with any entity that provides a service or property that meets a requirement in this part, including:

(1) ***Launch and reentry site use agreements.*** A Federal launch or reentry site operator, a licensed launch or reentry site operator, or any other person that provides services or access to or use of property required to support the safe launch or reentry under this part;

(2) ***Agreements for notices to mariners.*** Unless otherwise addressed in agreements with the site operator, for overflight of navigable water, the U.S. Coast Guard or other applicable maritime authority to establish procedures for the issuance of a Notice to Mariners prior to a launch or reentry and other measures necessary to protect public health and safety;

(3) ***Agreements for notices to airmen.*** Unless otherwise addressed in agreements with the site operator, the FAA Air Traffic Organization or other applicable air navigation authority to establish procedures for the issuance of a Notice to Airmen prior to a launch or reentry, for closing of air routes during the respective launch and reentry windows, and for other measures necessary to protect public health and safety; and

(4) ***Mishap response.*** Emergency response providers, including local government authorities, to satisfy the requirements of § 450.173.

(b) ***Roles and responsibilities.*** The agreements required in this section must clearly delineate the roles and responsibilities of each party to support the safe launch or reentry under this part.

(c) ***Effective date.*** The agreements required in this section must be in effect before a license can be issued, unless otherwise agreed to by the Administrator.

(d) ***Application requirements.*** An applicant must—

(1) Describe each agreement in this section; and

(2) Provide a copy of any agreement, or portion thereof, to the FAA upon request.

§ 450.149 Safety-critical personnel and qualifications.

(a) ***General.*** An operator must ensure safety-critical personnel are trained, qualified, and capable of performing their safety-critical tasks, and that their training is current.

(b) **Safety organization.** An operator must maintain a safety organization that has clearly defined lines of communication and approval authority for all public safety decisions. At a minimum, the safety organization must have the following two safety-critical positions:

(1) Mission director. For each launch or reentry, an operator must designate a position responsible for the safe conduct of all licensed activities and authorized to provide final approval to proceed with licensed activities. This position is referred to as the mission director in this part.

(2) Safety official. For each launch or reentry, an operator must designate a position with direct access to the mission director who is—

(i) Responsible for communicating potential safety and noncompliance issues to the mission director; and

(ii) Authorized to examine all aspects of the operator's ground and flight safety operations, and to independently monitor compliance with the operator's safety policies, safety procedures, and licensing requirements.

(3) Addressing safety official concerns. The mission director must ensure that all of the safety official's concerns are addressed.

(c) ***Application requirements.*** An applicant must—

(1) Identify safety-critical tasks that require qualified personnel;

(2) Provide internal training and currency requirements, completion standards, or any other means of demonstrating compliance with the requirements of this section; and

(3) Describe the process for tracking training currency.

§ 450.151 Work shift and rest requirements.

(a) ***General.*** For any launch or reentry, an operator must document and implement rest requirements that ensure safety-critical personnel are physically and mentally capable of performing all assigned tasks.

(b) ***Work shifts and deviation approval process.*** An operator's rest requirements must address the following:

(1) Duration of each work shift and the process for extending this shift, including the maximum allowable length of any extension;

(2) Number of consecutive work shift days allowed before rest is required;

(3) Minimum rest period required—

(i) Between each work shift, including the period of rest required immediately before the flight countdown work shift; and

(ii) After the maximum number of work shift days allowed; and

(4) Approval process for any deviation from the rest requirements.

(c) ***Application requirement.*** An applicant must submit rest rules that demonstrate compliance with the requirements of this section.

§ 450.153 Radio frequency management.

(a) ***General.*** For any radio frequency used, an operator must—

(1) Ensure radio frequency interference does not adversely affect performance of any flight safety system or safety-critical system; and

(2) Coordinate use of radio frequencies with any site operator and any local and Federal authorities.

(b) ***Application requirements.*** An applicant must submit procedures or other means to demonstrate compliance with the radio frequency requirements of this section.

§ 450.155 Readiness.

(a) ***General.*** An operator must document and implement procedures to assess readiness to proceed with the flight of a launch or reentry vehicle. These procedures must address, at a minimum, the following:

(1) Readiness of vehicle and launch, reentry, or landing site, including any contingency abort location;

(2) Readiness of safety-critical personnel, systems, software, procedures, equipment, property, and services; and

(3) Readiness to implement the mishap plan required by § 450.173.

(b) ***Application requirements.*** An applicant must—

(1) Demonstrate compliance with the requirements of paragraph (a) of this section through procedures that may include a readiness meeting close in time to flight; and

(2) Describe the criteria for establishing readiness to proceed with the flight of a launch or reentry vehicle so that public safety is maintained.

§ 450.157 Communications.

(a) An operator must implement communication procedures during the countdown and flight of a launch or reentry vehicle that—

(1) Define the authority of personnel, by individual or position title, to issue "hold/resume," "go/no go," and abort commands;

(2) Assign communication networks so that personnel identified in paragraph (a)(1) of this section have direct access to real-time, safety-critical information required to issue "hold/resume," "go/no go," and any abort commands; and

(3) Implement a protocol for using defined radio telephone communications terminology.

(b) An operator must ensure the currency of the communication procedures, and that all personnel are working with the approved version of the communication procedures.

(c) An operator must record all safety-critical communications network channels that are used for voice, video, or data transmissions that support safety-critical systems during each countdown.

§ 450.159 Pre-flight procedures.

(a) An operator must implement pre-flight procedures that—

(1) Verify that each flight commit criterion is satisfied before flight is initiated; and

(2) Ensure the operator can return the vehicle to a safe state after a countdown abort or delay.

(b) An operator must ensure the currency of the pre-flight procedures, and that all personnel are working with the approved version of the pre-flight procedures.

§ 450.161 Control of hazard areas.

~~(a) ***General.*** The operator must publicize, survey, control, or evacuate each flight hazard area identified in accordance with § 450.133 prior to initiating flight of a launch vehicle or the reentry of a reentry vehicle to the extent necessary to ensure compliance with § 450.101.~~

~~(b) ***Verification.*** The launch or reentry operator must perform surveillance sufficient to verify or update the assumptions, input data, and results of the flight safety analyses.~~

(a~~e~~) ***Publication.*** Prior to initiating flight of a launch vehicle or the reentry of a reentry vehicle, an operator must publicize warnings for each flight hazard area, identified in accordance with § 450.133, except for regions of land, sea, or air under the control of the vehicle operator, site operator, or other controlling authority with which the operator has an agreement. If the operator relies on another entity to publicize these warnings, it must:

(1) Determine whether the warnings have been issued; and

(2) Notify the FAA if the warnings have not been issued so that the FAA can determine if the launch or reentry can be conducted in a manner that sufficiently protects the public. This notification must provide sufficient information to enable FAA to issue warnings to U.S. aircraft.

(b) ***Surveillance.*** The launch or reentry operator must perform surveillance of flight hazard areas to the extent necessary to ensure compliance with § 450.101.

(c) ***Control and Evacuation.*** An operator must control and evacuate each flight hazard area identified in accordance with § 450.133 to the extent necessary to ensure compliance with § 450.101.

(1) For launch, control must be accomplished and evacuation complete prior to initiating flight of a launch vehicle.

(2) For reentry, control must be accomplished prior to initiating flight of a reentry vehicle; evacuation must be complete prior to the minimum time of endangerment.

(d) ***Application requirements.*** An applicant must submit—

~~(1) A description of how the applicant will provide for day-of-flight surveillance and control of flight hazard areas, if necessary, to ensure that the presence of any member of the public in or near a flight hazard area is consistent with flight commit criteria developed for each launch or reentry as required by § 450.165(b);~~

~~(2) A description of how the applicant will provide for any publication of flight hazard areas necessary to meet the requirements of this section; and~~

~~(3) A description of how the applicant will establish flight commit criteria based on the results of its toxic release hazard analysis, toxic containment, or toxic risk assessment for any necessary evacuation of the public from any toxic hazard area.~~

(1) A description of how the applicant will publish any flight hazard areas necessary as required by § 450.161(a);

(2) A description of how the applicant will provide for day-of-flight surveillance of flight hazard areas, if necessary, as required by § 450.161(b);

(3) A description of how the applicant will provide for day-of-flight control and evacuation of flight hazard areas, if necessary, as required by § 450.161(c);

(4) A description of how the applicant will ensure that the presence of any member of the public in a flight hazard area is consistent with flight commit criteria developed for each launch or reentry as required by § 450.165(b);

§ 450.163 Lightning hazard mitigation.

(a) ***Lightning hazard mitigation.*** An operator must—

(1) Establish flight commit criteria that mitigate the potential for a launch or reentry vehicle intercepting or initiating a direct lightning strike, or encountering a nearby discharge, using a means of compliance accepted by the Administrator; or

(2) Use a vehicle designed to protect safety-critical systems in the event of a direct lightning strike or nearby discharge.

(b) ***Application requirements.***

(1) An applicant electing to comply with paragraph (a)(1) of this section must submit flight commit criteria that mitigate the potential for a launch or reentry vehicle intercepting or initiating a direct lightning strike, or encountering a nearby lightning discharge.

(2) An applicant electing to comply with paragraph (a)(2) of this section must submit documentation providing evidence that the vehicle is designed to protect safety-critical systems against the effects of a direct lightning strike or nearby discharge.

§ 450.165 Flight commit criteria.

(a) ***General.*** For each launch or reentry, an operator must establish and observe flight commit criteria that identify each condition necessary prior to flight to satisfy the requirements of § 450.101, and must include:

(1) Surveillance of any region of land, sea, or air in accordance with § 450.161;

(2) Monitoring of any meteorological condition necessary to—

(i) Be consistent with any safety analysis required by this part; and

(ii) If necessary in accordance with § 450.163, mitigate the potential for a launch or reentry vehicle intercepting a lightning strike, or encountering a nearby discharge;

(3) Implementation of any launch or reentry window closure in the launch or reentry window for the purpose of collision avoidance in accordance with § 450.169;

(4) Confirmation that any safety-critical system is ready for flight;

(5) Confirmation from the FAA that the risk to critical assets satisfies the requirements of § 450.101(a)(4) or (b)(4);

(6) For any reentry vehicle, except a suborbital vehicle, monitoring by the operator or an onboard system that the status of safety-critical systems is healthy before enabling reentry flight, to assure the vehicle can reenter safely to Earth; and

(7) Any other hazard controls derived from any safety analysis required by this part.

(b) ***Application requirements.*** An applicant must submit a list of all flight commit criteria.

§ 450.167 Tracking.

(a) ***General.*** During the flight of a launch or reentry vehicle, an operator must measure and record in real time the position and velocity of the vehicle. The system used to track the vehicle must provide data to predict the expected impact locations of all stages and components, and to obtain vehicle performance data for comparison with the pre-flight performance predictions.

(b) ***Application requirements.*** An applicant must identify and describe each method or system used to meet the tracking requirements of paragraph (a) of this section.

§ 450.169 Launch and reentry collision avoidance analysis requirements.

(a) ***Criteria.*** Except as provided in paragraph (d) of this section, for an orbital or suborbital launch or reentry, an operator must establish window closures needed to ensure that the launch or reentry vehicle, any jettisoned components, or payloads meet the following requirements with respect to orbiting objects, not including any object being launched or reentered.

(1) For inhabitable objects, one of three criteria below must be met:

(i) The probability of collision between the launching or reentering objects and any inhabitable object must not exceed 1×10^{-6};

(ii) The launching or reentering objects must maintain an ellipsoidal separation distance of 200 km in-track and 50 km cross-track and radially from the inhabitable object; or

(iii) The launching or reentering objects must maintain a spherical separation distance of 200 km from the inhabitable object.

(2) For objects that are neither orbital debris nor inhabitable, one of the two criteria below must be met:

(i) The probability of collision between the launching or reentering objects and any object must not exceed 1×10^{-5}; or

(ii) The launching or reentering objects must maintain a spherical separation distance of 25 km from the object.

(3) For all other known orbital debris identified by the FAA or other Federal Government entity as large objects with radar cross section greater than 1 m^2 and medium objects with radar cross section 0.1 m^2 to 1 m^2:

(i) The probability of collision between the launching or reentering objects and any known orbital debris must not exceed 1×10^{-5}; or

(ii) The launching or reentering objects must maintain a spherical separation distance of 2.5 km.

(b) ***Screening time.*** A launch or reentry operator must ensure the requirements of paragraph (a) of this section are met as follows:

(1) Through the entire segment of flight of a suborbital launch vehicle above 150 km;

(2) For an orbital launch, during ascent from a minimum of 150 km to initial orbital insertion and for a minimum of 3 hours from liftoff;

(3) For reentry, during descent from initial reentry burn to 150 km altitude; and

(4) For disposal, during descent from initial disposal burn to 150 km altitude.

(c) ***Rendezvous.*** Planned rendezvous operations that occur within the screening time frame are not considered a violation of collision avoidance if the involved operators have pre-coordinated the rendezvous or close approach.

(d) ***Exception.*** A launch collision avoidance analysis is not required for any launched object if the maximum planned altitude by that object is less than 150 km.

(e) ***Analysis.*** Collision avoidance analysis must be obtained for each launch or reentry from a Federal entity identified by the FAA, or another entity agreed to by the Administrator.

(1) An operator must use the results of the collision avoidance analysis to establish flight commit criteria for collision avoidance; and

(2) The collision avoidance analysis must account for uncertainties associated with launch or reentry vehicle performance and timing, and ensure that each window closure incorporates all additional time periods associated with such uncertainties.

(f) ***Timing and information required.*** An operator must prepare a collision avoidance analysis worksheet for each launch or reentry using a standardized format that contains the input data required by appendix A to this part, as follows:

(1) Except as specified in paragraphs (f)(1)(i) and (ii) of this section, an operator must file the input data with an entity identified in paragraph (e) of this section and the FAA at least 7 days before the first attempt at the flight of a launch vehicle or the reentry of a reentry vehicle.

(i) Operators that have never received a launch or reentry conjunction assessment from the entity identified in paragraph (e) of this section, must file the input data at least 15 days in advance.

(ii) The Administrator may agree to an alternative time frame in accordance with § 404.15;

(2) An operator must obtain a collision avoidance analysis performed by an entity identified in paragraph (e) of this section, no later than 3 hours before the beginning of a launch or reentry window; and

(3) If an operator needs an updated collision avoidance analysis due to a launch or reentry delay, the operator must file the request with the entity identified in paragraph (e) of this section and the FAA at least 12 hours prior to the beginning of the new launch or reentry window.

§ 450.171 Safety at end of launch.

(a) ***Orbital debris mitigation.*** An operator must ensure for any proposed launch that for all vehicle stages or components that reach Earth orbit—

(1) There is no unplanned physical contact between the vehicle or any of its components and the payload after payload separation;

(2) Debris generation does not result from the conversion of energy sources into energy that fragments the vehicle or its components. Energy sources include chemical, pressure, and kinetic energy; and

(3) For all vehicle stages or components that are left in orbit, stored energy is removed by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system,

leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy.

(b) ***Application requirement.*** An applicant must demonstrate compliance with the requirements in paragraph (a) of this section.

§ 450.173 Mishap plan—reporting, response, and investigation requirements.

(a) ***General.*** An operator must report, respond to, and investigate mishaps, as defined in § 401.7 of this chapter, in accordance with paragraphs (b) through (g) of this section using a plan or other written means.

(b) ***Responsibilities.*** An operator must document—

(1) Responsibilities for personnel assigned to implement the requirements of this section;

(2) Reporting responsibilities for personnel assigned to conduct investigations and for anyone retained by the operator to conduct or participate in investigations; and

(3) Allocation of roles and responsibilities between the launch operator and any site operator for reporting, responding to, and investigating any mishap during ground activities at the site.

(c) ***Mishap reporting requirements.*** An operator must—

(1) Immediately notify the FAA Washington Operations Center in case of a mishap that involves a fatality or serious injury (as defined in 49 CFR 830.2);

(2) Notify within 24 hours the FAA Washington Operations Center in the case of a mishap that does not involve a fatality or serious injury (as defined in 49 CFR 830.2); and

(3) Submit a written preliminary report to the FAA Office of Commercial Space Transportation within five days of any mishap. The preliminary report must include the following information, as applicable:

(i) Date and time of the mishap;

(ii) Description of the mishap and sequence of events leading to the mishap, to the extent known;

(iii) Intended and actual location of the launch or reentry or other landing on Earth;

(iv) Hazardous debris impact points, including those outside a planned landing site or designated hazard area;

(v) Identification of the vehicle;

(vi) Identification of any payload;

(vii) Number and general description of any fatalities or injuries;

(viii) Description and estimated costs of any property damage;

(ix) Identification of hazardous materials, as defined in § 401.7 of this chapter, involved in the event, whether on the vehicle, any payload, or on the ground;

(x) Action taken by any person to contain the consequences of the event;

(xi) Weather conditions at the time of the event; and

(xii) Potential consequences for other similar vehicles, systems, or operations.

(d) ***Emergency response requirements.*** An operator must—

(1) Activate emergency response services to protect the public and property following a mishap as necessary including, but not limited to:

(i) Evacuating and rescuing members of the public, taking into account debris dispersion and toxic plumes; and

(ii) Extinguishing fires;

(2) Maintain existing hazard area surveillance and clearance as necessary to protect public safety;

(3) Contain and minimize the consequences of a mishap, including:

(i) Securing impact areas to ensure that no members of the public enter;

(ii) Safely disposing of hazardous materials; and

(iii) Controlling hazards at the site or impact areas.

(4) Preserve data and physical evidence; and

(5) Implement agreements with government authorities and emergency response services, as necessary, to satisfy the requirements of this section.

(e) ***Mishap investigation requirements.*** In the event of a mishap, an operator must—

(1) Investigate the root causes of the mishap; and

(2) Report investigation results to the FAA.

(f) ***Preventative measures.*** An operator must identify and implement preventive measures for avoiding recurrence of the mishap prior to the next flight, unless otherwise approved by the Administrator.

(g) ***Mishap records.*** An operator must maintain records associated with the mishap in accordance with § 450.219(b).

(h) ***Application requirements.*** An applicant must submit the plan or other written means required by this section.

§ 450.175 Test-induced damage.

(a) ***Applicability.*** This section applies to license applicants or operators seeking an optional test-induced damage exception.

(b) ***Coordination of potential test-induced damage.*** Test-induced damage is not a mishap if all of the following are true:

(1) A license applicant or operator coordinates potential test-induced damage with the FAA before the planned activity, and with sufficient time for the FAA to evaluate the operator's proposal during the application process or as a license modification;

(2) The test-induced damage did not result in any of the following:

(i) Serious injury or fatality (as defined in 49 CFR 830.2);

(ii) Damage to property not associated with the licensed activity; or

(iii) Hazardous debris leaving the pre-defined hazard area; and

(3) The test-induced damage falls within the scope of activities coordinated with the FAA in paragraph (b)(1) of this section.

(c) ***Application requirements.*** An applicant must submit the following information—

(1) Test objectives;

(2) Test limits;

(3) Expected outcomes;

(4) Potential risks, including the applicant's best understanding of the uncertainties in environments, test limits, or system performance;

(5) Applicable procedures;

(6) Expected time and duration of the test; and

(7) Additional information as required by the FAA to ensure protection of public health and safety, safety of property, and the national security and foreign policy interests of the United States.

§ 450.177 Unique safety policies, requirements, and practices.

(a) ***Unique hazards.*** An operator must review operations, system designs, analysis, and testing, and identify any unique hazards not otherwise addressed by this part. An operator must implement any unique safety policy, requirement, or practice needed to protect the public from the unique hazard.

(b) ***Unique requirements.*** The FAA may identify and impose a unique policy, requirement, or practice as needed to protect the public health and safety.

(c) ***Application requirements.*** An applicant must—

(1) Identify any unique safety policy, requirement, or practice necessary in accordance with paragraph (a) of this section, and demonstrate that each unique safety policy, requirement, or practice protects public health and safety.

(2) Demonstrate compliance with each unique safety policy, requirement, or practice imposed by the FAA in accordance with paragraph (b) of this section.

Ground Safety

§ 450.179 Ground safety—general.

(a) At a U.S. launch or reentry site, an operator must protect the public and property from adverse effects of hazardous operations and systems associated with—

(1) Preparing a launch vehicle for flight;

(2) Returning a launch or reentry vehicle to a safe condition after landing, or after an aborted launch attempt; and

(3) Returning a site to a safe condition.

(b) An operator is not required to comply with §§ 450.181 through 450.189 of this part if:

(1) The launch or reentry is being conducted from a Federal launch or reentry site;

(2) The operator has a written agreement with the Federal launch or reentry site for the provision of ground safety services and oversight; and

(3) The Administrator has determined that the Federal launch or reentry site's ground safety processes, requirements, and oversight are not inconsistent with the Secretary's statutory authority over commercial space activities.

(c) In making the determination required by paragraph (b)(3) of this section, the Administrator will consider the nature and frequency of launch and reentry activities conducted from the Federal launch or reentry site, coordination between the FAA and the Federal launch or reentry site safety personnel, and the Administrator's knowledge of the Federal launch or reentry site's requirements.

§ 450.181 Coordination with a site operator.

(a) ***General.*** For a launch or reentry conducted from or to a Federal launch or reentry site or a site licensed under part 420 or 433 of this chapter, an operator must coordinate with the site operator to—

(1) Ensure public access is controlled where and when necessary to protect public safety;

(2) Ensure launch or reentry operations are coordinated with other launch and reentry operators and other affected parties to prevent unsafe interference;

(3) Designate any ground hazard area that affects the operations of a launch or reentry site; and

(4) Ensure a prompt and effective response is undertaken in the event of a mishap that could impact the safety of the public and property.

(b) ***Licensed site operator.*** For a launch or reentry conducted from or to a site licensed under part 420 or 433 of this chapter, an operator must also coordinate with the site operator to establish roles and responsibilities for reporting, responding to, and investigating any mishap during ground activities at the site.

(c) ***Application requirement.*** An applicant must describe how it is coordinating with a Federal or licensed launch or reentry site operator in compliance with this section.

§ 450.183 Explosive site plan.

(a) ***Explosive siting requirements.*** For a launch or reentry conducted from or to a site exclusive to its own use, an operator must comply with the explosive siting requirements of §§ 420.63, 420.65, 420.66, 420.67, 420.69, and 420.70 of this chapter.

(b) ***Application requirement.*** An applicant must submit an explosive site plan in accordance with paragraph (a) of this section.

§ 450.185 Ground hazard analysis.

An operator must perform and document a ground hazard analysis, and continue to maintain it throughout the lifecycle of the launch or reentry system. The analysis must—

(a) ***Hazard identification.*** Identify system and operation hazards posed by the vehicle and ground hardware, including site and ground support equipment. Hazards identified must include the following:

(1) System hazards, including:

(i) Vehicle over-pressurization;

(ii) Sudden energy release, including ordnance actuation;

(iii) Ionizing and non-ionizing radiation;

(iv) Fire or deflagration;

(v) Radioactive materials;

(vi) Toxic release;

(vii) Cryogens;

(viii) Electrical discharge; and

(ix) Structural failure.

(2) Operation hazards, including:

(i) Propellant handling and loading;

(ii) Transporting of vehicle or vehicle components;

(iii) Vehicle testing; and

(iv) Vehicle or system activation.

(b) ***Hazard assessment.*** Assess each hazard's likelihood and severity.

(c) ***Risk acceptability criteria.*** Ensure that the risk associated with each hazard meets the following criteria:

(1) The likelihood of any hazardous condition that may cause death or serious injury to the public must be extremely remote; and

(2) The likelihood of any hazardous condition that may cause major damage to property not associated with the launch or reentry must be remote.

(d) ***Risk mitigation.*** Identify and describe the risk elimination and mitigation measures required to satisfy paragraph (c) of this section.

(e) ***Validation and verification.*** Document that the risk elimination and mitigation measures achieve the risk levels of paragraph (c) of this section through validation and verification. Verification includes:

(1) Analysis;

(2) Test;

(3) Demonstration; or

(4) Inspection.

(f) ***Application requirements.*** An applicant must submit—

(1) A description of the methodology used to perform the ground hazard analysis;

(2) A list of all systems and operations that may cause a hazard involving the vehicle or any payload; and

(3) The ground hazard analysis products of paragraphs (a) through (e) of this section, including data that verifies the risk elimination and mitigation measures.

§ 450.187 Toxic hazards mitigation for ground operations.

(a) ***Applicability.***

(1) Except as specified in paragraph (a)(2), this section applies to any launch or reentry vehicle, including all vehicle components and payloads, that use toxic propellants or other toxic chemicals.

(2) No toxic release hazard analysis is required for kerosene-based fuels, unless the Administrator determines that an analysis is required to protect public safety.

(b) ***General.*** An operator must—

(1) Conduct a toxic release hazard analysis in accordance with paragraph (c) of this section;

(2) Manage the risk of casualties that could arise from the exposure to toxic release through one of the following means:

(i) Contain hazards caused by toxic release in accordance with paragraph (d) of this section; or

(ii) Perform a toxic risk assessment, in accordance with paragraph (e) of this section, that demonstrates compliance with the risk criteria of § 450.185(c).

(3) Establish ground hazard controls based on the results of its toxic release hazard analysis and toxic containment or toxic risk assessment for any necessary evacuation of the public from any toxic hazard area.

(c) ***Toxic release hazard analysis.*** A toxic release hazard analysis must—

(1) Account for any toxic release that could occur during nominal or non-nominal launch or reentry ground operations;

(2) Include a worst-case release scenario analysis or a maximum-credible release scenario analysis for each process that involves a toxic propellant or other chemical;

(3) Determine if toxic release can occur based on an evaluation of the chemical compositions and quantities of propellants, other chemicals, vehicle materials, and projected combustion products, and the possible toxic release scenarios;

(4) Account for both normal combustion products and any unreacted propellants and phase change or chemical derivatives of released substances; and

(5) Account for any operational constraints and emergency procedures that provide protection from toxic release.

(d) ***Toxic containment.*** An operator using toxic containment must manage the risk of casualty from the exposure to toxic release either by—

(1) Evacuating, or being prepared to evacuate, the public from any toxic hazard area in the event of a worst-case release or maximum credible release scenario; or

(2) Employing meteorological constraints to limit a ground operation to times during which prevailing winds and other conditions ensure that the public would not be exposed to toxic concentrations and durations greater than accepted toxic thresholds for acute casualty in the event of a worst-case release or maximum credible release scenario.

(e) ***Toxic risk assessment.*** An operator using toxic risk assessment must manage the risk from any toxic release hazard and demonstrate compliance with the criteria in § 450.185(c). A toxic risk assessment must—

(1) Account for airborne concentration and duration thresholds of toxic propellants or other chemicals. For any toxic propellant, other chemicals, or combustion product, an operator must use airborne toxic concentration and duration thresholds identified in a means of compliance accepted by the Administrator;

(2) Account for physical phenomena expected to influence any toxic concentration and duration in the area surrounding the potential release site;

(3) Determine a toxic hazard area for each process surrounding the potential release site for each toxic propellant or other chemical based on the amount and toxicity of the propellant or other chemical, the exposure duration, and the meteorological conditions involved;

(4) Account for all members of the public that may be exposed to the toxic release; and

(5) Account for any risk mitigation measures applied in the risk assessment.

(f) ***Application requirements.*** An applicant must submit:

(1) The identity of the toxic propellant, chemical, or combustion products or derivatives in the possible toxic release;

(2) The applicant's selected airborne toxic concentration and duration thresholds;

(3) The meteorological conditions for the atmospheric transport and buoyant cloud rise of any toxic release from its source to downwind receptor locations;

(4) Characterization of the terrain, as input for modeling the atmospheric transport of a toxic release from its source to downwind receptor locations;

(5) The identity of the toxic dispersion model used, and any other input data;

(6) Representative results of an applicant's toxic dispersion modeling to predict concentrations and durations at selected downwind receptor locations, to determine the toxic hazard area for a released quantity of the toxic substance;

(7) For toxic release hazard analysis in accordance with paragraph (c) of this section:

(i) A description of the failure modes and associated relative probabilities for potential toxic release scenarios used in the risk evaluation; and

(ii) The methodology and representative results of an applicant's determination of the worst-case or maximum-credible quantity of any toxic release that might occur during ground operations;

(8) For toxic containment in accordance with paragraph (d) of this section, identify the evacuation plans or meteorological constraints and associated ground hazard controls needed to ensure that the public will not be within any toxic hazard area in the event of a worst-case release or maximum credible release scenario.

(9) For toxic risk assessment in accordance with paragraph (e) of this section:

(i) A demonstration that the risk criteria in § 450.185(c) will be met;

(ii) The population characteristics in receptor locations that are identified by toxic dispersion modeling as toxic hazard areas;

(iii) A description of any risk mitigation measures applied in the toxic risk assessment; and

(iv) A description of the population exposure input data used in accordance with § 450.123.

§ 450.189 Ground safety prescribed hazard controls.

(a) ***General.*** In addition to the hazard controls derived from an operator's ground hazard analysis and toxic hazard analysis, an operator must comply with paragraphs (b) through (e) of this section.

(b) ***Protection of public on the site.*** An operator must document a process for protecting members of the public who enter any area under the control of a launch or reentry operator, including:

(1) Procedures for identifying and tracking the public while on the site; and

(2) Methods the operator uses to protect the public from hazards in accordance with the ground hazard analysis and toxic hazard analysis.

(c) ***Countdown abort.*** Following a countdown abort or recycle operation, an operator must establish, maintain, and perform procedures for controlling hazards related to the vehicle and returning the vehicle, stages, or other flight hardware and site facilities to a safe condition. When a launch vehicle does not liftoff after a command to initiate flight was sent, an operator must—

(1) Ensure that the vehicle and any payload are in a safe configuration;

(2) Prohibit entry of the public into any identified hazard areas until the site is returned to a safe condition; and

(3) Maintain and verify that any flight safety system remains operational until verification that the launch vehicle does not represent a risk of inadvertent flight.

(d) ***Fire suppression.*** An operator must have reasonable precautions in place to report and control any fire caused by licensed activities.

(e) ***Emergency procedures.*** An operator must have general emergency procedures that apply to any emergencies not covered by the mishap plan of § 450.173 that may create a hazard to the public.

(f) ***Application requirement.*** An applicant must submit the process for protecting members of the public who enter any area under the control of a launch or reentry operator in accordance with paragraph (b) of this section.

Subpart D—Terms and Conditions of a Vehicle Operator License

§ 450.201 Responsibility for public safety and safety of property.

A licensee is responsible for ensuring public safety and safety of property during the conduct of a licensed launch or reentry.

§ 450.203 Compliance.

A licensee must conduct a licensed launch or reentry in accordance with representations made in its license application, the requirements of subparts C and D of this part, and the terms and conditions contained in the license. A licensee's failure to act in accordance with the representations made in the license application, the requirements of subparts C and D of this part, and the terms and conditions contained in the license, is sufficient basis for the revocation of a license or other appropriate enforcement action.

§ 450.205 Financial responsibility requirements.

A licensee must comply with financial responsibility requirements of part 440 of this chapter and as specified in a license or license order.

§ 450.207 Human spaceflight requirements.

A licensee conducting a launch or reentry with a human being on board the vehicle must comply with human spaceflight requirements of part 460 of this chapter as specified in a license or license order.

§ 450.209 Compliance monitoring.

(a) A licensee must allow access by, and cooperate with, Federal officers or employees or other individuals authorized by the FAA to observe any of its activities, or any of its contractors' or subcontractors' activities, associated with the conduct of a licensed launch or reentry.

(b) For each licensed launch or reentry, a licensee must provide the FAA with a console for monitoring the progress of the countdown and communication on all channels of the countdown communications network, unless the licensee has another acceptable means. A licensee must also provide the FAA with the capability to communicate with the mission director designated by § 450.103(a)(1).

§ 450.211 Continuing accuracy of license application; application for modification of license.

(a) A licensee is responsible for the continuing accuracy of ~~representations contained in its~~ application material for the entire term of the license.

(b) After a license has been issued, a licensee must apply to the FAA for modification of the license if—

(1) The licensee proposes to conduct a launch or reentry in a manner not authorized by the license; or

(2) ~~Any representation contained in the~~ Changes to license application material require an update to one or more means of compliance used to satisfy safety criteria in § 450.101 or any policy, procedure, requirement, criteria or standard that is safety critical. ~~that is material to public health and safety or the safety of property is no longer accurate and complete or does not reflect the~~

~~licensee's procedures governing the actual conduct of a launch or reentry. A change is material to public health and safety or the safety of property if it alters or affects—~~

~~(i) The class of payload;~~

~~(ii) The type of launch or reentry vehicle;~~

~~(iii) The type or quantity of hazardous material;~~

~~(iv) The flight trajectory;~~

~~(v) The launch site or reentry site or other landing site; or~~

~~(vi) Any system, policy, procedure, requirement, criteria, or standard that is safety critical.~~

(c) An application to modify a license must be prepared and submitted in accordance with part 413 of this chapter. If requested during the application process, the FAA may approve an alternate method for requesting license modifications. The licensee must indicate any part of its license or license application that would be changed or affected by a proposed modification.

(d) Upon approval of a modification, the FAA issues either a written approval to the licensee or a license order amending the license if a stated term or condition of the license is changed, added, or deleted. An approval has the full force and effect of a license order and is part of the licensing record.

§ 450.213 Pre-flight reporting.

(a) ***Reporting method.*** A licensee must send the information in this section as an email attachment to *ASTOperations@faa.gov,* or other method as agreed to by the Administrator in the license.

(b) ***Mission information.*** A licensee must submit to the FAA the following mission-specific information no less than 60 days before each mission conducted under the license, unless the Administrator agrees to a different time frame in accordance with § 404.15 in the license, except when the information was provided in the license application:

(1) Payload information in accordance with § 450.43(i); and

(2) Planned mission information, including the vehicle, launch site, planned flight path, vacuum instantaneous impact points of stage ~~staging~~ and impact locations, each payload delivery point, intended reentry or landing sites including any contingency abort location, and the location of any disposed launch or reentry vehicle stage or component that is deorbited.

(c) ***Flight abort and flight safety analysis products.*** A licensee must submit to the FAA updated flight abort and flight safety analysis products, using methodologies previously approved by the FAA, for each mission no less than 30 days before flight, unless the Administrator agrees to a different time frame in accordance with § 404.15 in the license.

(1) A licensee is not required to submit the flight abort and flight safety analysis products if—

(i) The analysis submitted in the license application satisfies all the requirements of this section; or

(ii) The licensee demonstrated during the application process that the analysis does not need to be updated to account for mission-specific factors.

(2) If a licensee is required to submit the flight abort and flight safety analysis products, the licensee—

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

(ii) Must account for potential variations in input data that may affect any analysis product within the final 30 days before flight;

(iii) Must submit the analysis products using the same format and organization used in its license application; and

(iv) May not change an analysis product within the final 30 days before flight unless the licensee has a process, approved in the license, for making a change in that period as part of the licensee's flight safety analysis process.

(d) ***Flight safety system test data.*** Any licensee that is required by § 450.101(c) to use a flight safety system to protect public safety must submit to the FAA, or provide the FAA access to, any test reports, in accordance with approved flight safety system test plans, no less than 30 days before flight, unless the Administrator agrees to a different time frame in accordance with § 404.15 in the license. These reports must include:

(1) A summary of the system, subsystem, and component-level test results, including all test failures and corrective actions implemented;

(2) A summary of test results demonstrating sufficient margin to predicted operating environments;

(3) A comparison matrix of the actual qualification and acceptance test levels used for each component in each test compared against the predicted flight levels for each environment, including any test tolerances allowed for each test; and

(4) A clear identification of any components qualified by similarity analysis or a combination of analysis and test.

(e) ***Collision avoidance analysis.*** A licensee must submit to a Federal entity identified by the FAA and to the FAA the collision avoidance information in appendix A to part 450 in accordance with § 450.169(f).

(f) ***Launch or reentry schedule.*** A licensee must file a launch or reentry schedule that identifies each review, rehearsal, and safety-critical operation. The schedule must be filed and updated in time to allow FAA personnel to participate in the reviews, rehearsals, and safety-critical operations.

§ 450.215 Post-flight reporting.

(a) For launches or reentries conducted under a license authorizing more than one flight, a licensee must submit to the FAA the information in paragraph (b) of this section no later than 90 days after a launch or reentry, unless the Administrator agrees to a different time frame in accordance with § 404.15 of this chapter.

(b) A licensee must send the following information as an email attachment to *ASTOperations@faa.gov,* or other method as agreed to by the Administrator in the license:

(1) Any anomaly that occurred during countdown or flight that is material to public health and safety and the safety of property;

~~(2) Any corrective action implemented or to be implemented after the flight due to an anomaly or mishap;~~

~~(3) The number of humans on board the vehicle;~~

(42) The actual trajectory flown by the vehicle, if requested by the FAA; and

(~~5~~3) For an unguided suborbital launch vehicle, the actual impact location of all impacting stages and impacting components, if requested by the FAA.

§ 450.217 Registration of space objects.

(a) To assist the U.S. Government in implementing Article IV of the 1975 Convention on Registration of Objects Launched into Outer Space, each licensee must submit to the FAA the information required by paragraph (b) of this section for all objects placed in space by a licensed launch, including a launch vehicle and any components, except any object owned and registered by the U.S. Government.

(b) For each object that must be registered in accordance with this section, no later than 30 days following the conduct of a licensed launch, a licensee must file the following information:

(1) The international designator of the space object;

(2) Date and location of launch;

(3) General function of the space object;

(4) Final orbital parameters, including:

(i) Nodal period;

(ii) Inclination;

(iii) Apogee;

(iv) Perigee; and

(5) Ownership, and country of ownership, of the space object.

(c) A licensee must notify the FAA when it removes an object that it has previously placed in space.

§ 450.219 Records.

(a) Except as specified in paragraph (b) of this section, a licensee must maintain for 3 years all records, data, and other material necessary to verify that a launch or reentry is conducted in accordance with representations contained in the licensee's application, the requirements of subparts C and D of this part, and the terms and conditions contained in the license.

(b) For an event that meets any of paragraph (1) through (5) or paragraph (8) of the definition of "mishap" in § 401.7 of this chapter, a licensee must preserve all records related to the event. Records must be retained until completion of any Federal investigation and the FAA advises the licensee that the records need not be retained. The licensee must make all records required to be maintained under the regulations available to Federal officials for inspection and copying.

Appendix B – SpARC Member Voting Responses and Ballots

The SpARC believes this report fulfills the tasks in the mission of the Charter. The recommendations contained in this report were robustly debated and the report was accepted by the full SpARC prior to submission to the FAA. In support of a transparent SpARC process, members were offered the opportunity to include a concurrence or non-concurrence on the final document. All submissions are included in this report. The SpARC completed its deliberations and report drafting on February 27, 2026. Voting ballots were distributed to the voting SpARC members on March 2, 2026. The tally is as follows:

19 – Concur as Written
03 – Concur with Exception
00 – Non-Concur
01 – Ballot not received

Voting Member List[41]

Primary Representative	Organization	Alternative Representative	Voting Response
Jay Skylus	Aevum		Concur with Exception
Maggie McNeece	Blue Origin		Concur as Written
Arthur Beckman	Boeing	Lisa Loucks	Concur with Exception
Caryn Schenewerk	CS Consulting		Concur as Written
Neil Milburn	Exos Aerospace and Technologies		Concur as Written
Cody Curabba	Firefly Aerospace		Concur as Written
Laura Montgomery	Ground Based Space Matters		Concur as Written
Collin Corey	Inversion Space		Concur as Written
Lorraine Martin	National Safety Council		Concur with Exception
Adam Lewis	Northrup Grumman	Dave Robinson	Concur as Written
Brian Mosdell	Phantom Space		Concur as Written
Kiersten Fortson	Relativity Space		Concur as Written
Nick Pearson	Rocket Lab	Michelle Loynes	Concur as Written
Christopher Allison	Sierra Space		Concur as Written
Mike French, *Industry Chair*	Space Policy Group		Concur as Written
Mat Dunn	SpaceX	Jillian Yuricich	Concur as Written
Mike Hopkins	Stratolaunch	Adam Materne	Concur as Written
Allie Crutchfield	Stoke Space		Concur as Written
Vernon Thorp	United Launch Alliance	Rachel Vaden	Concur as Written
Josh Martin	Varda Space Industries		Concur as Written
Evelyn Stein	Vaya Space		Concur as Written
Kyle Slover	Virgin Galactic		Concur as Written
Ryan Hartman	World View Enterprises		Ballot not received

[41] Members organized alphabetically by organization.

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Jay Skylus
Voting Member Organization	Aevum Space & Defense

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____

Date: _____

Exceptions provided via separate form

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: Jay Skylus Digitally signed by Jay Skylus Date: 2026.03.09 13:08:30 -07'00'

Date: 09 March 2026

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

AEVUM, INC.
2211 Seminole Drive SW, Huntsville, AL 35805
Phone 949.469.2238
www.aevumspace.com

CONFIDENTIAL

March 11, 2026

LETTER | Re: SpARC 450 Final Report

TO: **Federal Aviation Administration**
800 Independence Avenue, SW
Washington, DC 20591
United States

SUBJECT: Summary of Aevum Concurrence Exceptions

Dear FAA's Office of Commercial Space Transportation,

- REC-R32: AC 450.137-1 and AC 450.115-1B covers blast overpressure modeling. FAA should expand and standardize guidance for 450.137 far-field overpressure analyses (beyond de minimis screening), and harmonize accepted methods, terminology, and data expectations with established industry and USSF/RCC range safety practice where consistent with 450.101.
- REC-R31 seems to contain a typo, "…requirements (§ 450.135(c)(2)(4))" missing dash between (2) and (4).
- REC-R30: This recommendation seems to weaken §450.133's core purpose to define a controllable debris hazard footprint. Replacing 97% debris containment with probability-of-casualty contours makes the hazard area assumption-dependent (traffic/vulnerability models) and can mask a wide debris dispersion behind a "low Pc" result, reducing the area that gets surveyed/publicized/controlled even though casualty-capable debris can still land there.
- REC-R29: The redline risks reframing PoF from a hazard-weighting input for public-safety analysis into a more general reliability-style assessment, because it substitutes hazards with failure modes as the primary organizing construct, defines failure largely through outcome-based triggers, and adds prescriptive failure-rate distribution requirements that are not necessary to compute public risk. My nonconcurrence is not with streamlining; it is with the redline's change in regulatory anchor. § 450.131 seems to exist to ensure PoF is applied consistently across hazard-based public-safety analyses (debris/blast/toxic) across phases of flight. Rewriting the requirement around "reasonably foreseeable failure modes" and outcome-framed "failure" triggers shifts compliance toward debating reliability taxonomy and off-nominal behavior rather than directly supporting the hazard footprints and risk metrics the FAA must approve. My recommendation: keep hazards/phases as the governing requirement, restructure the section around the four PoF steps, and explicitly permit failure-mode/system-safety methods as an acceptable means of compliance while moving prescriptive failure-rate functional-form assumptions to guidance.
- REC-R26: Order of operations belongs in optional guidance, not the CFR.
- REC-R27: The CFR already scopes LUM to flight-abort users. A new section doesn't add clarity; it adds surface area and a new "artifact" that can harden into process-prescription.

- REC-R25: I think the rationale meant to say, "...FAA intends within § 450.117(a)(2)", not 450.117(b)(2). I recommend keeping "uncertainty" because replacing it with "incertitude" introduces a niche term which can create new interpretive questions without clear compliance gain.
- REC-R24: Exception to replacing "uncertainty" with "incertitude".

Very Respectfully,

Jay Skylus
Chief Executive Officer

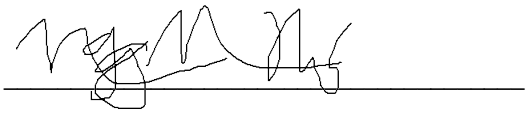
DocuSigned by:
Jay Skylus
C401387E5FCF4A4...

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Maggie McNeece
Voting Member Organization	Blue Origin

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: 

Date: 03/09/2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Bill Beckman
Voting Member Organization	Boeing

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____

Date: _____

Please see attachment

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: Bill Beckman

Date: 3/10/26

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

The Boeing Company
929 Long Bridge Drive
Arlington, VA 22202-4208

Recommendation - R-13

Page – 64

Section – Rationale, 2nd paragraph

Comment - Offering critical asset owners a more liberal risk threshold is unlikely to mitigate delays as asset owners naturally seek the greatest protection for their property and there's little incentive to accept a higher level of risk. An underlying issue behind delays is Range management not enforcing the definitions to identify critical assets, nor requiring asset owners to take action to mitigate elevated risk.

Recommendation - Boeing suggests an additional recommendation that FAA utilize agreements with Federal ranges to establish protocols that, upon identification of potential elevated risk to critical assets, facilitate plans for relocation of critical assets, implementation of other mitigation measures, and/or a more detailed risk assessment.

Recommendation - R-14

Page – 66

Section – Rationale, 2nd paragraph

Comment - While Boeing agrees that the term Broad Ocean Area needs to be objectively defined to indicate a minimum threshold for low vessel traffic density, the 450.101(d) option "or targets a broad ocean area" does not support the assertion of a disincentive for controlled disposal, only one close to populations.

Additionally, Boeing finds the definition of disposal overly broad as it expands scope of controlled reentry to include controlled landing of reusable launch vehicles. While reusability is a desirable approach, controlled landing of such stages is NOT disposal and involves significantly different flight profiles and linger times which may substantively increase risk and warrant FSA.

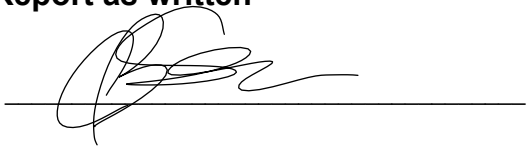
Recommendation - Boeing recommends the need to perform FSA be based on objective criteria related to population density and believes that the FAA should clarify the definition of disposal to exclude controlled landing of reusable stages.

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Caryn Schenewerk
Voting Member Organization	CS Consulting

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: 

Date: 3/2/2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	NEIL MILBURN
Voting Member Organization	EXOS AEROSPACE SYSTEMS & TECHNOLOGIES, INC

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Neil Milburn

Date: March 10, 2026

2. Concur with the following exception(s):
Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

3. Non-Concur. Letter of Dissent must be provided.
Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Cody Curabba
Voting Member Organization	Firefly Aerospace

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Cody Curabba Digitally signed by Cody Curabba Date: 2026.03.09 14:25:18 -07'00' _____

Date: _____

Firefly concurs by default due to unavailability caused by launch operations. Firefly will address any concerns in the FAA's published NPRM.

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Laura Montgomery
Voting Member Organization	Ground Based Space Matters, LLC

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____Laura Montgomery /signed/

Date: _____3/11/26_____

2. Concur with the following exception(s):
Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

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Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Collin Corey
Voting Member Organization	Inversion Space Company

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____

Date: 09-MAR-2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

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Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Lorraine Martin
Voting Member Organization	National Safety Council

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____

Date: _____

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: 3/3/2026

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

National Safety Council

March 3, 2026

FAA
SpARC 450

Subject: SpARC Comments

REC-P01 PROCESS: The FAA should ensure transition to any revised sections of part 450 does not negatively impact existing part 450 licensees.

Comment: This appears to be an indefinite "grandfather clause" that basically said if the company was in compliance under the original FAA standard, then they were in compliance forever - which is not best practice. Recommend requiring that existing license holders under Part 450 have a 5-year period to update their licenses with the revised Part 450. (5-years was just a suggestion, it could be more or less). Or tie compliance to when an update is made to the operations such that the license must be amended.

REC- PROCESS / GUIDANCE P05: For licensed operations at Federal Ranges, the FAA should accept equivalent safety documentation in its or form and identify in applicable Advisory Circulars the documents the FAA will accept without modification.

Comment: Suggest adding a statement that says “provided the equivalent safety documentation was established from applicable materials (i.e., Advisory Circulars or consensus standards) and they were following “good engineering practices” as applicable.

RED- R05: Definition of Safety Critical: Safety critical means essential to safe performance or operation. A safety-critical system, subsystem, component, condition, function, event, operation, process, or item, is one: whose proper recognition, control, performance, or tolerance, is essential to ensuring public safety and the safety of property.

(a) whose malfunction may result in a catastrophic hazard that cannot be sufficiently mitigated to meet the risk criteria in § 450.101; or
(b) that is necessary to mitigate a catastrophic hazard to ensure compliance with the risk criteria in § 450.101.
For human spaceflight vehicles, this includes systems necessary for crew to exercise safety-critical control.

Comment; change "hazard that cannot" to "hazard that has not"

Appendix A

National Safety Council

Mishap means any event, or series of events associated with a licensed or permitted activity resulting in any of the following:
(1) A fatality or serious injury (as defined in 49 CFR 830.2);
(2) A malfunction of a safety-critical system;
(3) A failure of the licensee's or permittee's to follow safety processes safety organization, safety operations, safety or procedures represented in its application material;
(4) High risk, as determined by the FAA, of causing a serious or fatal injury to any space flight participant, crew, government astronaut, or member of the public;
(5) Substantial Damage, as determined by the FAA, to property not associated with licensed or permitted activity resulting in a claim against an operator's financial responsibility required under Part 440;

Comment: Solid rewrite. Only comment is against the last item (5). What if there is substantial damage as determined by the FAA but no claim is issued for reasons not related to the substantial impact?

REC-P14

Comment: Use the of the phrase "unjustifiable roadblocks" could be reworded - unnecessary constraints?

Sincerely,

Lorraine Martin
CEO

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Dave Robinson
Voting Member Organization	Northrop Grumman

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: David Robinson

Date: 3/9/26

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

3. Non-Concur. Letter of Dissent must be provided.

Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Brian Mosdell
Voting Member Organization	Phantom Space Corporation

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Brian Mosdell

Date: 3/11/26

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

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Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Kiersten Fortson (Haugen)
Voting Member Organization	Relativity Space

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: 

Date: 6 Mar 2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

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Date: _____

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	MICHELLE LOYNES
Voting Member Organization	ROCKET LAB

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____

Date: 9 MARCH 2026

2. Concur with the following exception(s):

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Christopher Allison
Voting Member Organization	Sierra Space

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: 

Date: 3/3/26

2. Concur with the following exception(s):

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Michael French
Voting Member Organization	Space Policy Group

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: _____

Date: 3/4/26

2. Concur with the following exception(s):

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Date: _____

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Voting Member Signature: _____

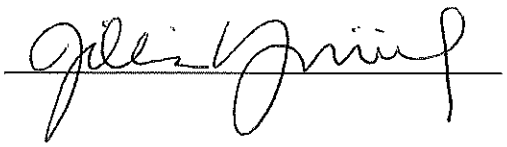
Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	JILLIAN YURICICH
Voting Member Organization	SPACEX

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: 

Date: 5 MAR 2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Adam Materne
Voting Member Organization	Stratolaunch LLC

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Adam Materne | JD

Date: 10MAR2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Allison Crutchfield
Voting Member Organization	Stoke Space

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Allison Crutchfield

Date: 3/10/2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

Voting Member Signature: _____

Date: _____

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Letters of Dissent must be on company letterhead and recommended to be 2 pages in length.

Voting Member Signature: _____

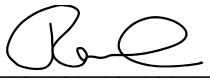
Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Rachel Vaden
Voting Member Organization	United Launch Alliance, LLC

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: 

Date: 3/10/2026

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Date: _____

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Josh Martin
Voting Member Organization	Varda Space

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Josh Martin

Date: March 9, 2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

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Date: _____

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Evelyn Stein
Voting Member Organization	Vaya Space

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Evelyn Stein

Date: 03/09/2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

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Date: _____

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Voting Member Signature: _____

Date: _____

LAUNCH AND REENTRY LICENSE REQUIREMENTS IMPROVEMENT
Aerospace Rulemaking Committee (SpARC)
Statement of Concurrence / Non-Concurrence

Voting Member Name	Kyle Slover
Voting Member Organization	Virgin Galacitc

As a voting member and full participant of the Launch and Reentry License Requirements Improvement SpARC, I hereby acknowledge that I have reviewed the Final Report and recommendations and make the following statement:

1. Concur with the Final Report as written

Voting Member Signature: Kyle Slover

Date: 3/6/2026

2. Concur with the following exception(s):

Fully explain the area(s) of exception in the text box above and include the specific language and page number from the document. Member may submit a separate paper on company letterhead if additional space is required. Separate papers recommended to be 2 pages in length.

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Date: _____