



**FEDERAL AVIATION
ADMINISTRATION**

Report to Congress:

U.S. Department of Transportation Evaluation of
Commercial Human Space Flight Activities Most
Appropriate for New Safety Framework

51 U.S.C. § 50905(c)(7)

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I. Executive Summary

Under 51 USC § 50905(c)(7), the Secretary of the U.S. Department of Transportation is required to submit a report to Congress by March 31, 2022, that identifies the activities described in 51 USC § 50905(c) and (d) most appropriate for a new safety framework that may include regulatory action, if any, and a proposed transition plan for such safety framework. The Secretary of Transportation has delegated this responsibility to the Administrator of the Federal Aviation Administration. Section 50905(c)(7) of Title 51 requires the Secretary to coordinate and consult with the commercial space sector, including the Commercial Space Transportation Advisory Committee (COMSTAC), or its successor organization. Due to significant change of COMSTAC members, they have not been available to fully collaborate on this report. Therefore this is an interim report and the Secretary of Transportation will submit a final report once COMSTAC's membership has had an opportunity to provide input on this report.¹

The commercial human space flight activity has significantly increased since the last report in 2019. Currently, there are three commercial launch companies operating both orbital and suborbital flights in FY2022, with a fourth set to begin operations early in FY2023.

The activities identified in 51 USC § 50905(c) and (d) include issuing regulations governing the design or operation of a launch vehicle to protect the health and safety of the crew, government astronauts, and space flight participants. Promulgation of rules to address these activities has been placed on hold to give the industry a learning period. Additionally, in accordance with § 50905(c)(3), the Secretary has and will continue to work "... to facilitate the development of voluntary industry consensus standards based on recommended best practices to improve the safety of crew, government astronauts, and space flight participants as the commercial space sector continues to mature." The Federal Aviation Administration (FAA) is supporting multiple Standard Development Organizations (SDOs) in their development of commercial space standards.

The FAA is preparing for regulating these activities by pursuing direct industry feedback through an Aerospace Rulemaking Committee (termed a "SpARC") on the framework, timing, and the activities to be regulated. Industry consensus standards are being developed and will support the framework of regulation of HSF. The FAA is also reviewing and updating the *Recommended Practices for Human Space Flight Occupant Safety* that was originally published in 2014.² 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, the FAA is also continuing to consult and work closely with NASA, FAA's Civil Aerospace Medical Institute, and COMSTAC.

The Department of Transportation believes industry and the Department are ready to develop a safety framework, knowing that the full transition to a regulatory regime will begin after

¹ The FAA will provide COMSTAC with this interim report prior to COMSTAC's next meeting and will consult with COMSTAC at that time on the most appropriate activities for a new safety framework that may include regulatory action.

² Available at: https://www.faa.gov/space/human_spaceflight

publication of any required rulemaking. The plan to transition to a new safety framework will be dependent upon the details of the framework and take a phased-in approach. The framework will grow as the industry grows in complexity and increases in launch frequency. The framework will be informed by industry, research and development into safety issues and new technologies to mitigate risks to human life, and appropriate oversight to include licensing, inspection, compliance and enforcement, and encouragement of safety culture within industry.

II. Introduction

The FAA has exercised oversight responsibility for certain aspects of commercial space transportation activities since 1995, when the Secretary of Transportation delegated authority to the FAA Administrator, and the Office of Commercial Space Transportation (AST) was established at the FAA. The FAA, through AST, licenses and permits the launch of launch vehicles, the reentry of reentry vehicles, and the operation of launch and reentry sites consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. AST's mission is unique within the FAA because it also includes the responsibility to encourage, facilitate, and promote commercial space launches and reentries by the private sector, including those involving space flight participants. These complementary mission objectives provide an oversight framework that has proven beneficial to both the industry and the American people. Since the FAA has licensed over 500 launches and reentries, there have been no fatalities, serious injuries, or significant property damage to the public or space flight participants.

The FAA's responsibilities are not limited to protecting the public. In 2004, Congress granted the Secretary of Transportation authority to oversee the safety of the emerging commercial human space flight industry. 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 space flight participant in writing about the risks of launch or reentry.

The FAA established requirements for human space flight under Title 14 Code of Federal Regulation (CFR) Part 460, as required by the CSLAA. Part 460 defines crew and flight crew and imposes notification, medical, qualification, and training requirements. These requirements are focused on public safety. Part 460 also establishes informed consent and training requirements for space flight participants. 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 space flight participants on board a vehicle, or employs a remote operator of a launch or reentry vehicle with a human on board.

Other than informed consent, the FAA's authority to protect crew, space flight participants, and government astronauts for their own safety is limited. To ensure that the industry has an ample "learning period" to develop, Congress prohibited the Secretary, absent death, serious injury, or an unplanned event during a launch or reentry that posed a high risk of causing a serious or fatal injury, from promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew and space flight participants until the year 2012. Congress has extended this prohibition twice - the FAA Modernization and Reform

Act of 2012 extended it to October 1, 2015, and the Commercial Space Launch Competitiveness Act (CSLCA) extended it to October 1, 2023. However, Congress did encourage FAA to continue to work with industry on ways to improve human space flight safety. This has been accomplished through working with industry, NASA, and Commercial Space Transportation Advisory Committee (COMSTAC) to develop recommended practices, to share information, and to develop voluntary consensus standards.

The first three commercial human space flight operators have successfully flown humans to space or the edge of space as of August 1, 2022. Since February 2019 through August 2022, there have been 15 FAA-licensed commercial human space flight (HSF) launches with no fatalities or serious injury.

U.S. companies offering HSF opportunities to paying customers is projected to grow as space tourism is increasing in popularity. Commercial space travel will include not only suborbital and orbital trips, but also travel to cis-lunar and beyond destinations, travel to space habitats (commercial space stations and other tourist destinations), and, perhaps, point-to-point earth destinations through space.

The CSLCA requires the Secretary of Transportation to submit a report that identifies activities most appropriate for a new safety framework that may include regulatory action, if any, and a proposed transition plan for such safety framework. Specifically, Section 111(5) of the CSLCA revised 51 U.S.C. § 50905(c) by inserting, among other things, a new paragraph (7), which states:

(7) REPORTS.-Not later than March 31 of each of 2018 and 2022, the Secretary, in consultation and coordination with the commercial space sector, including the Commercial Space Transportation Advisory Committee, or its successor organization, shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Science, Space, and Technology of the House of Representatives a report that identifies the activities, described in this subsection and subsection (d) most appropriate for a new safety framework that may include regulatory action, if any, and a proposed transition plan for such safety framework.

III. Legislative Direction

The FAA has exercised oversight responsibility for certain aspects of commercial space transportation activities since 1995, when the Secretary of Transportation delegated authority to the FAA Administrator, and the Office of Commercial Space Transportation (AST) was established at the FAA. The FAA, through AST, licenses and permits the launch of launch vehicles, the reentry of reentry vehicles, and the operation of launch and reentry sites consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. AST's mission is unique within the FAA because it also includes the responsibility to encourage, facilitate, and promote commercial space launches and reentries by the private sector, including those involving space flight participants. These complementary mission objectives provide an oversight framework that has proven beneficial to both the industry and the American people. Since the FAA has licensed over 500 launches

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IV. Activities Most Appropriate For New Safety Framework

Commercial human space flight activity has grown and is increasing year over year since the initial report was submitted in February 2019. There are three operators that have launched under an FAA license carrying humans onboard: SpaceX has successfully operated two commercial and four NASA HSF orbital missions to and from the ISS, while Virgin Galactic has successfully flown four sub-orbital missions and Blue Origin has successfully carried out six suborbital missions.

The activities most appropriate for a new safety framework have been identified at this time as many of the activities described in the *Recommended Practices for Human Space Flight Occupant Safety* (2014) as it is being updated by AST. This document was originally developed to provide a compilation of practices that the FAA believes are important and recommends for commercial human space flight occupant safety, although it now requires substantial updates. The update effort includes incorporating lessons learned, adding new recommended practices to address the expanding scope of commercial human space flight, 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 space flight missions as well as considerable differences in the scope and type of missions compared to those proposed in 2014. 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 2 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 2 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 space flight participants may perform limited safety critical tasks.

The updated *Recommended Practices* will address gaps we have identified and will provide a good foundation for the upcoming safety framework discussions with industry. 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 will serve as a starting point for developing a safety framework and includes those activities identified at this time as most appropriate for potential inclusion in a safety framework.

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

Activities identified at this time as most appropriate for inclusion in the new Safety Framework include:

- *Quality Assurance*: Includes system safety programs, safety quality assurance, life cycle risk sustainment, refurbishment, and facilities.
- *Design Documentation*: Includes documentation related to the design of the human space flight system necessary to operate the system safely.
- *Lifecycle Management*: Includes program controls necessary to ensure proper implementation of safety requirements.
- *Planning, Procedures, and Rules*: Includes plans and procedures necessary to safely operate a human space flight system with clear lines of decision making authorities, flight readiness, anomaly investigations, and cyber security integration
- *Medical Considerations*: Includes medical needs and constraints for flight crew and space flight participants.
- *Training*: Includes training needs of flight crew, space flight participants, ground controllers and safety-critical ground operations personnel.

While this is the current list of activities considered for potential inclusion in a new safety framework, AST will work with industry and other government departments and agencies to collaborate on the final list of activities and the timeline to transition to the new framework.

V. Transitioning from Today to New Safety Framework Tomorrow

As noted earlier, since 2004, Congress has maintained a "learning period" prohibiting DOT, absent death, serious injury, or a launch or reentry that posed a high risk of causing a serious or fatal injury, from promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew and space flight participants.

It is from this point we start on the transition to a new safety framework, envisioning a not-too-distant future in which it will be common for humans to travel suborbital and beyond to various destinations with multiple companies all competing for HSF customers.

The current safety framework is an informed consent regime. Space flight participants are informed of the risks and that the U.S. Government does not certify the safety of the vehicle on which they have purchased or been given a seat to fly into space. The FAA and the commercial operator must provide information on the risks, so the occupants can make the informed decision to fly or not to fly.

The transition from informed consent to a new safety framework will need to be done in phases and must evolve as the industry develops. As Congress noted in 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.

The future of the commercial human space flight industry will depend on its ability to continually improve its safety performance, and the FAA is dedicated to performing its part.

To help support the development of a safety framework, the FAA contracted with the Aerospace Corporation (a Federally Funded Research and Development Corporation) to research the safety frameworks of multiple transportation and leisure sectors and analyze case studies to show any emerging common themes which might be applicable to the commercial HSF safety. These case studies came from cars, autonomous vehicles, cruise ships, commercial aviation, and submarines. Three common components were identified:

- i. People
- ii. Safety Culture
- iii. Data Collection and Analytics

Aerospace Corporation identified people as the most fundamental element in any safety framework, noting that human beings are fallible and will make mistakes. Regardless of the exacting nature of risk mitigation strategies, people being involved throughout the design, development, and operation of systems will introduce risks. Those risks can be mitigated, but unanticipated hazards can be spotted by humans who must be empowered to speak up and identify those hazards. This leads to the second element identified – safety culture. A positive safety culture will allow people to “see something and say something” without fear of punishment or retribution. The final key element is data collection and analytics. Aerospace noted, “[w]ithout collecting data on hazards, risks materials, processes and the subsequent analyses, any reaction to mishaps or accidents will be retroactive.”³

Aerospace Corporation found that elements of a sound safety framework include but are not limited to industry consensus standards, best practices, regulations, oversight and enforcement, inspections, audits, and verifications, certifications or licensing, international agreements and treaties, accident and mishap investigations. The safety framework for commercial HSF should exhibit, as noted in the Aerospace report⁴ the following five characteristics:

1. **Adaptive and evolutionary.** Technologies and safety aspects change through continuous innovation. As such, a framework should be able to evolve and adapt to various transportation and launch methods. It should also be adaptive to the various maturity of individual operators and companies.
2. **Innovation permissible.** A safety framework should encourage innovation and be open to new approaches to accomplish safety goals.
3. **Comprehensive.** A framework should consider all system risks and not ignore risks absent of regulatory authorities. Hazards exist along all phases of flight. However, it should be flexible enough to address the range of risk factors appropriately.
4. **Quantifiable and technically informed.** Identified hazards and associated risks should be assessed in a quantifiable manner which calls for consistent data collection and analysis. Similarly, best practices, voluntary consensus standards, and regulations need

³ AEROSPACE REPORT NO. ATR-2022-02101, p. 6.

⁴ AEROSPACE REPORT NO. ATR-2022-02101, p. 9.

to be technically informed and based on quantifiable data.

5. **Collaborative and transparent.** Safety is a shared interest of all stakeholders. Approaches and solutions to safety issues should be shared as broadly as possible.

These five characteristics should help any safety framework development to be successful and future-proof.

Industry's proactive participation in creating a safety framework will significantly influence the timing and extent of government regulatory involvement, and successful implementation of an industry participatory framework will minimize any regulatory burden on the industry while encouraging development of increased safety protocols.

Any new regime will require development of new performance-based rules, not prescriptive rules, giving industry flexibility to develop new safety approaches at the speed of innovation and the ability to use industry consensus standards to meet the performance requirements. At this point in the commercial human space flight industry's evolution, transitioning to a new safety framework that is phased in from the current informed consent regime should not stifle technology development but will instead grow with industry.

VI. Aerospace Rulemaking Committee

To help establish a safety framework, the FAA is establishing an Aerospace Rulemaking Committee (termed “SpARC”) for HSF, due to begin in early 2023. Under 49 U.S.C. § 106(p)(5), the Secretary of Transportation is authorized to establish SpARCs, similar to Aviation Rulemaking Committees, termed ARCs, that have been used for many years by the FAA’s Aviation Safety organization to gather industry data and feedback on potential aviation regulations.

The SpARC for HSF will be 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 will be private to encourage full participation and open discussion. The HSF SpARC will be tasked to provide consensus comments on two major items. The first is determining the scope of future human space flight occupant safety regulations. The level of safety for the occupants should also be considered—how safe should flights be for space flight 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 space flight 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 extent of the oversight should be considered. The aviation industry is regulated down to the exact design specifications, parts, and materials used on passenger aircraft, and the SpARC will investigate and make recommendations on a middle of the road approach between the current informed consent regime and the regime used for aviation. The SpARC will provide input for the FAA to determine that approach.

The full transition plan from informed consent regime to a new regulatory framework will be

developed in collaboration with industry through this SpARC, informed by case-studies from other transportation modes, and will be incremental in nature.

VII. Other Actions Being Taken Now

As noted earlier, the FAA is updating its *Recommended Practices for Human Space Flight Occupant Safety* document. This update will be complete in time to support the SpARC discussed earlier.

The FAA has also been supporting industry's efforts to develop voluntary consensus standards for HSF, primarily with ASTM. The ASTM Committee F47 on Commercial Spaceflight was formed in 2016 and has 5 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 space flight industry. Among other standards, the committee is developing human space flight safety standards. The 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.

The FAA is continuing its research and development effort to identify risks and risk mitigations for HSF participants to include equipment safety as well as environmental risks (e.g. space medicine). These projects have and will identify risks as well as research tools and methodologies to mitigate the risks identified, informing the regulatory regime as well as standards development and best practices until they can be incorporated into requirements. AST has developed a significant body of research through the Center of Excellence for Commercial Space Transportation and is transitioning to an even greater collaborative body of research across the US Government as well as academia. This body of growing work is informing the update of the *Recommended Practices for Human Space Flight Occupant Safety* document, and will support safety framework discussions with industry.

Lastly, the FAA plans to facilitate a discussion with appropriate U.S. Interagency partners to contemplate a strategy for commercial space flight participant search and rescue (SAR) to include potential roles and responsibilities as well as working to clarify international treaty language (e.g. Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space).⁵

VIII. Conclusion

The HSF industry is moving at the pace of innovation and the Department of Transportation is ready to establish a new safety framework built on case study, experience, research, industry collaboration, and public input. The Department will work with industry to establish the activities most appropriate for inclusion at this time in a new safety framework as well as the transition plan for implementation. The safety framework should not stifle industry technology development but encourage innovation while guarding the safety of the crew, government astronauts, and space flight participant as well as the uninvolved public. The United States is the

⁵ The U.S. is applying the term Space Flight Participant (SFP) and not using the term astronaut for commercial space travelers. A clarification of the terms needs to be made by the U.S. government to ensure safe treatment of personnel and return of equipment pursuant to the treaty.

world leader in the exploration of the next frontier: space, and we must continue to be the leader in regulating only to the extent necessary to make sure space travel is as safe as possible.

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