U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, DC 20591

January 14, 2022

The Honorable Maria Cantwell
Chair
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Chair Cantwell:

Enclosed is the Interim Report on Voluntary Industry Consensus Standards Development as required by Public Law 114-90, U.S. Commercial Space Launch Competitiveness Act (CSCLA), Section 111(5). CSLCA Section 111(5) requires the Secretary of Transportation to submit a report on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety. Moreover, Section 111(5) requires the Secretary to coordinate and consult with the commercial space sector, including the Commercial Space Transportation Advisory Committee (COMSTAC), or its successor organization, while preparing this report on industry's progress in developing voluntary industry consensus standards.

The report updates the information provided in the initial 2017 report titled FAA Evaluation of Commercial Human Space Flight Safety Frameworks and Key Industry Indicators. In it, FAA reviews voluntary industry consensus standards development and acceptance by industry and identifies areas that have the potential to become voluntary consensus standards. It also contains an assessment of the general progress of the industry in adopting voluntary industry consensus standards, and provides the COMSTAC's recommendations, findings, and observations, related to voluntary industry standards consensus development and promotion of best practices.

This report satisfies the requirements of CSLCA Sections 111(5). The Department continues to monitor standards development activity and looks forward to reporting additional progress in the next and final report.

A similar response has been sent to the Ranking Member of the Senate Committee on Commerce, Science, and Transportation and the Chair and Ranking Member of the House Committee on Science, Space, and Technology.

Sincerely,

Steve Dickson
Administrator

Enclosure

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, DC 20591

January 14, 2022

The Honorable Roger F. Wicker
Ranking Member
Committee on Commerce,
Science, and Transportation
United States Senate
Washington, DC 20510

Dear Ranking Member Wicker:

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Steve Dickson
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800 Independence Ave., S.W.
Washington, DC 20591

January 14, 2022

The Honorable Eddie Bernice Johnson
Chair
Committee on Science, Space, and Technology
House of Representatives
Washington, DC 20515

Dear Chair Johnson:

Enclosed is the Interim Report on Voluntary Industry Consensus Standards Development as required by Public Law 114-90, U.S. Commercial Space Launch Competitiveness Act (CSCLA), Section 111(5). CSLCA Section 111(5) requires the Secretary of Transportation to submit a report on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety. Moreover, Section 111(5) requires the Secretary to coordinate and consult with the commercial space sector, including the Commercial Space Transportation Advisory Committee (COMSTAC), or its successor organization, while preparing this report on industry's progress in developing voluntary industry consensus standards.

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Sincerely,

Steve Dickson
Administrator

Enclosure

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, DC 20591

January 14, 2022

The Honorable Frank Lucas
Ranking Member
Committee on Science, Space, and Technology
House of Representatives
Washington, DC 20515

Dear Ranking Member Lucas:

Enclosed is the Interim Report on Voluntary Industry Consensus Standards Development as required by Public Law 114-90, U.S. Commercial Space Launch Competitiveness Act (CSCLA), Section 111(5). CSLCA Section 111(5) requires the Secretary of Transportation to submit a report on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety. Moreover, Section 111(5) requires the Secretary to coordinate and consult with the commercial space sector, including the Commercial Space Transportation Advisory Committee (COMSTAC), or its successor organization, while preparing this report on industry's progress in developing voluntary industry consensus standards.

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Sincerely,

Steve Dickson
Administrator

Enclosure

FEDERAL AVIATION ADMINISTRATION

Report to Congress:

Interim Report on Voluntary Industry Consensus Standards Development – January 2022

U.S. Commercial Space Launch Competitiveness Act (CSLCA), Public Law 114-90, Section 111; 51 U.S.C. Section 50905(c)(5), as amended

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Executive Summary

Under 51 U.S.C. § 50905(c)(5), the Secretary of the U.S. Department of Transportation is required to submit an interim report to Congress for the period between January 1, 2017 through June 30, 2019 that reports on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety. This is the second of three reports on this topic as required by law. The Secretary delegated the responsibility of writing this report to the Administrator of the Federal Aviation Administration (FAA). 49 CFR 1.83(b). This report meets the interim report requirement from January 1, 2017 through June 20, 2019; however, this report also reflects current spaceflight activity as of December 2021 and the agency is delivering the third and final report to Congress, upon approval.

During the reporting period, non-governmental standards development organizations (SDOs) published ten standards related to the global commercial space transportation industry. Eleven more standards are proposed and three existing standards are undergoing revision. All standards that are under development, proposed, or under revision are detailed in Appendix A. While the Department is encouraged by the increasing availability of commercial space transportation standards, the extent to which industry is incorporating voluntary standards into commercial space transportation operations is unclear. To gain more insight, the Department assigned the Commercial Space Transportation Advisory Committee (COMSTAC) to investigate this question. The primary lessons learned to date associated with the development of standards include that there is a need for an institutional framework to develop standards, and a need to assess the extent to which industry is accepting and implementing standards.

Moreover, 51 U.S.C. § 50905(c)(5) requires the Secretary to coordinate and consult with the commercial space sector, including COMSTAC, or its successor organization, while preparing this report on industry's progress in developing voluntary industry consensus standards.

At their May 2019 meeting, COMSTAC recommended to the FAA that the Department compile a directory of commercial spaceflight SDOs and determine if their standards are in progress or published to support tracking the development of consensus standards. At their June 2020 meeting, COMSTAC committed to support the continuing development of commercial human spaceflight standards.

The Department continues to monitor standards development activity and looks forward to reporting additional progress in the next and final report.

Status	Number of Standards
Finalized	10
Proposed	11
Under Revision	3

Introduction

The FAA has exercised oversight responsibility for commercial space transportation activities since 1995, when the Secretary of Transportation delegated authority over the activities to the FAA Administrator, and the Office of Commercial Space Transportation (AST) was transferred to 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 in that it also includes the responsibility to encourage, facilitate, and promote launches and reentries by the private sector. These mission objectives provide an oversight framework that has proven to be very beneficial both to the industry and to the American people. While the FAA has licensed or permitted over 400 launches, there have been no fatalities or serious injuries to the public, nor has there been significant public property damage during FAA licensed activity. Appendix B provides additional detail on the state of the commercial human spaceflight industry.

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 spaceflight industry but limited the FAA's rulemaking authority. To ensure that the industry has an ample "learning period" to develop, Congress placed a moratorium on the FAA, unless a death, serious injury, or near-catastrophe occurs, from promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew and spaceflight participants until the year 2012. Congress extended this moratorium three times – the FAA Modernization and Reform Act of 2012[1] extended it to October 1, 2015, the Airport and Airway Extension Act of 2015[2] extended it to April 1, 2016, and the Commercial Space Launch Competitiveness Act of 2015 (CSLCA)[3] extended it to October 1, 2023. Appendix C summarizes indicators FAA may use to determine if the commercial human spaceflight industry is ready for a safety framework that may include additional regulation.

However, Congress encouraged FAA to continue to work with industry on ways to improve human spaceflight safety. In August 2014, the FAA released a set of "Recommended Practices for Human Spaceflight Occupant Safety." This document covers three major areas: design, manufacturing, and operations. While the recommended practices are voluntary and do not constitute regulation, the document gives industry insight into the various areas of concern that future safety frameworks may address. Also, the FAA is engaged with the commercial space transportation industry in its development of voluntary consensus standards, which is the focus of this report.

The CSLCA requires the Secretary of Transportation to submit reports to Congress on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety. Specifically,

[1] Pub. L. No. 112-95, § 827.
[2] Pub. L. No. 114-55, § 102(e).
[3] Pub. L. No. 114-90, § 111(5).

Section 111(5) of the CSLCA modified 51 U.S.C. § 50905(c) by adding, among other things, paragraph (5) which directs the Secretary of Transportation to:

> *(A) IN GENERAL.—Not later than December 31, 2016, and every 30 months thereafter until December 31, 2021, 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 on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety.*
>
> *(B) CONTENTS.—The report shall include, at a minimum—*
>
> *(i) any voluntary industry consensus standards that have been accepted by the industry at large;*
>
> *(ii) the identification of areas that have the potential to become voluntary industry consensus standards that are currently under consideration by the industry at large;*
>
> *(iii) an assessment from the Secretary on the general progress of the industry in adopting voluntary industry consensus standards;*
>
> *(iv) any lessons learned about voluntary industry consensus standards, best practices, and commercial space launch operations;*
>
> *(v) any lessons learned associated with the development, potential application, and acceptance of voluntary industry consensus standards, best practices, and commercial space launch operations; and*
>
> *(vi) recommendations, findings, or observations from the Commercial Space Transportation Advisory Committee, or its successor organization, on the progress of the industry in developing voluntary industry consensus standards that promote best practices to improve industry safety.*

This report is the second report required under 51 U.S.C. § 50905(c)(5).

Progress of the Industry in Developing Voluntary Industry Consensus Standards

The FAA found moderate progress in the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety.

Standards can often apply to various aspects of commercial space transportation, including human spaceflight. Therefore, to avoid overlooking a potentially relevant standard, this report includes information on standards development related to the entire commercial space transportation industry. However, standards related to other areas of the greater aerospace industry but not specifically tied to commercial space transportation - such as those related to communications satellite operations, for example - are not included in this report.

Several organizations are engaged in working on industry consensus standards including: the American Institute of Aeronautics and Astronautics (AIAA), ASTM International, the Commercial Spaceflight Federation (CSF), the International Organization for Standardization (ISO), the National Fire Protection Association (NFPA), and SAE International (SAE). All standards that are under development, proposed, or being revised are detailed in Appendix A.

Required Contents from CSLCA Section 111(5)

1) Voluntary Consensus Standards Accepted by the Industry at Large.

   Four SDOs (AIAA, ASTM International, ISO, and SAE) have published ten standards related to commercial space transportation that are relevant to commercial human spaceflight. They cover the following areas: propellant handling, space systems, launch site operations, human factors, life support systems, stage disposal, standardized terminology, and reentry.

   A detailed list of the published standards is included in Appendix A.

2) Areas that have the potential to become voluntary industry consensus standards that are currently under consideration by the industry at large.

   Five SDOs are considering for publication an additional eleven standards that could be applicable to commercial human spaceflight and are revising three more. These standards cover the following areas: occupant safety, flight controller training, spacecraft classification, airspace integration, safety event reporting, vehicle structures, systems engineering, seat restraints, and fire protection at spaceports.

   Additionally, ASTM International is considering revisions to a previously approved standard on industry terminology and the ISO is considering revisions on two standards related to launch vehicles and space launch complexes. ASTM International is also

updating its regulatory road-mapping effort to guide future standards development for the commercial space industry.

A detailed list of the eleven proposed standards and three standards under revision are included in Appendix A.

The FAA will encourage SDOs to publish standards related to a new set of FAA commercial space transportation regulations. On December 10, 2020 Part 450 was published in the Federal Register, creating a new regulatory part to streamline launch and reentry licensing requirements for commercial space transportation. The part 450 regulation is performance-based, providing a regulatory requirement but allowing industry the opportunity to determine how they will meet that requirement. The FAA also is publishing Advisory Circulars as suggested means of compliance, but not the only acceptable means of compliance, for certain requirements of the new regulation. The regulation allows, and the FAA encourages, industry to identify other methods of compliance that incorporate new technologies or processes. The FAA anticipates that SDOs will create additional standards that will provide industry with acceptable means of compliance.

3) FAA's assessment on the general progress of the industry in adopting voluntary industry consensus standards.

Since the FAA's last report to Congress on this topic, SDOs have made moderate progress in finalizing and proposing additional needed standards. However, the extent to which these standards are being adopted by industry is not known.

The Department has assigned COMSTAC to assess and report on industry's preparation for human spaceflight. COMSTAC issued five recommendations related to human spaceflight at their September 14, 2020 meeting. Additional information on these recommendations will be provided in the final report to Congress.

4) Any lessons learned about voluntary industry consensus standards, best practices, and commercial space launch operations.

The primary lessons learned to date associated with the development of standards include that there is a need for an institutional framework to develop standards, and a need to assess the extent to which industry is accepting and implementing standards. The Department has assigned COMSTAC the task of making that assessment. However, the fact that at least five SDOs are actively publishing and proposing standards addresses the first concern as aerospace industry SDOs represent an established institutional framework for standards development.

5) Any lessons learned associated with the development, potential application, and acceptance of voluntary industry consensus standards, best practices, and commercial space launch operations.

An institutional framework supporting the development of standards is helpful because creating these documents is resource and time intensive. It can take months to develop a level of consensus between a quorum of stakeholders before a standard that is acceptable to industry is ready to be published. Furthermore, having sophisticated SDOs is helpful because the companies in the industry are often limited in the bandwidth they can devote to writing standards. The enhanced use of performance-based regulations allows for new opportunities for standards as acceptable means of compliance. The willingness of SDOs to provide an institutional framework for standards development will be a key to the success of the new performance-based launch and reentry regulatory regime.

6) Recommendations, findings, or observations from COMSTAC or its successor organization, on the progress of the industry in developing voluntary industry consensus standards that promote best practices to improve industry safety.

In May 2019, the COMSTAC made the following finding and recommendation regarding the development of voluntary consensus standards focused on human spaceflight[4]:

"Finding: The COMSTAC finds that industry is aligned and making progress related to the FAA's vision of safety framework elements such as standards and voluntary safety reporting systems, as described in its [October 2017] report to Congress."

"Recommendation: The COMSTAC recommends that FAA and industry collaborate to create a directory and classification of U.S. and international commercial spaceflight SDOs (Standard Development Organizations), including if their standards are in progress or are published."

The standards identified in Appendix A of this report are taken from the beginning of a directory that will meet the intent of this recommendation.

[4]https://www.faa.gov/about/office_org/headquarters_offices/ast/advisory_committee/meeting_news/media/2019/may/Spring_2019_COMSTAC_Finalized_FRs.pdf

Summary

This document provides the second report required under statute to report on the progress of the commercial space transportation industry in developing voluntary industry consensus standards that promote best practices to improve industry safety. SDOs published ten standards related to commercial space transportation. Publication is being considered for eleven more standards, and three existing standards are being revised. The new 14 CFR Part 450, with its performance-based focus will benefit from such a programmatic framework to accept standards.

While the Department is encouraged by the increasing availability of commercial space transportation standards, the extent to which industry is incorporating voluntary standards into commercial space transportation operations is unclear. To gain more insight, the Department has assigned COMSTAC to investigate this question.

Additionally, in May 2019, COMSTAC recommended the Department compile a directory of commercial spaceflight SDOs and determine if their standards are in progress or published. The FAA favorably received this recommendation, and presents the start of that directory in Appendix A.

Appendix A: List of Standards[5]

ID Number	Standard Title	Responsible Org	Current Status	Published
ASTM WK59508	New Specification for Failure Tolerance for Occupant Safety of Suborbital Vehicles	ASTM International, Committee F47 on Commercial Spaceflight; F47.01 Occupant Safety of Suborbital Vehicles	Under Development	N/A
ASTM WK70011	New Practice for Crew Safety	ASTM International, Committee F47 on Commercial Spaceflight; F47.02 Occupant Safety of Orbital Vehicles	Under Development	N/A
ASTM WK61254	New Classification for Spacecraft vehicle types	ASTM International, Committee F47 on Commercial Spaceflight; F47.03 Unoccupied Launch and Reentry Vehicles	Under Development	N/A
ASTM WK64814	New Guide for Flight controller Training	ASTM International, Committee F47 on Commercial Spaceflight; F47.03 Unoccupied Launch and Reentry Vehicles	Under Development	N/A
ASTM F3344 - 19	Standard Guide for Storage, Use, and Handling of Liquid Rocket Propellants	ASTM International, Committee F47 on Commercial Spaceflight; F47.04 Spaceports	Published	Jun-19
ASTM WK70413	New Guide for Space Data Exchange to Support the Integration of Space Operations into Air Traffic Management	ASTM International, Committee F47 on Commercial Spaceflight; F47.05 Cross-Cutting	Under Development	N/A
ASTM WK65152	New Classification for Reportable safety related events	ASTM International, Committee F47 on Commercial Spaceflight; F47.05 Cross-Cutting	Under Development	N/A
ASTM F3377 - 19	Standard Terminology Relating to Commercial Spaceflight	ASTM International, Committee F47 on Commercial Spaceflight; F47.91 Terminology	Published	2019
ASTM WK71964	Revision of F3377 - 19 Standard Terminology Relating to Commercial Spaceflight	ASTM International, Committee F47 on Commercial Spaceflight; F47.91 Terminology	Under Revision	2019

[5]Organizations included in Appendix A are members of, or have an affiliation with the American National Standards Institute (ANSI). ANSI facilitates the development of American National Standards (ANSI) by accrediting the procedures of standards developing organizations (SDOs). The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies. ISO's work results in international agreements, which are published as International Standards. These groups work cooperatively to develop voluntary national consensus standards. The government has the purview to evaluate and accept industry developed standards. Each Standards Development Organization develops its own internal numbering/tracking nomenclature.

ID Number	Standard Title	Responsible Org	Current Status	Published
114A-202x	Moving Mechanical Assemblies for Space and Launch Vehicles	AIAA	Under Revision	2005
145-20xx	Commercial Space Systems Development	ANSI/AIAA	Under Development	N/A
153-20xx	Human Spaceflight – Space Vessels Architecture and Systems Engineering Ontology	AIAA	Under Development	N/A
AS6818	Commercial Spaceflight Seat Restraints	SAE: Issuing Committee: Commercial Space	Under Development	N/A
NFPA 461	NFPA 461 Standard for Fire Protection of Spaceport Facilities	NFPA	Under Development	N/A
ISO 14620-2:2019	Space systems — Safety requirements — Part 2: Launch site operations	ISO; 49.14 (Space Systems and Operations)	Published	Dec-19
ISO 16157:2018	Space systems — Human-life activity support systems and equipment integration in spaceflight — Techno-medical requirements for space vehicle human habitation environments	ISO; 49.14 (Space Systems and Operations)	Published	Jun-18
ISO 16726:2018	Space systems — Human-life activity support systems and equipment integration in spaceflight — Techno-medical requirements for space vehicle human habitation environments — Requirements for the air quality affected by harmful chemical contaminants	ISO; 49.14 (Space Systems and Operations)	Published	May-18
ISO 17763:2018	Space systems — Human-life activity support systems and equipment integration in spaceflight	ISO; 49.14 (Space Systems and Operations)	Published	Sep-18
ISO 19971:2018	Space systems — Spacecraft and launch vehicle combined operation plan (COP) at launch site — General format	ISO; 49.14 (Space Systems and Operations)	Published	Jan-18
ISO/TR 20590:2017	Space systems - Debris mitigation design and operation manual for launch vehicle orbital stages	ISO; 49.14 (Space Systems and Operations)	Published	Feb-17

ID Number	Standard Title	Responsible Org	Current Status	Published
ISO 20892:2018	Space systems — Launch complexes modernization process — General requirements	ISO; 49.14 (Space Systems and Operations)	Published	Feb-18
ISO 27875:2019	Space systems — Re-entry risk management for unmanned spacecraft and launch vehicle orbital stages	ISO; 49.14 (Space Systems and Operations)	Published	Feb-19
ISO 24917:2010	Space systems — General test requirements for launch vehicles	ISO; 49.14 (Space Systems and Operations)	Under Revision	2010
ISO/TR 17400:2003	Space systems — Space launch complexes, integration sites and other facilities — General testing guidelines	ISO; 49.14 (Space Systems and Operations)	Under Revision	2003

Appendix B: Review - State of the Commercial Human Spaceflight Industry

This report meets the interim report requirement from January 1, 2017 through June 20, 2019; however, this report also reflects the current spaceflight activity as of December 2021 and the agency is delivering the third and final report to Congress, as required by CSCLA.
In recent years, the pace of development in the commercial space transportation industry has increased dramatically. For decades, private companies have been delivering satellites to space, but now engage in even more complex space-related tasks. The delivery of cargo to the International Space Station (ISS) has become routine. Now, the commercial space transportation industry is opening up yet another new market segment: the first commercial transportation of humans to orbit occurred in May 2020 with the launch of CCP DM-2 by SpaceX.

The National Aeronautics and Space Administration (NASA) Commercial Resupply Services program now includes three launch providers (up from two at the start of the program) that are charged to deliver cargo to the ISS. NASA awarded contracts to Northrop Grumman Innovation Systems, Sierra Nevada Corporation, and Space Exploration Technologies Corporation (SpaceX) through this program in January 2016. The FAA licenses all launches and reentries of the NASA commercial resupply program.

SpaceX and Boeing continue to complete various milestones of NASA's Commercial Crew Program. In May 2020, SpaceX successfully launched NASA astronauts to the ISS as part of the CCP DM-2 demonstration mission. In November 2020, SpaceX launched Crew-1, which was the first operational mission to the ISS under the Commercial Crew Program[6]. Crew-1 successfully returned from the ISS in May 2021. SpaceX Crew-2 successfully launched in late April 2021 to the ISS. In November 2021, SpaceX Crew-2 returned from the ISS and SpaceX Crew-3 was launched. The FAA is a critical partner in the program and will license all future Commercial Crew launches, now that NASA has certified the Commercial Crew system. The FAA is working with the industry, NASA, and other stakeholders to ensure processes are in place for conducting these important flights safely.

While NASA is currently the only U.S. human orbital space transportation customer, in the past, private citizens have traveled to the ISS on foreign launch vehicles. There are several private human spaceflight missions expected to launch in the next couple years. Space Adventures is planning a mission to launch four private citizens on a SpaceX Crew Dragon free-flyer mission.[7] In January 2021, Axiom Space announced the crew for the first entirely private mission to the ISS, Ax-1. Former NASA astronaut and Axiom Vice President Michael López-Alegría will serve as the commander for Ax-1. The first launch opportunity for this mission is expected to be no earlier than January 2022 aboard a SpaceX Crew Dragon.[8] In February 2021, The Inspiration4 mission was announced. Inspiration4 was the first all-civilian mission to space,

[6] https://www.spacex.com/updates/crew-1-docks-to-iss/index.html
[7] https://spaceadventures.com/space-adventures-announces-agreement-with-spacex-to-launch-private-citizens-on-the-crew-dragon-spacecraft/
[8] https://www.axiomspace.com/press-release/ax1-crew

commanded by Jared Issacman. Inspiration4 launched from Kennedy Space Center on a SpaceX Falcon 9 September 2021.[9]

The industry has seen significant advances in space transportation technology over the past ten years. This is evident in the recent reusability technology flown by companies like Virgin Galactic, Blue Origin, and SpaceX. Virgin Galactic's SpaceShipTwo has flown to space several times, Blue Origin has shown that it can launch and land the same rocket multiple times, and SpaceX demonstrated it can deliver a payload to orbit and land the first stage of its rocket safely, either on land or on a drone ship in the ocean. If the ability to reuse rockets becomes more common across launch service providers, and the companies with this capability can successfully and regularly, reuse rockets on missions with customer payloads, the price of reaching space will likely drop significantly. These incredible advancements demonstrate an ongoing and ever-increasing technological evolution and the competitive nature of the industry. Additionally, the industry supplier network that makes up the materials, subsystems, vehicles and equipment, and infrastructure that supports the human spaceflight industry is rapidly expanding.

Several companies are successfully carrying out operations that take people to the edge of space, where they can observe the curvature of the Earth, peer into the blackness of space, and experience several minutes of weightlessness. In February 2019, Virgin Galactic sent its first non-crew, non-paying spaceflight participant on their VSS Unity spacecraft; taking the company one step closer to launching paying spaceflight participants. On May 22, 2021, Virgin Galactic's VSS Unity completed its third spaceflight and the first ever spaceflight from Spaceport America, New Mexico. This flight achieved several objectives including carried revenue-generating scientific research experiments as part of NASA's Flight Opportunities Program, collected data to be used for the final two verification reports that are required as part of the current FAA commercial reusable spacecraft operator's license, and tested the spaceship's upgraded horizontal stabilizers and flight controls and validated EMI reductions.[10] On July 11, 2021, Virgin Galactic completed its fourth rocket-powered spaceflight and the first test flight with a full crew in the cabin, including the company's founder Sir Richard Branson.[11]

In April 2021, Blue Origin conducted a series of simulations to rehearse operations for future customer flights. This was a verification step prior to flying spaceflight participants.[12] On July 20, 2021, Blue Origin successfully completed New Shepard's first human flight today with four private citizens onboard. One of the private citizens, Oliver Daemen, was the first spaceflight participant to purchase a ticket and fly to space on a privately-funded and licensed space vehicle from a private launch site.[13]

[9] https://inspiration4.com/mission
[10] https://virgingalactic.com/articles/virgin-galactic-completes-first-human-spaceflight-from-spaceport-america-new-mexico/
[11] https://www.virgingalactic.com/articles/virgin-galactic-successfully-completes-first-fully-crewed-spaceflight/
[12] https://www.blueorigin.com/news/ns-15-mission-to-conduct-astronaut-rehearsal
[13] https://www.blueorigin.com/news-archive/first-human-flight-updates

Appendix C: Review - Industry and Government Readiness Indicators and Progress in Developing a Safety Framework

On October 20, 2017, the FAA submitted a report to Congress[14] on key industry metrics that might indicate readiness of the commercial space sector and the Department to transition to a safety framework that may include regulations for commercial human spaceflight. The tables below describe the indicators outlined in the FAA's previous report to Congress. The development and use of Voluntary Consensus standards is foundational to the Safety Framework envisioned below.

Table 1
Industry Readiness Indicators

Readiness Area	Indicators
• Purpose of people flying in space.	• The extent to which people are flying for adventure purposes. • The extent to which people are flying as part of their occupation. • 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 spaceflight. • The number of suppliers of similar space flight types, such as vertical suborbital, horizontal suborbital, and balloon. • The extent to which there is a broad supplier network. • The extent to which operations occur internationally.
• Safety of the industry.	• The extent to which there is evidence of unsafe operations. • The extent to which the industry is having difficulty attracting new customers. • The extent to which insurance companies are willing to insure human spaceflight operations.

[14] 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

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. • 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. • The extent to which industry has developed and maintains voluntary consensus standards in high priority areas. • The extent to which industry has developed and maintains a robust set of voluntary consensus standards.
• Compliance.	• The extent to which individual companies self-verify compliance with voluntary consensus standards. • The extent to which a third party verifies compliance with voluntary consensus standards.

Table 3
FAA Readiness Indicators

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