



ASSESSING THE READINESS FOR

HUMAN COMMERCIAL SPACEFLIGHT SAFETY REGULATIONS



CHARTING A TRAJECTORY FROM
REVOLUTIONARY TO ROUTINE TRAVEL

SUMMARY

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About This Report

Human spaceflight has evolved from a world that was once the purview of highly trained government astronauts to one in which a member of the public is able to purchase a ticket to space—albeit a very expensive one. Although space travel by private citizens is still revolutionary and headline-making, it could conceivably become more routine in the years ahead. Like the evolution of other industries, the question of how and when the spaceflight industry should be regulated at a federal level is receiving increasing attention—not only within the industry and federal agencies responsible but also from Congress.

In 2015, Congress directed the Secretary of Transportation to contract for an independent report that would provide an assessment of whether the commercial space industry was ready to transition to a safety framework that might include regulations. The RAND Corporation was asked to conduct this assessment, the results of which are contained in this report. The assessment primarily covers three topics: the progress the commercial space industry has made in adopting voluntary standards, the industry’s progress in meeting key industry metrics set out by the Federal Aviation Administration in 2017, and whether the industry has reached a level of maturity such that certain areas identified in previous Federal Aviation Administration reports were ready for regulatory action. This research report reflects work conducted from May 2022 to December 2022. This report should be of interest to Congress, federal department and agency leaders and policymakers, the commercial space industry, professional standards organizations, the space commercial industry, and the general public.

This research was sponsored by the Federal Aviation Administration and was conducted within the Community Health and Environmental Policy Program within RAND’s Social and Economic Well-Being division.

Community Health and Environmental Policy Program

RAND Social and Economic Well-Being is a division of the RAND Corporation that seeks to actively improve the health and social and economic well-being of populations and communities throughout the world. This research was conducted in the Community Health and Environmental Policy Program within RAND Social and Economic Well-Being. The program focuses on such topics as infrastructure, science and technology, community design, community health promotion, migration and population dynamics, transportation, energy, and climate and the environment, as well as other policy concerns that are influenced by the natural and built environment, technology, and community organizations and institutions that affect well-being. For more information, email chep@rand.org.

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Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense intelligence enterprise. For more information on the RAND Acquisition and Technology Policy Program, see www.rand.org/nsrd/atp or contact the director (contact information is provided on the webpage).

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We also wish to thank George Nield and George Nacouzi for their careful peer review of the report. Finally, we would like to thank Rebecca Sepich for assisting with sponsor and interviewee interactions and for all of her administrative support throughout this project.

Summary

This report was produced in response to a call by Congress in the Commercial Space Launch Competitiveness Act (CSLCA) of 2015 for an independent review of the “readiness of the commercial space industry and the Federal Government to transition to a safety framework that may include regulations.”¹ The Federal Aviation Administration (FAA) contracted with the RAND Corporation to conduct this independent review. Specifically, the CSLCA requires that the independent review evaluate three items: (1) the progress of the commercial space industry in adopting voluntary industry consensus standards for participant safety, (2) the progress of the commercial space industry toward meeting key metrics that would indicate readiness for regulation, and (3) whether areas identified in previous reports to Congress are appropriate for regulatory action or whether those areas should see further development of voluntary consensus standards without regulatory actions.

Currently, the CSLCA sets limitations on federal human safety regulation of the commercial space industry. Any such regulations apply only to launches in which humans are on board the spacecraft—i.e., crew, government astronauts, and “space flight participants.”² Additionally, the law imposes a moratorium on these safety regulations until October 1, 2023, unless design features or operating practices result in serious or fatal injury or there is an “unplanned event or series of events . . . that posed a high risk of causing a serious or fatal injury.”³

There is significant attention on this topic because of the increasing number of commercial spaceflights, and because decisions about whether to extend the moratorium have substantive implications for the commercial space launch industry, the FAA, flight participants, and other stakeholders. Even though the FAA will be authorized to propose and issue regulations upon expiration of the moratorium, the law requires the FAA to “encourage, facilitate,

¹ Public Law 114-90, U.S. Commercial Space Launch Competitiveness Act, Section 111, Consensus Standards and Extension of Certain Safety Regulation Requirements, November 25, 2015.

² See U.S. Code, Title 51, Section 50905, License Applications and Requirements, Subsection c, Safety Regulations. We note that the FAA has authority to regulate safety related to launch and reentry activities and operations and is not restricted to incidents in which there is a loss of life or serious injury during these phases of phases of activities and operations. See U.S. Code, Title 51, Section 50905, License Applications and Requirements, Subsection a, Applications, and U.S. Code, Title 51, Section 50905, License Applications and Requirements, Subsection b, Requirements. A “space flight participant” is defined as “an individual, who is not crew or a government astronaut, carried within a launch vehicle or reentry vehicle.” See U.S. Code, Title 51, Section 50902, Definitions, Subsection 20.

Throughout this report, we refer to *spaceflight* as the activity conducted by the commercial space industry. However, the phrase *space flight* is also used where appropriate—i.e., with respect to quoted material or in reference to the federal statute, in which it is used to define “space flight participant.” See U.S. Code, Title 51, Section 50902, Definitions, Subsection 20.

³ See U.S. Code, Title 51, Section 50905, License Applications and Requirements, Subsection c, Safety Regulations, subsection (2)(C).

and promote commercial space launches and reentries, including those involving space flight participants,” and “take actions to facilitate private sector involvement in commercial space transportation activity.”⁴ Therefore, the FAA must seek to balance both participant safety and the growth of the industry when considering whether to regulate, and the FAA must incorporate industry input into its decisionmaking processes.

Our team took a holistic approach in its examination and analysis of the three study objectives. We conducted an in-depth review of the existing literature and the public data, information, and other documentation available on this topic. We also conducted detailed interviews of subject-matter experts and stakeholders across the space domain, including government, industry, and standards development organizations (SDOs). These sources informed our assessment of the current status of voluntary industry standards, the key metrics that have been developed and adopted so far, and the readiness of the industry for regulation. Our assessment of the industry’s readiness for regulation adopts an analytic framework used in other sectors (specifically the energy sector). We also acknowledge a broad suite of normative and subjective concerns (ethically, morally, or otherwise value-based considerations) inherent in making judgments about the distribution of risks and responsibilities among public spaceflight participants, federal regulators, and the commercial industry. Finally, we discuss the suite of available options, their potential implications, and our recommendations about how to develop a safety framework that might include regulations.

As to the current state of voluntary industry consensus standards, we found that SDOs have developed standards related to commercial spaceflight safety that could impact participant safety, although the consensus is that significant work remains to be done. Some stakeholders expressed concern that the process is moving too slowly. We identified several challenges that are limiting the development of consensus standards, but we also found that the process of building consensus standards remains valuable, particularly because it provides a forum for collaboration and for industry members to provide input and feedback. Although no single set of consensus standards for participant safety has been adopted across the industry, commercial spaceflight companies have their own set of safety practices that may (or may not) incorporate SDO standards. Directly assessing the safety practices of individual companies was not possible because this information is treated as proprietary.

As to the current progress of meeting key metrics that support voluntary consensus safety standards and a transition to a safety framework, many of the same challenges and impediments exist. Like the standards, the data and information related to many key metrics are also unique to the individual companies and are deemed by the companies to be proprietary or otherwise not publicly releasable. Additionally, many of the current metrics do not have the characteristics (e.g., definition, specificity, measurability, or temporality) that would allow for an appropriate and scientifically valid assessment to be conducted such that progress of the industry toward meeting them could be determined with confidence. This fact inhibits

⁴ See U.S. Code, Title 51, Section 50903, General Authority, Subsection b, Facilitating Commercial Launches and Reentries.

the ability to operationalize the metrics, collect corresponding data and information, and determine benchmarks or targets that would signify readiness of the industry for regulation. Interviewees were hard-pressed to identify bright lines based on these or other metrics that would signal readiness to end the moratorium and transition to a framework that might include regulations. Most did not believe that a binary view of whether regulations were appropriate was the right approach; rather, they believed that some aspects of industry operations might be ready for some forms of regulations while others might not be.

This view is reflected in our assessment that the readiness of the commercial space industry for regulation, or for further development of voluntary consensus standards, does not depend only on the progress of adopting voluntary consensus standards and meeting key metrics. An assessment of regulatory readiness depends also on five key factors: (1) access to, and understanding of, the regulatory process; (2) security of regulatory support (i.e., the level of certainty of future regulations); (3) the effectiveness of the regulatory support for the technology (i.e., that regulations could be issued that would support both public safety and technology development); (4) environmental effects, costs, and security issues related to the regulation; and (5) the ability to pass the regulation (or legislation) (i.e., political and social acceptability of the regulation). Additionally, normative and subjective judgments (e.g., how much risk or liability burden is appropriate for an individual versus a corporation to accept) must be made as these factors are applied to the unique particularities of the commercial space industry at this point in its development.

In sum, we find that regulatory action is appropriate in the following form: allowing the moratorium to expire as per current law, the continuation of development of voluntary consensus standards, and the institution of Space Aerospace Rulemaking Committees. Equally as important, we find that the foregoing regulatory actions should be accompanied by additional resourcing of the FAA. Although we also suggest options to consider for potential areas of regulation in this report (such as data-sharing), we do not recommend specific regulations, nor do we make any findings or judgments as to when it may be appropriate for such regulations to be issued. We find that further research, and further coordination and collaboration, will be required between the FAA, industry, and SDOs to address and answer these specific questions.



At Congress's request, RAND researchers assessed the progress that the commercial spaceflight industry has made in adopting voluntary safety standards, the industry's progress in meeting key metrics set by the Federal Aviation Administration (FAA) in 2017, and whether the industry has matured such that areas identified in FAA reports are ready for regulatory action. The Commercial Space Launch Competitiveness Act of 2015 imposes a moratorium on safety regulations until October 1, 2023. The FAA will be authorized to propose and issue regulations upon expiration of the moratorium (if it is allowed to expire). The RAND team reviewed the existing literature and public data. They also conducted interviews with subject-matter experts and stakeholders across the space domain, including government, industry, and standards development organizations. In the authors' assessment, the readiness of the commercial space industry for regulation, or for further development of voluntary consensus standards, does not only depend on the progress of adopting standards and meeting metrics. Regulatory readiness depends also on five key factors: access to, and understanding of, the regulatory process; security of regulatory support; the effectiveness of the regulatory support for the technology; environmental effects, costs, and security issues related to the regulation; and the ability to pass the regulation. The authors found that regulatory action is appropriate in the following form: allowing the moratorium to expire as per current law, continuing the development of voluntary consensus standards, and instituting Space Aerospace Rulemaking Committees. These regulatory actions should be accompanied by additional resourcing of the FAA.