



RAND REPORT's Assessing the Readiness for Human Commercial Spaceflight Safety Regulations

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Rand’s report “Assessing the Readiness for Human Commercial Spaceflight Safety Regulations, Charting a Trajectory from Revolutionary to Routine Travel”

The RAND Corporation issued a report this week (“Rand Report”), basically recommending that, when the **moratorium on safety regulation on human commercial spaceflights** expires in October 2023, it should non be extended.

The Rand Report is in response to a Congressional call 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.” The FAA contracted with RAND for the review. (Rand Report at v).

“In 2004, the Commercial Space Launch Act of 1984, was amended among other, “to authorize the FAA to issue regulations governing the design or operation of a launch vehicle to protect the safety of its human occupants that (1) are incorporated into the FAA’s launch and reentry licensing process; and (2) govern the design or operation of a launch vehicle carrying a human being for compensation or hire to protect the health and safety of crew and space flight participants. However, the 2004 Act also established an eight-year regulatory “learning period” that restricted this authority ... In 2004, the rationale for an eight-year learning period was to give the industry enough time to establish commercial human space flight operations and a body of safety lessons learned ... In 2012, legislation extended the learning period to September 30, 2015** and the CSLCA extended it to October 1, 2023.***”

* Commercial Space Launch Act of 2004, Pub. L. 108-492, § 2(c)(14)

** FAA Modernization and Reform Act of 2012, Pub. L. 112-95, § 827.

*** Pub. L. 114-90, § 111(5).

FAA, Report to Congress: FAA Evaluation of Commercial Human Space Flight Safety Frameworks and Key Industry Indicators, available at

https://www.faa.gov/about/plans_reports/congress/media/CSLCA_Sec111_Report_to_Congress.pdf, at 7



Moratorium language

“Beginning on October 1, 2023, the Secretary may propose regulations under this subsection without regard to subparagraphs (C) and (D) of paragraph (2). The development of any such regulations shall take into consideration the evolving standards of the commercial space flight industry as identified in the reports published under paragraphs (5), (6), and (7).” 51 U.S.C. § 50905(c)(9)

Consequence of moratorium



FAA CAN ISSUE NO SAFETY REGULATION 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.” 51 U.S.C. § 50905(c)(2)(C).



Commercial human spaceflights

In 2014 Tommaso Sgobba (IAASS Executive Director and Board Secretary, former responsible person for flight safety at the European Space Agency (ESA)) distinguished space into two regions:

- “Space exploitation” region
- “Space exploration” region

At that time, he saw the border between the 2 regions at the upper end of the geosynchronous orbit, 36,000 km.

Tommaso Sgobba, *Commercial Human Spaceflight Safety*, available at <https://www.unoosa.org/pdf/pres/stsc2014/tech-35E.pdf>, (“Sgobba’s Slides”) at 3.

Obviously with the development of the Moon, the mining of the asteroids, and the Mars missions by private sector, the boundary will change.

Human commercial spaceflights, however, have happened and will continue to happen in the “space exploitation region,” regardless of the location of the boundary.

As the Rand Report points out, “[a]lthough space travel by private citizens is still revolutionary and headline-making, it could conceivably become more routine in the years ahead.” (Rand Report at iii)

Commercial human spaceflights

Space tourism is a “growing market expected to be worth at least \$3 billion by 2030,” including “suborbital tourism” and “orbital vacations (See e.g., [Dylan Taylor](#), *The future of space tourism: op-ed*, available <https://www.space.com/future-of-space-tourism-op-ed>.)

Suborbital flights: “flight[s] up to a very high altitude which [do] not involve sending the vehicle into orbit.” *ICAO’s 2005 Study on Suborbital Flights*, at 2. “Most commercial human suborbital systems ... are essentially high-performance aircraft that use rocket propulsion to accelerate in air (rocket burn-out around an altitude of 60 km) while in a parabolic flight.” (Sgobba’s Slides)

Example of suborbital flights with civilian passengers: In Oct. 2021, Blue Origin transported the first paying customer on a suborbital flight* and in Aug 2022, it launched 6 people on a 10-minute flight**).

*<https://www.space.com/blue-origin-first-crewed-launch-four-world-records>

**<https://spaceflightnow.com/2022/08/04/blue-origin-ns-22-live-coverage/>

Commercial human spaceflights



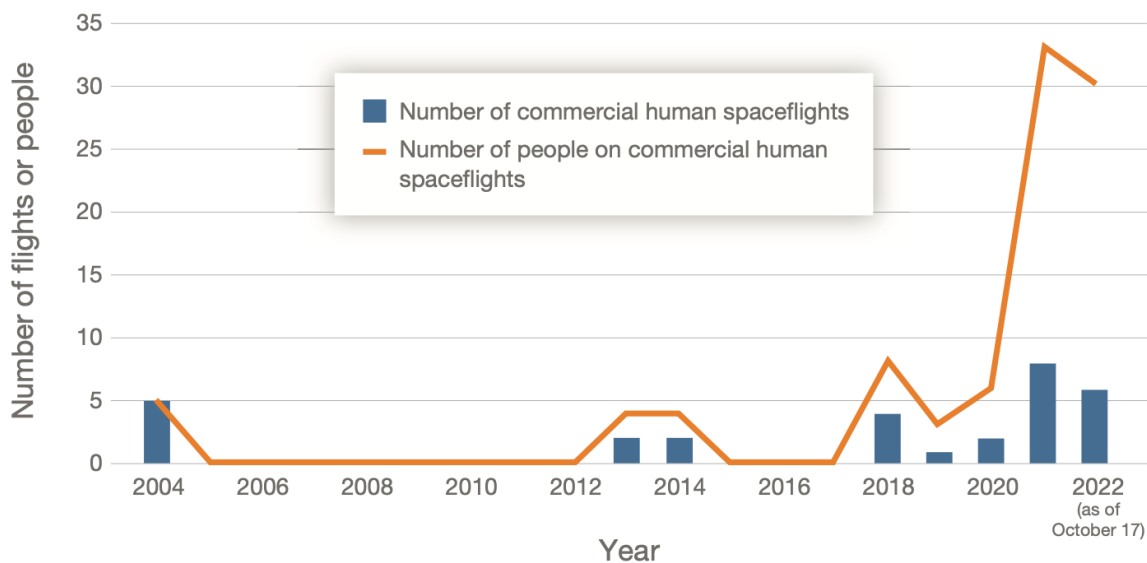
- **Flights in Earth orbit.** “By early 2022 ... adventure-seekers had gone into orbit along with NASA astronauts who were ferried to the International Space Station.” Rand Report at 27.
- **Orbital vacations.** Plans for “private initiatives ...[to] establish small – or not so small – orbital laboratories, ranging from industrial facilities for the manufacturing and processing of materials to the long-dreamed of “space hotels” in Low-Earth Orbit (LEO). Rafael Clemente, *NASA’s plans for the end of the ISS: private space stations and hotels with an Earth view*, available at <https://english.elpais.com/science-tech/2023-03-06/nasas-plans-for-the-end-of-the-iss-private-space-stations-and-hotels-with-an-earth-view.html>
- The major proponent of space hotels was Bigelow Aerospace, which is not in the “space hotel business” anymore; in 2016 it sent an inflatable module to the ISS, which is still there and its ownership “passed to NSA, which continues to fund maintenance.” id.

Commercial human spaceflights

A practical example of the moratorium problem:

In October 2021, Spacenews reported that “Virgin Galactic’s and Blue Origin’s passengers do not wear pressurized suits to protect them in the event of a cabin pressure leak during the mission. The shirtsleeve environment of the crew cabins makes the flight look and feel more like a joyride. However, NASA, Russia, and the European Space Agency all require pressure suits because of past fatal accidents. The Soyuz 11 disaster of 1971 resulted in the death of three Russian crew members when a faulty valve caused the spacecraft to depressurize. Even though the two companies’ suborbital flights are of short duration, loss of cabin pressure can kill a human in seconds. In the Space Shuttle Columbia accident (1986), the astronauts died before they could even close the visors on their helmets when the cabin suddenly depressurized. However, under the congressional moratorium, these basic, standard safety rules no longer apply to commercial flights.” Jonathan H. Ward, It’s Time to Rescind the Moratorium on Regulation of Commercial Spaceflight

FIGURE 3.1
Number of Commercial Human Spaceflights and People Flying, 2004–
October 2022



SOURCE: Total number of flights: FAA, 2022e. Number of people by flight by year: FAA, “Licensed Launches,” webpage, undated-f, and FAA, “Permitted Launches,” webpage, undated-h.

NOTE: The number of people includes crew, spaceflight participants, and government astronauts flying on commercial flights. The data do not distinguish between these categories.

Informed consent

“§ 509.05 of Title 51 of the United States Code and part 460 of Title 14 of the Code of Federal Regulations require an informed consent regime for commercial human space flight.

§ 460.9 requires an operator to notify in writing any individual serving as crew that the United States Government has not certified any launch or reentry vehicle as safe for carrying flight crew or space flight participants (“non-certification statement”).

§ 460.45 requires an operator to provide space flight participants with the same non-certification statement given to crewmembers as well as to notify space flight participants of the hazards and risks of the launch or reentry in which they wish to participate.”

Federal Aviation Administration, Guidance on Informing Crew and Space Flight Participants of Risk – Version 1.1, available at https://www.faa.gov/space/legislation_regulation_guidance/media/Guidance_on_Informing_Crew_and_Space_Flight_Participants_of_Risk.pdf, at 1. (“FAA’s Guidance”)

Informed consent

§ 460.9 disclaimer: “The United States Government has not certified the launch vehicle and any reentry vehicle as safe for carrying flight crew or space flight participants.”

§ 460.45 informed consent regarding “risks of launch and reentry”. No specific language is required but “the space flight participant must attest they understand the risks.” FAA/Guidance at 3. In Appendix C the FAA provides an example of an acceptable format.

Appendix C: Example of Space Flight Participant Consent

Example of acceptable documentation to comply with section 460.45 (Space flight participant):

INFORMED CONSENT FOR SPACE FLIGHT PARTICIPANTS ACKNOWLEDGEMENT OF RECEIPT

Company Name:

Vehicle Name:

I ACKNOWLEDGE that before paying compensation or agreeing to fly on [INSERT THE SPECIFIC LAUNCH OR REENTRY VEHICLE THE CONSENT COVERS], I received and reviewed the following information from [INSERT OPERATOR NAME].

INFORMATION

- (1) The following are known hazards and risks that could result in a serious injury, death, disability, or total or partial loss of physical and mental function. [INSERT or ATTACH: LIST OF EACH KNOWN HAZARD AND RISK] (____) INITIAL EACH HAZARD AND RISK
- (2) There are hazards that are not known. (____) INITIAL
- (3) My participation may result in my death, serious injury, disability, or total or partial loss of physical and mental function; (____) INITIAL
- (4) The United States Government has not certified the launch vehicle and any reentry vehicle as safe for carrying crew or space flight participants. (____) INITIAL
- (5) I have received from [INSERT OPERATOR NAME] Appendix A (Human Space Flight Safety Record) to this Acknowledgment of Receipt, and have been informed of the safety record of all launch and reentry vehicles that have carried one or more persons on board, including both U.S. government and private sector vehicles, which included (i) the total number of people who have been on a suborbital or orbital space flight and the total number of people who have died or been seriously injured on these flights and (ii) the total number of launches and reentries conducted with people on board and the number of catastrophic failures of those launches and

reentries. () INITIAL [PROVIDE **APPENDIX A** TO THIS AGREEMENT]

- (6) I have received from [INSERT OPERATOR NAME] Appendix B (Vehicle Safety Record) to this Acknowledgment of Receipt, which describes the safety record of [INSERT VEHICLE NAME], as detailed at Appendix B to this Acknowledgment of Receipt. This description included the number of any launch and reentry accidents and human space flight incidents that occurred during and after vehicle verification performed, and included: the number of vehicle flights; the number of accidents and human space flight incidents; and whether any corrective actions were taken to resolve these accidents and human space flight incidents. () INITIALS [PROVIDE **APPENDIX B** TO THIS AGREEMENT]
- (7) I understand that I may request additional information regarding any accidents and human space flight incidents reported. () INITIALS
- (8) I have been provided with the opportunity to ask questions orally to acquire a better understanding of the hazards and risks of this mission. () INITIALS

ACKNOWLEDGE OF RECEIPT

I knowingly consent to participate in the launch and/or reentry of the [INSERT THE SPECIFIC LAUNCH OR REENTRY VEHICLE THE CONSENT COVERS] vehicle. I understand the risk and my presence on board is voluntary.

SPACE FLIGHT PARTICIPANT

DATE

RAND Report

RAND considers the following as factors showing readiness of the commercial human space industry for regulation: (1) “access to, and understanding of, the regulatory process;” (2) “security of regulatory support;” (3) “the effectiveness of the regulatory support for the technology;” (4) “environmental effects, costs, and security issues;” and (5) “the ability to pass the regulation”.

RAND Report

The RAND Report recommends

A) To allow “the moratorium to expire as per current law,”

B) To continue “development of voluntary consensus standards,”

C) To institute “Space Aerospace Rulemaking Committee” and

D) To resource the FAA appropriately.

The Report suggests “options to consider for potential areas of regulation in this report (such as data-sharing)” but did NOT “recommend specific regulations”

- Rand Report at vii.

RAND Report

- “While no single set of consensus standards for participant safety have been adopted across the industry, commercial spaceflight companies have their own set of safety practices that may (or may not) incorporate SDO standards.” (standards development organizations) Id. at 18.
- SDOs are organizations like ASTM International, the American Institute of Aeronautics and Astronautics (AIAA), the ISO, and SAE International (SAE; formerly the Society of Automotive Engineers). Id. at 9.
- “The FAA and industry members [have] ...worked together through COMSTAC [Commercial Space Transportation Advisory Committee].” Id.
- Because of the relatively immaturity of the industry, “Consensus on voluntary standards between companies remains elusive.” Id. at 19.

RAND Report

Commercial human spaceflight standards (SDOs) “[Ex]isted as early as 2002” but increased after 2015.

Examples: 2019 ASTM International’s commercial spaceflight committee’s F47 “storage, use, and handling of liquid rocket propellants.” (See ASTM <https://www.astm.org>). Rand Report at 10.

“The ISO currently has 12 published standards that address participant safety under its 49.140 Space Systems and Operations working group.” Id. at 11.

- From 2017 the FAA “documented industry’s progress in adopting voluntary consensus standards.” Id. at 12.

RAND Report

PROBLEMS

- “According to the information garnered during our interviews, the commercial space industry has yet to develop and/or adopt a common set of voluntary consensus standards for space-flight participant safety. While some standards and guidance related to participant safety exist, companies have yet to clearly or consistently adopt them in a manner that can be confirmed or verified publicly.” Id. at 13-14.
- “[P]rivate space companies continued to apply their own independent safety practices for spaceflight participants.” Id. at 14.
- Multiple interviewers stressed the important of maintaining safety for “reputation” (id.) and some expressed “the need for and benefit of a common set of participant safety standards.” Id. at 15.
- “Multiple interviewees noted that industry members hesitate to commit to a common set of standards due to the nascent nature of the commercial spaceflight field.” Id. at 17.
- “Publicly sharing information” even only with the Government or “industry stakeholders” is felt problematic because “information ..[is] proprietary” Id. at 18.

RAND Report

However, Rand concludes that

“there is value in the process of building consensus standards, particularly because it provides a forum for collaboration and for industry members to provide input and feedback.” *Id.* at 19.

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RAND Report

- As an analogy RAND refers to **commercial aviation** and some requirements for safety:
- “These include the requirement for an oral passenger briefing, details on the location of survival equipment, details on the location and use of oxygen, provision of a visual.
- diagram of emergency exits with methods of operation, and the use of safety belts and shoulder harnesses.
- Airframes are required to meet specific sets of airworthiness standards outlined in 14 CFR Part 121 Subpart H. These standards require certificate holders to have an airworthiness certificate for each airframe,¹³ and they must be in a safe operating condition.
- The materials used in aircraft design, such as fabrics and fasteners, along with specific design factors, such as bearings, fittings, castings, and the aeroelastic stability requirement (to be included all in airplane systems), are also regulated in 14 CFR Part 25 Subpart D.
- Crewmembers are required to be qualified in the airframe in which they operate, and each certificate holder is required to establish and implement a training program that ensures that all crewmembers are adequately trained. Training programs are required to be approved by the FAA before implementation. Id. 66, 67.

- Reference to other industry are made.

RAND Report

- Notwithstanding this tension, we recommend that the FAA and industry explore a means to identify, collect, report, and analyze these data in a manner that prevents public release of sensitive or otherwise proprietary data and information. We recognize that this could require legislation from Congress and formal rulemaking by the FAA. Id. 74