

### **Regulatory Preparation for U.S. Commercial Human Spaceflight**

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#### Abstract

The United States (U.S.) Federal Aviation Administration's (FAA) Office of Commercial Space Transportation is preparing for expiration of a clause in U.S. law that has limited development of safety regulations for commercial human spaceflight (HSF). Since passage of the 2004 Commercial Space Launch Amendments Act, there has been a "learning period," or what is commonly referred to as a "moratorium," on adding additional safety regulations to protect people on board vehicles. While the FAA published limited regulations for human spaceflight in 2006 in response to the 2004 law, the U.S. Congress also stated that "[t]he regulatory standards governing human spaceflight must evolve as the industry matures so that regulations neither stifle technology development nor expose crew or spaceflight participants to avoidable risks as the public comes to expect greater safety for crew and spaceflight participants from the industry". The expiration of the learning period has been extended by the U.S. Congress three times. The current expiration date is October 1, 2023. As flight rates by industry increase, the U.S. Congress is considering whether to extend the learning period or to let it expire. During 2021, the FAA licensed eight commercial launches (orbital and suborbital) and three reentries with humans on board. Five more FAA-licensed commercial launches have taken place so far in 2022.

The purpose of this paper is to describe current activities the FAA is conducting to address occupant safety on board commercial launch and reentry vehicles. The FAA is pursuing three major efforts to prepare for future human spaceflight regulations. First, the FAA is establishing an Aerospace Rulemaking Committee (SpARC) which will bring launch and reentry operators, government agencies, academia, and other interested parties together to discuss a potential framework for human spaceflight regulations. Second, the FAA has a current effort to review and update the 2014 *Recommended Practices for Human Space Flight Occupant Safety*. The FAA is updating and adding additional information on how operators could show they comply with the recommended practices and incorporating lessons learned from recent commercial human spaceflight experiences. The third area of concentration for the FAA is consensus standards development through organizations like ASTM International and the International Organization for Standardization. FAA-licensed operators may utilize these standards when designing and operating their HSF vehicles. The paper is useful to industry and countries that are considering models to adapt in development of national frameworks for commercial space transportation.

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## 1. Introduction

The future of the commercial human spaceflight industry will depend on the industry's ability to continually improve its safety performance. The Federal Aviation Administration (FAA) is dedicated to improving both public safety and occupant safety during commercial human spaceflight. As Congress noted in Title 51 of the United States Code (51 U.S.C.) § 50901 (a)(15):

*The regulatory standards governing human space flight must evolve as the industry matures so that regulations neither stifle technology development nor expose crew, government astronauts, or space flight participants to avoidable risks as the public comes to expect greater safety for crew, government astronauts, and space flight participants from the industry.*<sup>1</sup>

In 2004, Congress granted the Secretary of Transportation authority to oversee the safety of the emerging commercial human spaceflight industry, but limited the FAA's rulemaking authority. To ensure that the industry had an ample "learning period" to develop, Congress put in place an 8-year moratorium on human spaceflight regulations. This moratorium *only allowed* issuance of regulations that restricted or prohibited design features or operating practices that resulted in a death, serious injury, or contributed to an unplanned event or series of events that posed a high risk of causing a serious or fatal injury, during a licensed or permitted human spaceflight mission. Congress has extended this moratorium three times – the FAA Modernization and Reform Act of 2012 extended it to October 1, 2015, the Airport and Airway Extension Act extended it to April 1, 2016, and the Commercial Space Launch Competitiveness Act extended it to October 1, 2023.<sup>2</sup> However, Congress did encourage the FAA to continue to work with industry on ways to improve human spaceflight safety.<sup>3</sup>

The FAA has seen an increase in commercial human spaceflight activity that may indicate readiness of the commercial space sector to collaborate on a safety framework including regulations for human spaceflight. The FAA is entering a regulatory preparation period. The agency is investigating potential commercial human spaceflight regulatory oversight as the legislatively-established learning period sunsets on October 1, 2023. The FAA's regulatory preparation includes three major aspects – an Aerospace Rulemaking Committee (SpARC), updating the *Recommended Practices for Human Space Flight Occupant Safety*, and participating in voluntary consensus standards

development.

## 2. Current State of the Industry

In recent years, the pace of development in the commercial space transportation industry has increased dramatically. From 2018 to early August 2022, there have been 20 FAA-licensed human spaceflight launches and 5 FAA-licensed reentries from orbit with people on board.<sup>4</sup>

SpaceX and Boeing continue to complete the milestones of the National Aeronautics and Space Administration's (NASA's) Commercial Crew Program (CCP). In May 2020, SpaceX successfully launched NASA astronauts on board a Dragon capsule to the International Space Station (ISS) as part of the CCP DM-2 demonstration mission. In November 2020, SpaceX launched Crew-1, which was the first operational mission to the ISS under the Commercial Crew Program. Crew-1, licensed by the FAA, was the first human spaceflight mission to the ISS where the FAA was responsible for public safety oversight rather than NASA. The FAA is a critical partner in the CCP and will license all future Commercial Crew launches, now that NASA has certified SpaceX's Dragon Commercial Crew spacecraft. The FAA is shadowing the initial Boeing CST-100 flights and is working to license future CST-100 missions. The FAA coordinates with the industry, NASA, and other stakeholders to ensure processes are in place for conducting these important flights safely.

Just one year later, the first all-civilian mission to space launched from Kennedy Space Center, Florida. In September 2021, the Inspiration4 mission, commanded by Jared Issacman, became the first crewed orbital mission without professional astronauts on board. In April 2022, Axiom Space launched Ax-1 on SpaceX's Falcon 9 rocket for an expedition to the ISS. Ax-1 was the first entirely private mission to the ISS. Former NASA astronaut and Axiom Vice President Michael López-Alegría served as the commander.

Two other companies are successfully operating FAA-licensed suborbital launch vehicles that take people to the edge of space, where they can observe the curvature of the Earth, peer into the blackness of space, and experience several minutes of weightlessness. On July 11, 2021, Virgin Galactic completed its fourth rocket-powered spaceflight and the first test flight with a full crew in the cabin, including the company's founder Sir Richard Branson. Then, on July 20, 2021, Blue Origin successfully completed New Shepard's first human

flight with four private citizens on board. One of the private citizens, Oliver Daemen, was the first spaceflight participant to purchase a ticket and fly to space on a privately-funded and licensed space vehicle from a private launch site.

See Table 1 in the appendix for a history of FAA-licensed commercial human spaceflight launches.

### **3. FAA Part 460 Regulation**

The FAA's authority to issue rules on commercial space transportation safety is found in 51 U.S.C., Chapter 509. Under 51 U.S.C. § 50905 no holder of a license or permit may launch or reenter crew unless the crew has received training and satisfied medical or other conditions specified in a license or permit, all in accordance with FAA regulations. Section 50905 also directs the FAA to promulgate regulations requiring that the holder of a license or permit inform each spaceflight participant in writing about the risks of launch or reentry.<sup>5</sup>

The FAA established requirements for human spaceflight under Title 14 Code of Federal Regulation (CFR) Part 460, as required by the Commercial Space Launch Amendments Act of 2004. Part 460 defines crew and flight crew and imposes notification, medical, qualification, and training requirements. It also establishes informed consent and training requirements for spaceflight participants.<sup>6</sup> Part 460 became effective on February 13, 2007, and applies to anyone applying for or having a license or permit under 14 CFR Chapter III who conducts a launch or reentry with crew or spaceflight participants on board a vehicle, or employs a remote operator of a launch or reentry vehicle with a human on board.

The Part 460 regulations are split into two subparts. Subpart A describes the requirements for launch and reentry with crew. Per the definitions in Part 401.7, the FAA defines crew as “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.” Crew consists of flight crew or a remote operator. Per the FAA’s definitions, flight crew means crew that is on board a vehicle during a launch or reentry, and remote operator means a crew member who has the ability to control, in real time, a launch or reentry vehicle’s flight path, and is not on board the controlled vehicle. Subpart B of Part 460 describes the requirements for

launch and reentry with a spaceflight participant. The FAA defines spaceflight participant as an individual, who is not crew, carried aboard a launch vehicle or reentry vehicle.

Part 460 requires that the crew must be qualified and trained such that public safety is ensured in both nominal and non-nominal situations. Part 460 lays out additional requirements and training for pilots and remote operators to have the necessary knowledge and skill to control the launch or reentry vehicle and make sure public safety is safeguarded. Each crew member with a safety-critical role is also required to possess and carry an FAA second-class airman medical certificate. In addition to the requirements directly imposed on crew, Part 460 also describes responsibilities of the commercial space operators. Operators are required to ensure the implementation of crew training, training device fidelity, maintenance of training records, and currency of qualifications and training.

Operators must inform crew and spaceflight participants in writing that the U.S. Government has not certified the launch vehicle and any reentry vehicle as safe for carrying flight crew or spaceflight participants. This is part of what is known as “informed consent”. An operator must also inform each spaceflight participant in writing about the risks of the launch and reentry, including the safety record of the launch or reentry vehicle type. An operator must present this information in a manner that can be readily understood by a spaceflight participant with no specialized education or training.

Part 460 also requires launch or reentry vehicle operators to ensure adequate environmental control and life support systems, smoke detection and fire suppression systems, account for human factors, and have a verification program which should include flight testing. Finally, the operator must train each spaceflight participant before flight on how to respond to emergency situations, including smoke, fire, loss of cabin pressure, and emergency exit. Security requirements must be implemented to prevent any spaceflight participant from jeopardizing the safety of the flight crew or the public.

### **4. Establishment of the SpARC**

The Secretary of the U.S. Department of Transportation (DOT), of which FAA is a part, is authorized to establish aerospace rulemaking committees under 49 U.S.C. § 106(p)(5). Aviation Rulemaking Committees (ARCs) have been used for many years by the FAA’s Aviation Safety organization to gather industry data and feedback on

potential aviation regulations. The authority for the FAA’s Office of Commercial Space Transportation (AST) to establish SpARCs began in 2018. The Human Spaceflight SpARC, scheduled to begin in 2022, is only the second SpARC established by AST.

A SpARC is comprised of 20 to 30 representatives from current and prospective license and permit holders, training providers, industry groups, and academia. The discussions within the SpARC meetings are private to encourage full participation and open discussion. Only the final report, created by and agreed to, by the committee members is shared outside the SpARC.

The SpARC is led by two co-chairs—one senior manager from AST and one industry representative. An emphasis is placed on filling out the SpARC with a diverse group – not only in the types of companies and operations represented – but also in the diversity of the people that are included. Members will be selected based on their familiarity and experience with human spaceflight operations, design, and training, and will be balanced in viewpoints and interests. The FAA will work with the invited organizations to ensure the membership reflects the diversity of the U.S. and its viewpoints.

The Human Spaceflight SpARC will be tasked to provide consensus comments on three major items. The first is determining the scope of any future human spaceflight occupant safety regulations. FAA human spaceflight regulations could focus on the safety of occupants on suborbital flights, or also include orbital flights. The level of safety for the occupants should also be considered – how safe flights should be for spaceflight participants, crew, and government astronauts. A higher level of safety would require a more rigorous and extensive pre-flight evaluation and licensing process.

The second SpARC task will be providing a recommendation on how to create a human spaceflight occupant safety regime. This will be the framework for potential regulations – how the FAA should monitor and oversee occupant safety on commercial launch and reentry vehicles. The aviation industry is regulated down to the exact design specifications, parts, and materials used on passenger aircraft. Congress has not directed such “certification” of commercial human spaceflight vehicles but has instead directed an informed consent requirement to be in place.<sup>7</sup> The SpARC will investigate and make recommendations on if there is a balanced approach between the current informed consent requirement and possible future certification.

The SpARC will help determine that approach.

The third task of the SpARC will be estimating the cost of occupant safety regulations to the industry. This is an important factor needed for future rulemaking. Any proposed regulations need to be analyzed for the costs and benefits to the affected industry. Proposed regulations may impose cost on the industry, but the benefit should justify the cost.

## **5. Update to the 2014 Recommended Practices**

The FAA is reviewing and updating the *Recommended Practices for Human Space Flight Occupant Safety* that was originally published in 2014.<sup>8</sup> This document was developed to provide a compilation of practices that the FAA believes are important and recommends for commercial human spaceflight occupant safety, although it now requires substantial updates. This effort includes incorporating lessons learned, adding new recommended practices to address the expanding scope of commercial human spaceflight, and incorporating additional information on how operators could show implementation of the recommended practices, in the design, manufacture, and operation of launch and reentry vehicles.

Since 2014, when the original *Recommended Practices* document was published, there has been a significant increase in the frequency of commercial human spaceflight missions as well as considerable differences in the scope and type of missions compared to those proposed in 2014. In the original version, public safety, mission assurance, long-term health effects, security, and legal issues (informed consent) were not directly addressed. Both orbital and suborbital flights were considered, from when occupants are exposed to vehicle hazards prior to flight through when they are no longer exposed to vehicle hazards after landing. In the 2014 document, orbital rendezvous and docking, long-duration flights (longer than two weeks), extravehicular activity, and any flights beyond Earth orbit were not explicitly covered. More specifically, it was assumed that any orbital vehicle would stay on orbit for a maximum of two weeks, and could return to Earth in under 24 hours if necessary. It was also assumed that each member of the flight crew would be safety-critical and spaceflight participants would perform limited safety-critical tasks.

The 2014 document was very broadly written and did not address how a designer or operator would verify that it meets each safety measure. These are some of the reasons the FAA has initiated these revisions to the *Recommended Practices* document and seeks to expand the scope and original

assumptions. Notably, the updated *Recommended Practices* document may include flights longer than two weeks, flights outside of Low Earth Orbit, rendezvous and docking, protection from radiation hazards, inclusion of government astronauts, and consideration of the situation where spaceflight participants would fly without any crew on board.

The updated *Recommended Practices* will address some of those gaps and can provide a good starting point to guide any upcoming safety framework discussions. The FAA has a statutory mandate to encourage, facilitate, and promote the continuous improvement of the safety of launch and reentry vehicles designed to carry humans. During the development and revision process for the *Recommended Practices for Human Space Flight Occupant Safety* document, the FAA recognizes that the document may serve as a starting point for a future rulemaking project.

The development processes for the original and updated *Recommended Practices* both follow similar ground rules and assumptions. Some of the key sets of requirements include protecting occupants from avoidable risks, leveraging existing knowledge of human spaceflight safety, ensuring readability by all audiences, tailoring recommendations to be performance-based, and applicability to all known likely system designs.

In line with the goals of the learning period put in place by Congress, the *Recommended Practices* aim to minimize any restrictions on innovation and cost burdens on industry. Throughout the development process, the FAA is reviewing existing government and private sector requirements and standards. While the FAA is incorporating newer standards into the updated version of the document, it should be noted that the original primarily used NASA's requirements and guidance for its Commercial Crew Program (1100 Series) as a guide, i.e. *CCT-PLN-1120*, *CCT-REQ-1130*, and *CCT-STD-1150*. The FAA is continuing to consult and work closely with NASA, the FAA's Civil Aerospace Medical Institute, and the Commercial Space Transportation Advisory Committee. The FAA has established regular working group sessions where NASA experts are heavily involved and provide valuable input.

The original document includes 89 recommended safety practices that are grouped into three categories: Design, Manufacturing, and Operations. For the effort to update the *Recommended Practices*, the FAA set up three working groups to focus on each category, spearheaded by a team that would be

responsible for integrating all three groups. In the *Recommended Practices* document, safety practices applicable to more than one category are written only once and then referred to in subsequent categories. The document is neutral as to whether separate entities design, manufacture, and operate a human spaceflight system, or whether one entity does it all.

The *Recommended Practices* are written to ensure safety concerns are addressed in an integrated fashion over the entire life cycle of a system. The established practices are primarily performance-based where a safety objective to be achieved is stated, and the operator would have flexibility to implement design or operational solutions. One of the key additions to the *Recommended Practices* update is the inclusion of "Verification Statements", aimed to provide the operators or designers guidance on ways to implement the *Recommended Practices* and demonstrate their implementation. For any future rulemaking efforts, these verification statements could describe the expectation for demonstrations of compliance for performance-based FAA regulations.

Some examples of the topics in the *Recommended Practices* include:

- *Human Needs and Accommodations*: Includes the steps necessary to accommodate specific human needs, such as consumables, human waste disposal, etc., that have no relation to specific mission tasks or physical stress, unless not met.
- *Human Protection*: Includes the steps necessary to keep an occupant's physical or psychological stress at levels that can be considered safe for spaceflight participants, and sufficient for flight crew to execute the flight.
- *Flightworthiness*: Identifies the minimum system capabilities necessary to maintain occupant safety.
- *Human/Vehicle Integration*: Includes operational and design constraints necessary to integrate humans with a HSF system.
- *System Safety*: Includes engineering and management principles, criteria, and techniques to achieve acceptable risk, within the constraints of operational effectiveness and suitability, time, and cost, throughout all phases of the system life cycle.
- *Design Documentation*: Includes documentation related to the design of the human spaceflight system necessary to operate the system safely.
- *Management*: Includes program controls necessary to ensure proper implementation of

safety requirements.

- *Lifecycle Management*: Includes system safety management and engineering principles, criteria, and techniques applicable during the operational phase of a system's life cycle.
- *Planning, Procedures, and Rules*: Includes plans and procedures necessary to safely operate a human spaceflight system.
- *Medical Considerations*: Includes medical needs and constraints for flight crew and spaceflight participants.
- *Training*: Includes training needs of flight crew, spaceflight participants, ground controllers and safety-critical ground operations personnel.

## 6. Voluntary Consensus Standards Development

### *Congressional Reports on Standards Development*

51 U.S.C. § 50905(c)(5), *Interim Voluntary Industry Consensus Standards Reports*, required the Secretary of the U.S. DOT to periodically report to Congress on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety.<sup>9</sup> The third and final report is currently under review within the agency. Overall, the FAA is encouraged by the increasing availability of commercial space transportation standards, particularly those from ASTM<sup>10</sup>. The number of standards published has increased over the reporting period. Although, it is unclear the extent to which industry is utilizing these consensus standards. The FAA delivered an Interim Report on Voluntary Industry Consensus Standards Development to the Congress in January 2022.<sup>11</sup>

### *ASTM F47 overview & goals*

The ASTM Committee F47 on Commercial Spaceflight was formed in 2016 as a result of the privatization and commercialization of spaceflight. F47 has five technical subcommittees that develop and maintain standards. The scope of the Committee is the development and maintenance of voluntary consensus standards and recommended practices for the commercial spaceflight industry. Areas addressed in standards include, but are not limited to, design, manufacturing and operational use of vehicles used for spaceflight. The committee is also developing human spaceflight safety standards.

FAA supports ASTM through involvement with the subcommittees and working groups. FAA subject matter experts provide input and apply their expertise

to assist with the development of ASTM standards.

### *International Organization for Standardization (ISO)*

The ISO Technical Committee 20 (TC20) Subcommittee 14 (SC14) for Space Systems and Operations was founded in 1992. There are seven working groups that develop standards for crewed and uncrewed space vehicles, including design, production, maintenance, operation, disposal, and the environment. FAA monitors the activities of the U.S. Technical Advisory Group for ISO TC20/SC 14.

### *AST Process for Accepting Standards*

Voluntary consensus standards can and are used to improve the safety of the commercial human spaceflight industry as a whole. Since one of AST's statutory mandates is to encourage, facilitate, and promote the continuous improvement of the safety of launch vehicles designed to carry humans, AST has an interest in seeing industry succeed in developing voluntary consensus standards. AST will utilize a process to review and accept voluntary industry consensus standards. AST plans to review standards that are currently in draft form and provide any technical comments to improve the standard and improve the potential for acceptance by the government as a means of compliance.

## 7. Conclusion

Commercial human spaceflight is ramping up with FAA-licensed operators regularly taking spaceflight participants to the edge of space. Regulatory approaches used by the FAA could be considered as a model for use by other countries. The FAA has public safety oversight of these missions, and is preparing for additional occupant safety oversight.

The FAA's regulatory preparation includes industry engagement through the SpARCs, incorporation of recent lessons learned and subject matter expertise into an update of the *Recommended Practices for Human Space Flight Occupant Safety*, and increased participation in voluntary consensus standards development.

The commercial human spaceflight learning period is coming to a close, and the FAA is preparing for the next phase of human spaceflight.

Appendix

Table 1. FAA-Licensed Commercial Human Spaceflight Launches (2004-August 31, 2022)

	<b>Launch Date</b>	<b>Mission</b>	<b>Vehicle</b>	<b>Operator</b>	<b>Site</b>	<b>Type</b>
29	Aug 4, 2022	NS-22/A2	New Shepard System	Blue Origin	Texas	Suborbital
28	Jun 4, 2022	NS-21/A1	New Shepard System	Blue Origin	Texas	Suborbital
27	Apr 27, 2022	Crew-4	Falcon 9	SpaceX	Florida	Orbital
26	Apr 8, 2022	Axiom-1	Falcon 9	SpaceX	Florida	Orbital
25	Mar 31, 2022	NS-20/M18	New Shepard System	Blue Origin	Texas	Suborbital
24	Dec 11, 2021	NS-19/M17	New Shepard System	Blue Origin	Texas	Suborbital
23	Nov 10, 2021	Crew-3	Falcon 9	SpaceX	Florida	Orbital
22	Oct 13, 2021	NS-18/M16	New Shepard System	Blue Origin	Texas	Suborbital
21	Sep 15, 2021	Inspiration4	Falcon 9	SpaceX	Florida	Orbital
20	Jul 20, 2021	NS-16/M15	New Shepard System	Blue Origin	Texas	Suborbital
19	Jul 11, 2021	VH-01	SpaceShipTwo	Virgin Galactic	New Mexico	Suborbital
18	May 22, 2021	VF02-02	SpaceShipTwo	Virgin Galactic	New Mexico	Suborbital
17	Apr 23, 2021	Crew-2	Falcon 9	SpaceX	Florida	Orbital
16	Dec 12, 2020	VF02	SpaceShipTwo	Virgin Galactic	New Mexico	Suborbital
15	Nov 15, 2020	Crew-1	Falcon 9	SpaceX	Florida	Orbital
14	Feb 22, 2019	VF-01	SpaceShipTwo	Virgin Galactic	California	Suborbital
13	Dec 13, 2018	VP-03	SpaceShipTwo	Virgin Galactic	California	Suborbital
12	Jul 26, 2018	N/A	SpaceShipTwo	Virgin Galactic	California	Suborbital
11	May 29, 2018	VP01-2	SpaceShipTwo	Virgin Galactic	California	Suborbital
10	Apr 5, 2018	N/A	SpaceShipTwo	Virgin Galactic	California	Suborbital
9	Oct 31, 2014	Flight PF04	SpaceShipTwo	Scaled Composites	California	Suborbital
8	Jan 10, 2014	Flight PF03	SpaceShipTwo	Scaled Composites	California	Suborbital
7	Sep 5, 2013	Flight PF02	SpaceShipTwo	Scaled Composites	California	Suborbital
6	Apr 29, 2013	Flight PF01	SpaceShipTwo	Scaled Composites	California	Suborbital
5	Oct 4, 2004	Flight 17P	SpaceShipOne	Scaled Composites	California	Suborbital
4	Sep 29, 2004	Flight 16P	SpaceShipOne	Scaled Composites	California	Suborbital
3	Jun 21, 2004	Flight 15P	SpaceShipOne	Scaled Composites	California	Suborbital
2	May 13, 2004	Flight 14P	SpaceShipOne	Scaled Composites	California	Suborbital
1	Apr 8, 2004	Flight 13P	SpaceShipOne	Scaled Composites	California	Suborbital

All launch dates are Coordinated Universal Time (UTC).

FAA also licenses the reentry of applicable human spaceflight orbital missions.

Source: FAA Office of Commercial Space Transportation August 31, 2022.<sup>12</sup>

Endnotes

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<sup>1</sup> 51 U.S.C. § 50901 (a) (15)

<https://uscode.house.gov/view.xhtml?path=/prelim@title51/subtitle5/chapter509&edition=prelim>

<sup>2</sup> 51 U.S.C. § 50905 (9) Learning Period.

<sup>3</sup> 51 U.S.C. § 50901 (b) 2 C.

<sup>4</sup> See FAA/AST [https://www.faa.gov/data\\_research/commercial\\_space\\_data/launches/?type=Licensed](https://www.faa.gov/data_research/commercial_space_data/launches/?type=Licensed) and [https://www.faa.gov/data\\_research/commercial\\_space\\_data/reentries/](https://www.faa.gov/data_research/commercial_space_data/reentries/)

<sup>5</sup> 51 USC Chapter 509 is available at

<https://uscode.house.gov/view.xhtml?path=/prelim@title51/subtitle5/chapter509&edition=prelim> Note: in 2010, the Congress codified national space laws into a new 51 US Code called National and Commercial Space Programs. As a result, FAA commercial space transportation law was moved from 49 USC to 51 USC.

<sup>6</sup> CFR Part 460: <https://www.ecfr.gov/current/title-14/chapter-III/subchapter-C/part-460#sp14.4.460.a>

<sup>7</sup> The FAA also does not certify expendable launch vehicles.

<sup>8</sup> Available at: [https://www.faa.gov/space/human\\_spaceflight](https://www.faa.gov/space/human_spaceflight)

<sup>9</sup> In accordance with Title 49 of the Code of Federal Regulations (49 CFR) § 1.83(b), the Secretary delegated the responsibility of writing these reports to the Administrator of the Federal Aviation Administration (FAA).

<sup>10</sup> The list of published F47 standards is available at: <https://www.astm.org/get-involved/technical-committees/committee-f47/subcommittee-f47>

<sup>11</sup> The January 2022 Interim Report on Voluntary Industry Consensus

Standards Development is available at: [https://www.faa.gov/space/human\\_spaceflight](https://www.faa.gov/space/human_spaceflight)

<sup>12</sup> FAA/AST. [https://www.faa.gov/data\\_research/commercial\\_space\\_data/launches/?type=Licensed](https://www.faa.gov/data_research/commercial_space_data/launches/?type=Licensed)  
[https://www.faa.gov/data\\_research/commercial\\_space\\_data/launches/?type=Permitted](https://www.faa.gov/data_research/commercial_space_data/launches/?type=Permitted)