

Statement of

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Thank you, Chairman Lucas, Ranking Member Lofgren, and distinguished members of the Committee, for inviting me to join the discussion on commercial space regulation matters for human spaceflight safety.

I am a Systems Director at The Aerospace Corporation, a non-profit Federally Funded Research and Development Center (FFRDC) working across the entire space domain to solve complex problems and advance solutions in the national interest. Established by the U.S. Congress in 1960 to provide independent and objective technical advice to all governmental space programs, Aerospace has a workforce of over 3000 scientists and engineers, with the only motivation to help the U.S. space enterprise achieve success. In addition to helping lead Aerospace’s Center for Space Policy and Strategy, I am also the co-founder of Aerospace’s Space Safety Institute and have studied space safety issues ranging from space debris to human spaceflight safety.

Allow me to cover aspects of a safety framework, a regulatory authority issue, and why a holistic, all-encompassing approach is critical to enable the projected growth in a space economy.

Commercial Human Spaceflight Safety and the Learning Period

The year 2021 was extraordinary for commercial human spaceflight. After a long-anticipated development cycle, the world watched several commercial entities successfully launch paying customers into suborbital and orbital space. These launches were indeed a remarkable achievement and broadly celebrated. However, the increasing maturity of the commercial human space flight market reopens the lingering question of whether the current safety

framework is sufficient or whether a more comprehensive one is necessary. Can the safety of spaceflight passengers be left to the industry alone?

The current approach in the commercial spaceflight sector is for industry to develop consensus standards before the government begins developing and implementing binding regulation. This approach appears sensible and puts the industry in the driver's seat. There is a fear among commercial providers that regulation would only be a hindrance and could slow down innovation and progress. At the same time, even commercial providers are concerned that an accident would set the industry back by many years.

These concerns center on finding the "right" balance to foster commercial innovation and safety. Instead of focusing too much on what the right balance is, we should broaden our discussion and create a more comprehensive picture of what contributes to safety. In the end, government regulation or industry standards cannot guarantee an accident-free environment; only through a comprehensive series of safety-promoting initiatives can we achieve a procedurally efficient, safety-effective, and innovation-permissible environment.

Let me briefly describe our findings from a study on developing a comprehensive safety framework for commercial spaceflight. A team of Aerospace experts looked into other commercial sectors, including commercial aviation, cruise lines, autonomous vehicles, commercial submarines, and their approaches to safety. Based on our research, we identified five guiding principles and five major components of a successful safety framework that would be suitable for commercial human spaceflight safety.

First, the five guiding principles are that any spaceflight safety framework should be:

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 launch methods. It should also be adaptive to the different maturity levels of individual operators and companies. As the space industry grows over time, it will likely see a growing demand for enhanced safety standards, as we did over the decades of civil aviation.
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 that fall outside current legal and regulatory authorities; hazards exist along all phases of flight.
4. **Quantifiable and technically informed.** Identified hazards and associated risks should be assessed in a quantifiable manner, which calls for consistent data collection and analyses. Similarly, best practices, voluntary consensus standards, and regulations all have a role to play, and all have a 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.

Based on these five principles, we identified components that contribute to and accomplish safety goals. The critical point I am making here is that it is more than just a regulation versus industry standards dichotomy. The major components that contribute to a safe environment are:

1. **People, Safety Culture, and Safety Management Systems.** These three are the most critical aspect of any safety framework, as people are your eyes and ears on the ground and catch mistakes and possible failure modes early on before any regulators can. Safety Management Systems provide a formalized approach, adaptive to the maturity of the individual company, to implement and promote a just safety culture.
2. **Best practices, industry consensus standards, regulation, certification, licensing, and accident investigations.** These activities are based on a collaboration between the commercial provider and the government, and should be implemented flexibly and performance-based.
3. **Third-party reviews and safety case methods.** Regardless of the commercial sector, or high-risk endeavor, the role of third-party safety review, in addition to the interaction between the launch provider and regulator, is to identify safety blind spots because everybody can have them. Using the approach of safety case methods is one formalized way of implementing third-party safety reviews.
4. **Data collection and analysis.** Accident investigations are purely retroactive measures. Safety frameworks should not only be retrospective and must collect safety data and subsequent analysis to catch safety issues so failure modes can be anticipated, predicted, and mitigated.
5. **International cooperation and open collaboration.** In the future, commercial human spaceflight will include more international participants and destinations. It is essential to develop roles and responsibilities between nations. The United States should lead internationally in establishing a comprehensive safety framework. In addition, safety approaches should not be treated as proprietary but should be collaborative and transparent.

Since the crewed spaceflight industry consists of just a handful of companies at this point, all with different launch methods, a safety framework needs to focus on common components across all operators. Human spaceflight providers are also in various stages of their development cycle, and some companies are more mature than others. With that in mind, we identified three key areas that could be promoted even before a learning period ends—**people, safety culture, and data collection with analysis.**

In essence, any complex system has people involved. Vehicles are designed, operated, and maintained by people. While people make mistakes, they also catch mistakes, mitigate hazards, and improve the system. People are the "boots on the ground" who can reduce hazardous situations before they lead to disaster. However, people also need to be able to speak up without fear of retribution, which is where safety culture comes into play. Focusing on a positive and just safety culture will ensure that the industry can thrive and mitigate as many

accidents and anomalies as possible. Thirdly, safety data collection and subsequent analysis enable the prevention of accidents and can provide a prediction of failure modes. Anything else would be considered retroactive and, as such, inadequate. The “failing often and early” paradigm is no longer applicable once passengers are on board. At that time, the operations should be as safe as possible.

Our report "Commercial Human Spaceflight Safety Regulatory Framework" identified a series of additional, specific recommendations and a roadmap to a successful spaceflight safety framework with near, mid, and long-term recommendations. The report is publicly available online¹ and an executive summary is attached here.

Selective mission authorization for commercial human spaceflight

The Federal Aviation Administration (FAA) recognizes more than 50 people who have traveled to space on commercially licensed vehicles, and the list will continue to grow. Remarkably, regulatory agencies lack continuous oversight throughout the whole duration of a commercial human spaceflight going to orbit.

To illustrate with an aviation example, the FAA regulates commercial aviation through all phases of flight. FAA's oversight of air travel is not limited to the riskier stages of takeoff and landing and does not transition oversight responsibility during cruise flights to someone else. Instead, a continuous chain of custody over the entire commercial aviation flight secures the safety of passengers and bolsters overall confidence in commercial aviation, a well-established U.S. industry carrying 2.3 million passengers daily in 2022².

Commercial spaceflight is handled differently. The FAA oversees commercial spaceflight safety during launch and reentry, but operations outside the atmosphere are not part of the FAA's regulatory authority. Even when the learning period, or regulatory moratorium, ends, the FAA authority to oversee passenger safety currently only applies during launch and reentry. However, it is unlikely to be devoid of on-orbit safety oversight indefinitely. Eventually, it will be necessary to provide a regulatory agency with the authority to oversee the whole flight and implement the comprehensive safety framework I described earlier.

While the U.S. Government is considering a mission authorization for novel space missions (including robotic and crewed), there is a question of which agency should hold what responsibility or if all novel activities should be handled with a one-stop approach. I think it is essential to distinguish between one key aspect: Is the health and safety of lives of flight participants directly at risk? The answer could be a distinguishing factor in where to place the roles and responsibilities. In particular, to ensure the safety of spaceflight travelers throughout

¹ Aerospace Report ATR-2022-02101 “Commercial Human Spaceflight Safety Regulatory Framework”, https://www.faa.gov/sites/faa.gov/files/ATR_2022_02101_Commercial_Human_Spaceflight_Safety_Regulatory_Framework.pdf

² Airlines for America, Economic Impact of Commercial Aviation, <https://www.airlines.org/impact/>

the whole mission from launch to landing, the United States should consider the continuity of a single executive agency overseeing commercial human spaceflight activities. This responsibility could be with an agency with safety as its guiding north star. At the same time, a purely robotic mission could fall under an organization that is more focused on economic and commercial growth.

If the U.S. Government can consider human spaceflight as a different category compared to robotic missions, it could also provide a streamlined authorization process that does not add more oversight agencies than necessary. This concept of mission-specific one-stop-shop would ensure that future commercial spaceflights benefit from a continuous chain of custody, have a single-entry point for licensing, and promote passenger safety throughout all phases of flight. Passenger safety is important enough to merit a single authoritative body that benefits from experts within one agency, limits bureaucracy, and encourages commercial companies to deliver innovative and safe human spaceflight solutions.

Conclusion

In closing, I want to highlight the need for practical solutions and their implementation in addition to a comprehensive safety framework rather than the status quo. Economic growth is not enabled by the status quo but by a practical, innovation-permissive environment that is consistent with domestic and international obligations. The United States should lead the way in commercial human spaceflight safety.

Thank you again for the opportunity to testify on these essential topics, and I look forward to your questions.