**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 Title 51 United States Code (USC § 50905(c)(7)), National and Commercial Space Programs License applications and requirements, the Secretary of the United States (US) Department of Transportation (DOT) is required to submit a report to Congress by March 31, 2022, that identifies the commercial human space flight (HSF) 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 (FAA). 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. The FAA has coordinated and consulted with COMSTAC, and COMSTAC recommendations have been taken into consideration in developing this report.

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. Congress placed a hold on the promulgation of rules to address these activities to provide the industry a learning period or moratorium without significant US Government regulatory oversight.

In the October 20, 2017 report to Congress[1], the FAA developed a list of proposed indicators with the intent to determine if the agency and the commercial space transportation industry were ready to develop and transition to a new safety framework for the safety of human space flight. In the first report in 2019[2], the FAA indicated that the industry and the FAA were not ready to transition to a safety framework. However, the industry has evolved substantially since then, and the FAA believes both the industry and the agency are ready to develop and transition to a new safety framework. To ensure that future regulations are only to the extent necessary, the FAA will work closely with the industry to develop the safety framework. The current expiration of the learning period will allow for the adoption and implementation of critical safety principles that are absolutely necessary to ensure the success of this new and quickly growing mode of transportation.

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 the crew, government astronauts, and space flight participants as the commercial space sector continues to mature." The FAA is supporting multiple Standard Development Organizations (SDOs) in their development of commercial space standards and most recently delivered the status of standard develop in the latest report to Congress, *Final Report on Voluntary Industry Consensus Standards Development*, in December 2021.

The Department is chartering an Aerospace Rulemaking Committee (termed "SpARC") under

[1] Available at: https://www.faa.gov/about/plansreports/report-congress-faa-evaluation-commercial-human-space-flight-safety-frameworks

[2] Available at: https://www.faa.gov/sites/faa.gov/files/2021-11/New-Safety-Framework-for-Commercial-Human-Space-Flight-Completed-report.pdf

49 U.S.C. § 106(p)(5), with membership represented across the space industry, to assist the Department in formulating a safety framework. The SpARC will submit a report of recommendations approximately 18 months after establishment. The FAA is also updating the *Recommended Practices for Human Space Flight Occupant Safety* originally published in 2014.[3] These updates will include an FAA review of existing government and private sector requirements and standards. The FAA is consulting closely with NASA, FAA's Civil Aerospace Medical Institute (CAMI), and COMSTAC to update these recommended practices. Once published, the FAA will work with SDOs to develop voluntary industry consensus standards built around these best practices.

The safety framework will evolve and expand as the industry grows in complexity and increases in launch frequency. The pace of industry will inform the development of the new safety framework, as well as 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 more importantly, the encouragement of a robust safety culture within the industry.

The human space flight industry is moving at the pace of innovation, and the DOT believes that as the leader in transportation safety, the United States is ready for the sunset of the moratorium and will work together with industry and other United States Government agencies to establish a new safety framework for space transportation providing for the safety of the crew, government astronauts, and space flight participants.

# 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 FAA established the Office of Commercial Space Transportation (AST). 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. Since 1989, the FAA (or its predecessor office in the Office of the Secretary of Transportation) has licensed over 500 launches and reentries, and 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 USC § 50905(b)(4), 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. In addition, section 50905(b)(5) 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 and

[3] Available at: https://www.faa.gov/space/human_spaceflight

reentry.

The FAA established requirements for human space flight 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. While these requirements are focused on public safety, part 460 also established informed consent 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 U.S. Commercial Space Launch Competitiveness Act of 2015 (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 in general, NASA, and COMSTAC to develop recommended practices, to share information, and to develop voluntary consensus standards.

US companies offering HSF opportunities to paying customers are projected to grow as space tourism and other applications increase 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. Since February 2019 through March 2023, three commercial HSF operators have successfully flown humans on suborbital trajectories or in Earth orbit. There have been 18 FAA-licensed commercial HSF launches with no fatalities or serious injury.

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 USC § 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. Review of Readiness Indicators

In the October 20, 2017 CSLCA Section 111(5) report to Congress[4], the FAA developed a list of proposed indicators with the intent to determine if the agency and the commercial space transportation industry were ready to develop and transition to a new safety framework for the safety of human space flight. These indicators did not have specific and measurable metrics associated, but were developed as guides to indicate when a framework should be established. The detailed list of indicators is in Appendix A, and a general discussion is provided below.

The first set of indicators includes industry's readiness to enter into a safety framework, focusing on three areas:

1. Purpose of people flying in space
2. Size and complexity of the industry
3. Safety of the industry

Commercial human space flight activity has grown and is increasing year over year since the Department submitted its initial report in February 2019. Three operators have launched under an FAA license carrying humans onboard. As of 30 March 2023, SpaceX has successfully operated two commercial and six NASA human space flight orbital missions, Virgin Galactic has successfully flown four sub-orbital missions, and Blue Origin has successfully carried out six suborbital missions. Boeing is looking to be certified by NASA in 2023 to fly government astronauts and will be ready to fly space flight participants for tourism and other purposes. Sierra Space is also developing a crewed version of its Dream Chaser spaceplane.

The public perception of space flight safety has increased as people are flying for adventure by either a sponsored seat or a purchased ticket to fly. There has been an increase in celebrities and members of the public flying for adventure. Employees of space flight companies have also flown. Government astronauts, through the commercial crew program, fly on FAA-licensed flights to the International Space Station as part of their occupation. At this time, there are no vehicle manufacturers supplying launch or reentry vehicles for operators; all companies manufacture their own launch and reentry vehicles. In addition, all launches have been from the United States, as opposed to international spaceports.

With the exception of a Virgin Galactic SpaceShipTwo mishap in 2014, all licensed or permitted human space flight missions have been completed safely.

The second set of indicators include the industry's progress in developing a safety framework, also focusing on three areas:

[4] https://www.faa.gov/about/plans_reports/congress/media/Sec.-111-Report-to-Congress-Evaluation-of-Commercial-Human-Space-Flight-Safety-Frameworks-and-Key-Industry-Indicators.pdf

1. Voluntary safety reporting
2. Voluntary consensus standards
3. Compliance with standards

This set of indicators points to the extent of industry self-regulation and establishment of an industry-led safety regime. There has not been an appetite from industry to establish a voluntary safety reporting system yet. There are several reasons given for this reluctance on the part of industry. First, there are no statutory data protection safeguards in place for the commercial space transportation industry as there are for the aviation transportation industry (49 USC 40123). Another reason often cited by industry is that safety issues, if reported, could affect the income or potential venture capital investments for the company reporting an issue. A third reason given is that those safety issues are proprietary knowledge in a nascent industry that is failing forward and taking failures as learning opportunities. An expensive lesson learned by one company may give a capital advantage to another company.

The development of robust voluntary consensus standards is another indicator that is not as advanced as expected. The industry has not established a robust set of voluntary industry consensus standards on high priority areas and, therefore, companies do not self-identify adherence to voluntary consensus standards. There are several reasons leading to this lagging development and use of standards. First, it is expensive for a company to devote subject matter expert time to discussion and to build consensus around a standard for a mode of transportation that is so divergent. The subject matter expert's time is spent designing, building, or modifying its employer's vehicle; this is a critical issue with the known shortage of engineers and scientists with the background to work in this booming industry. Another reason for the less than robust number of published standards is there are no regulatory performance requirements to establish boundaries and direction for the development of standards. Additionally, there is no third-party verification of adherence or compliance with standards.

The final set includes indicators of the FAA's readiness to enter into a safety framework, focusing on two areas:

1. US DOT authority to transition to a safety framework
2. US DOT expertise in Human Space Flight Safety

The current expiration of the learning period will facilitate the first indicator. Other than public safety-focused requirements, the FAA's part 460 rule is limited to the informed consent of space flight participants.

The FAA engages with the ASTM F47 Committee on Commercial Spaceflight in developing standards and has increased participation with the working groups establishing standards for human space flight. Additionally, the FAA is working to update and publish a new *Recommended Practices for Human Spaceflight Occupant Safety,* which is an update to the 2014 published document of the same name. The updated version will be provided to COMSTAC for their review, observations, and recommendations before being published later this year. 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, and incorporating additional information on how operators could verify the implementation of the recommended practices in the design, manufacture, and operation of launch and reentry vehicles.

Since 2014, when the original *Recommended Practices for Human Space Flight Occupant Safety* document was published, there has been a significant increase in the frequency of commercial human space flight missions, as well as differences in the scope and type of missions compared to those envisioned 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 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 space flight participants may perform limited safety-critical tasks. The updated *Recommended Practices for Human Space Flight Occupant Safety* will address gaps we have identified and will provide a good foundation for the upcoming safety framework discussions with industry.

Based on the review of these readiness indicators, DOT believes both the industry and the Department are ready to work together and begin developing a safety framework. As will be discussed below, the FAA plans to begin a formal gathering of industry recommendations by establishing a SpARC this year. Because of the large time gap between the sunsetting of the learning period and the effective date of any new safety framework that includes regulation, the expiration of the learning period will allow for the implementation of a safety framework in an appropriate timeframe to meet industry needs.

# IV. Activities Most Appropriate for New Safety Framework

In our October 20, 2017 report to Congress[5], we outlined several safety elements that a comprehensive set of safety standards for human space flight should address, as follows:

*Design*

- Human Needs and Accommodations – the steps necessary to accommodate specific human needs, such as consumables, human waste disposal, etc.
- Human Protection – the steps necessary to keep an occupant's physical or psychological stress at levels that can be considered safe for space flight participants and sufficient for flight crew and government astronauts to execute the flight.
- Flightworthiness – the minimum system capabilities necessary to maintain occupant safety.
- Human/Vehicle Integration – operational and design constraints necessary to integrate humans with a human space flight system.

[5] https://www.faa.gov/about/plans_reports/congress/media/Sec.-111-Report-to-Congress-Evaluation-of-Commercial-Human-Space-Flight-Safety-Frameworks-and-Key-Industry-Indicators.pdf

- System Safety – 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.

*Manufacturing*

- Steps necessary to ensure the system manufactured matches its design, including quality assurance, acceptance testing, and configuration management.

*Operations*

- Management – program controls necessary to ensure proper implementation of safety requirements.
- System Safety – system safety management and engineering principles, criteria, and techniques applicable during the operational phase of a system's life cycle.
- Planning, Procedures, and Rules – plans and procedures necessary to safely operate a human space flight system.
- Medical Considerations – medical needs and constraints for flight crew and space flight participants.
- Training – training needs of flight crew, government astronauts, space flight participants, ground controllers, and safety-critical ground operations personnel.

These elements are reflected in our *Recommended Practices for Human Space Flight Occupant Safety* document, August 2014. The activities most appropriate for a new safety framework early on will most likely include a number of these activities.

To further investigate activities most appropriate for new safety framework, the FAA contracted with the Aerospace Corporation (a Federally Funded Research and Development Center) to research the safety frameworks of multiple transportation and leisure sectors and analyze case studies to show any emerging common themes that might be applicable to commercial HSF safety. These case studies came from cars, autonomous vehicles, cruise ships, commercial aviation, and submarines. Aerospace Corporation identified three common components in their research:

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."[6]

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, and accident and mishap investigations. The safety framework for commercial HSF should exhibit, as noted in the Aerospace report[7] 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 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 are envisioned to enable successful and future proof development of the safety framework.

Aerospace noted that the industry's proactive participation in creating consensus standards, systems for data collections and sharing, and maturing a sustainable industry safety culture 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 the development of increased safety protocols.

In summary, the FAA plans to use the *Recommended Practices* document, the Aerospace study, and any other relevant input to enable the FAA and the industry, using a SpARC, discussed below, as a collaboration platform to methodically and deliberately produce a list of activities most appropriate for a new safety 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.

[6] Aerospace Report , p. 1.
[7] Aerospace Report, p. 5.

The current safety framework is based on 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 continual improvement in its safety performance, and the FAA is dedicated to performing its part. Performance based regulatory regimes can be positive guardrails allowing innovation and development within established bounds for safety. These requirements also allow voluntary consensus standards to be developed to provide a means of compliance and can be the basis for updating or establishing new performance requirements for the industry to increase the safety of the participants.

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

The expected phases of a new regulatory framework regime will first, update and publish the *Recommended Practices for Human Space Flight Occupant Safety* (2023) document. This document could then be the basis for SDOs, such as ASTM, to create consensus standards for the industry to utilize and the government to use to support the establishment of performance-based regulations. This activity is being accomplished and does not require additional regulatory or legislative action.

DOT is also chartering an Aerospace Rulemaking Committee under 49 USC § 106(p)(5), where the Secretary of Transportation is authorized to establish SpARCs, which are 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. This will assist the Department in formulating the first set of rules when the learning period has sunset. Eighteen months after establishment, the SpARC will submit a report of recommendations. After the SpARC report has been received, the FAA will draft a Notice of Proposed Rulemaking (NPRM) for the proscribed period of public comment during which time industry, the general public, and other government agencies will have the opportunity to review and comment on the proposed rule. Following the public comment period, a decision will be

made as to publishing a final rule, or if significant changes need to be made prior to publishing a final rule. This process will follow the Administrative Procedure Act (APA) as codified in 5 U.S.C. §§ 551–559. A final rule is projected to take approximately five years from start of the SpARC until it is published with an effective date sometime after the rule is published.

The FAA will diligently seek recommendations from industry and other government departments and agencies to develop the final list of activities to include in the initial new safety framework. The FAA is working with industry and others through COMSTAC, SpARCs, and international space agencies, to garner the best ideas for the development of the safety framework.

# VI. Aerospace Rulemaking Committee

The SpARC for HSF Occupant Safety (HSFOS) 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 closed sessions to encourage full participation and open discussion. The HSFOS SpARC will be tasked to provide consensus comments on two major items.

The first task 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 task will be providing recommendations 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 after receiving recommendations from this SpARC, informed by case studies from other transportation modes, and will be incremental in nature.

# VII. Other Actions Being Taken Now

In addition to the actions discussed above, 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 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 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. The FAA 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 United States 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 work with appropriate US Interagency partners to establish a strategy for commercial space flight participant search and rescue (SAR) 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).[8]

# VIII. Conclusion

The United States is the world leader in the exploration of the next frontier: space. The HSF industry is moving at the pace of innovation and the DOT believes both the Department and industry are ready to work together to establish a new safety framework. A framework built on case study, industry and government experience, research, and public input. The Department continues to fully support industry in the development of substantial voluntary industry consensus standards as an integral part of any safety framework. The safety framework will not stifle industry technology development but rather encourage innovation while guarding the safety of the crew, government astronauts, and space flight participants.



[8] 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.

# Appendix

**Table 1**

**Industry Readiness Indicators**

| Readiness Area | Indicators |
|---|---|
| • Purpose of People Flying in Space | • The extent to which people are flying for adventure purposes.<br>• The extent to which people are flying as part of their occupation.<br>• The extent to which people are flying as a mode of transportation. |
| • Size and Complexity of the Industry | • The number of suppliers of orbital or suborbital space flight.<br>• The number of suppliers of similar space flight types, such as vertical suborbital, horizontal suborbital, and balloon.<br>• The extent to which there is a broad supplier network.<br>• The extent to which operations occur internationally. |
| • Safety of the Industry | • The extent to which there is evidence of unsafe operations.<br>• The extent to which the industry is having difficulty attracting new customers.<br>• The extent to which insurance companies are willing to insure human space flight operations. |

**Table 2**

**Industry's Progress in Developing a Safety Framework Indicators**

| Readiness Area | Indicators |
|---|---|
| • Voluntary Safety Reporting | • The extent to which individual companies have an internal voluntary reporting system to identify and address potential precursors to accidents.<br>• The extent to which industry members share safety data with each other, with a common data format and taxonomy. |
| • Voluntary Consensus Standards | • The extent to which industry has formed a consensus on top level performance standards.<br>• The extent to which industry has developed and maintains voluntary consensus standards in high priority areas.<br>• The extent to which industry has developed and maintains a robust set of voluntary consensus standards. |
| • Compliance with Standards | • The extent to which individual companies self-verify compliance with voluntary consensus standards.<br>• The extent to which a third party verifies compliance with voluntary consensus standards. |

**Table 3**

**U.S. Department of Transportation Readiness Indicators**

| Readiness Area | Indicators |
|---|---|
| • USDOT Authority to Transition to a Safety Framework<br>• USDOT Expertise in Human Space Flight Safety | • Status of the "learning period."<br>• The extent to which the FAA has helped create elements of a space safety framework.<br>• The extent to which the FAA has engaged with industry regarding standards development.<br>• The extent to which the FAA has published safety practices related to commercial human space flight.<br>• The extent to which the FAA has experience participating in a space safety framework. |