IAC-13-E6.4.5

INDUSTRY STANDARDS FOR COMMERCIAL SPACE TRANSPORTATION

Dr. George C. Nield
Federal Aviation Administration
Office of Commercial Space Transportation
Washington, DC, United States, george.nield@faa.gov

Mr. Kelvin B. Coleman
Federal Aviation Administration
Office of Commercial Space Transportation
Washington, DC, United States, kelvin.coleman@faa.gov

The U.S. Federal Aviation Administration's Office of Commercial Space Transportation regulates U.S. commercial space transportation, including launch and reentry vehicle operations and U.S. commercial launch and reentry site operations. This regulatory oversight, coupled with a strong commitment toward public safety by U.S. companies conducting these operations, has resulted in an exemplary safety record, with no fatalities, serious injuries, or significant property damage suffered by third parties since the inception of the U.S. Commercial Space Launch Act (CSLA) -- a legislative act passed by the U.S. Congress in 1984, which marked the beginning of the commercial space transportation era in the U.S. and entrusted the FAA with the authority to ensure public safety during these operations. Since enactment of the CSLA, the commercial space transportation industry has become increasingly more operationally diverse and innovative in serving a broader array of highly competitive global markets, which include suborbital and orbital space tourism, and scientific exploration.

As the industry continues its evolution, it is imperative that a commitment to public safety be continuously upheld while simultaneously enabling the commercial space transportation industry to meet market demands in a competitive, cost effective manner. The FAA Office of Commercial Space Transportation continues to actively address this challenge, and in so doing has begun to investigate the role voluntary consensus standards have in meeting industry's increasing needs to gain and maintain market access, trim costs, and conduct safe operations. Today, in the U.S., there are few widely distributed standards for commercial space transportation operations that have been developed and are in use; the current status can in part be attributed to perceptions of associated, unnecessary regulatory burdens that might befall the industry. However, in recent months a more positive tone has been struck as more U.S. stakeholders have expressed a desire to begin an earnest examination of the industry's standards development needs.

This paper will examine the prospects and benefits of industry-developed standards and practices in the United States for commercial space transportation and the potential for international impact.

I. INTRODUCTION

The U.S. Federal Aviation Administration's (FAA) Office of Commercial Space Transportation (AST) regulates U.S. commercial space transportation, including launch and reentry vehicle operations and U.S. commercial launch and reentry site operations. AST's mission is to ensure protection of the public, property, and the national security and foreign policy interests of the United States (U.S.) during these operations, and to concurrently encourage, facilitate, and promote U.S. commercial space transportation.

AST's mission is derived from the Commercial Space Launch Act (CSLA) -- a legislative act passed by the U.S. Congress in 1984, which marked the beginning of the commercial space transportation era in the U.S. The CSLA, and its subsequent amendments, grant the U.S. Secretary of Transportation (hereinafter the Secretary) authority to oversee and coordinate the conduct of commercial launch and reentry operations, issue permits and commercial licenses authorizing those operations, and to facilitate the strengthening and expansion of space transportation infrastructure in the U.S., including the enhancement of existing U.S. launch sites and support facilities, and the development of new launch and reentry sites to support the full range of U.S. space related activities.[1] The Secretary's authority does not encompass launch operations and related activities conducted by the U.S. Government (USG).

In carrying out this authority, as delegated by the Secretary, FAA/AST has promulgated performance-based regulations for vehicle and site operations.[2] U.S. citizens seeking to conduct vehicle or site operations, or any non-U.S. entity seeking to conduct vehicle or site operations in the U.S., must apply for and obtain an FAA-issued license or a permit, as applicable, in accordance with these regulations, prior to the conduct of the operations.[3] The FAA has a statutorily limited time period of up to 180 days to evaluate license applications to assess a proponent's conformity with the applicable regulations. In the case of experimental permits for suborbital vehicle operations, a similar evaluation is performed, but must be completed within a 120-day period. At the conclusion of the evaluation of the application, the FAA makes a determination either to issue or to deny a license or permit.

This regulatory oversight, coupled with a strong commitment toward public safety by U.S. companies conducting these operations, has resulted in an exemplary safety record. In the 29 years since the inception of the CSLA, there have been a total of 245 FAA-licensed or permitted launches, with none resulting in any fatalities, serious injuries, or property damage suffered by the uninvolved public.

While this safety record is indeed exemplary, the FAA and the U.S. industry it regulates cannot afford to rest on the laurels of past achievements. Since enactment of the CSLA, the commercial space transportation industry has become increasingly more operationally diverse and innovative in serving a broader array of highly competitive global markets, which include suborbital and orbital space tourism, and scientific exploration. The FAA recognizes that it must evolve its oversight in accordance with the progress of industry.

II. RECENT DEVELOPMENTS IN U.S. COMMERCIAL SPACE TRANSPORTATION INDUSTRY

II.I Launch and Reentry Vehicle Operations

The vast majority of the 245 aforementioned licensed and permitted launches were conducted by large U.S. companies, such as Lockheed Martin and Boeing, operating traditional expendable launch vehicles (ELVs) from government ranges located along U.S. coastlines. However, in recent years many of these safe and successful launches have been conducted by new U.S. entrants in the global marketplace from less than traditional locations and sites. These companies include Space Exploration Technologies (SpaceX), Scaled Composites, and a host of small, entrepreneurial companies like Armadillo Aerospace, and Masten Space Systems, to name a few, which offer new and exciting capabilities that will fuel new market development and growth opportunities for years to come.

While the exact details of flight rates and how rapidly they will increase are not known, it is expected that vehicle flight rates in the future will be significantly greater than historical flight rates.[4]

II.I.I. Orbital Operations

Commercial activities licensed by the FAA are now filling the void in U.S. transportation capabilities created by the retirement of the Space Shuttle in July 2011.[5] In December 2010, Space X completed a successful launch using its Falcon 9 launch vehicle, and a reentry of its Dragon spacecraft. The reentry of the Dragon marked the first time that a commercial reentry operation had been conducted under an FAA reentry license.[6] In May 2012, the Dragon became the first commercial spacecraft to successfully rendezvous with and attach to the International Space Station (ISS), and in October of the same year, Space X began delivering cargo aboard Dragon to the ISS as part of NASA's Commercial Resupply Services program. Orbital Science Corporation successfully conducted the maiden flight of its Antares launch vehicle in April 2013 and expects to soon begin delivering cargo aboard its Cygnus spacecraft to the ISS.

II.I.II. Suborbital Operations

Suborbital operations are primarily focused on four markets: commercial human spaceflight, basic and applied research, aerospace technology test and demonstration, and education.[7] A number of companies, large and small, are developing innovative approaches to serve these markets.

Since making history and winning the $10 million Ansari X-prize in 2004 with SpaceShipOne, the first privately developed human space vehicle, Scaled Composites (Scaled) has continued to design and fabricate vehicle systems intended to serve the ever growing suborbital space tourism market. In April 2013, Scaled successfully conducted the first powered flight operation of SpaceShipTwo, which is roughly twice the size of SpaceShipOne, and which will have the capability of carrying two crew members and up to six passengers.

Virgin Galactic soon plans to offer commercial operations with SpaceShipTwo and has applied for a launch license from the FAA to authorize those operations. Additionally, XCOR Aerospace and Blue Origin are also working diligently to provide reusable vehicle capabilities to serve the suborbital space tourism and research markets.

II.I.III. Spaceports

There are currently eight licensed launch and reentry sites in the U.S. These sites, commonly referred to as "spaceports" offer a variety of features that will accommodate traditional vertical launch operations, as well as horizontal takeoff and landing operations. Three of these sites, Mojave Air and Spaceport (California), Spaceport America (New Mexico), and Oklahoma Spaceport (Oklahoma) are inland sites. Additionally, several other state agencies and private entities have proposed launch sites in Alabama, Colorado, Florida, Georgia, Hawaii, and Texas.

III. COMMERCIAL SPACE TRANSPORTATION STANDARDS USE AND DEVELOPMENT IN THE U.S.

III.I. National Technology Transfer and Advancement Act and OMB A-119

As the industry continues its evolution, it is imperative that a commitment to public safety be continuously upheld while simultaneously enabling the commercial space transportation industry to meet market demands in a competitive, cost effective manner. With this objective in mind, AST has begun to investigate how voluntary consensus standards may support industry's increasing needs to gain and maintain market access, trim costs, and conduct safe operations. AST's approach to standards development and use is derived from U.S. public law 104-113, the "National Technology Transfer and Advancement Act of 1995" (NTTAA), and the U.S. Office of Management and Budget's policy directive regarding voluntary consensus standards.

Specifically, the NTTAA stipulates that U.S. federal agencies and departments shall use technical standards that are developed and adopted by voluntary consensus standards bodies to carry out policy objectives and activities determined by the agencies and departments.[8] The only exception to this provision is if the federal agency or department determines that use of industry-developed voluntary consensus standards would be inconsistent with applicable law or otherwise impractical -- in such instances, the head of the agency must support this claim in writing to the U.S. Office of Management and Budget (OMB).[9]

Further, the NTTAA directs that U.S. federal agencies and departments shall consult

with voluntary, private-sector consensus bodies, and participate with such bodies in the development of technical standards, when such participation is in the public interest and is compatible with the agency missions, authorities, priorities, and budget resources.[10]

OMB Circular A-119 (A-119) establishes policies on federal agency use and development of voluntary consensus standards and on conformity assessment activities and provides the basis of the codified provisions of the NTTAA.[11]

A-119 explicitly outlines goals for USG agency use of voluntary consensus standards. These include:

- Eliminating the cost to Government of developing its own standards;
- Establishing standards that serve national needs;
- Encouraging long term growth for U.S. enterprises; and
- Promoting efficiency and economic competition through standards harmonization.

III.II U.S. Industry Perceptions

Today, in the U.S., there are few widely distributed standards for commercial space transportation operations that have been developed and are in use; the current status can in part be attributed to perceptions of associated, unnecessary regulatory burdens that might befall the industry. However, recent developments have offered hope that the perception of commercial space transportation standards in the U.S. is improving, particularly in the human space flight arena.

In 2004, the CSLA was amended, granting FAA/AST the authority to regulate commercial human space flight.[12] However, provisions of the amendment, known as the Commercial Space Launch Amendments Act (CSLAA) required a phased approach, over an eight-year period, to commercial human space flight regulation, thus allowing industry the time to gain experience upon which future regulations related to occupant safety could be based. As the eight-year learning period neared an end in 2012, the U.S. Congress determined that not enough experience in operations involving human space flight participants had been accumulated and thus extended the "moratorium" on regulatory development activities focused on crew and spaceflight participant safety to October 2015. After October 2015, presuming that the moratorium is not again extended, FAA/AST may propose regulations without restriction, taking into account the evolving standards of safety in the commercial space flight industry.

In the meantime, as the moratorium continues, some have suggested that the real race in space is against the regulatory clock, and not necessarily which of the companies flies paying passengers first.[13] While FAA/AST is unlikely to impose new regulations immediately at the conclusion of the moratorium, the prospect of the potential for the FAA to issue regulations has served as motivation for U.S. industry to think about "self-regulation" for human space flight activities.[14] Consequently, the development of voluntary consensus standards in the U.S. is now under strong consideration by leading industry organizations and advocates in the U.S.

One such organization, the Commercial Spaceflight Federation (CSF), a private, non-profit, U.S. industry association focused on safety issues for the commercial human spaceflight industry, has already begun work developing standards to protect crew and passengers. The CSF believes that innovation and growth for the still-developing industry is best supported through self-regulation, rather than through detailed government regulations.

In his May 16, 2013 testimony to the U.S. Senate Subcommittee on Science and Space of the Committee on Commerce, Science, and Transportation on "Partnerships to Advance the Business of Space," Wayne Hale, Jr., retired NASA Flight Director and Program Manager, stated "Establishing good, effective safety, engineering, and management standards in a voluntary industry association is the hallmark of any reputable and mature industry."[15] Further, Mr. Hale went on to state, "evolution of these industry standards inevitably proceeds more rapidly than the development of government regulations and can therefore take rapid advantage of best practices as they emerge."[16]

While it is apparent that parts of U.S. industry strongly favor a self-regulation approach, the willingness of industry to commit to engaging in standards development activities alongside government remains uncertain. AST certainly believes that USG participation

alongside industry is important to help inform the standards development process, and in turn to gain insight into issues and challenges faced by the industry as it seeks to operate safely at acceptable cost levels.

III.III AST's Activities Supporting Industry Standards Development

While the U.S. currently does not have any standards development activities underway domestically, aside from the aforementioned CSF activity, AST has actively engaged in international standards development activities for space transportation. AST's participation in these activities is intended to help promote the development and use of performance-based standards that will make a significant and meaningful contribution towards ensuring public safety, and delivering high-quality space-related products and services. This is in keeping with the FAA's approach to incorporate performance-based requirements in its regulations and enforcing them through a rigorous compliance monitoring system that has been at the cornerstone of the FAA's successful safety record.

The FAA's licensing regime allows design and technology innovation and development by setting performance-based requirements that give industry the flexibility to meet safety objectives without specifying how safety must be achieved.

III.III.I. International Organization of Standardization (ISO)

AST is an active participant in the U.S. Technical Advisory Group (U.S. TAG) to ISO Technical Committee 20 (Aircraft and Space Vehicles), Subcommittee 14 (Space Systems and Operations).[17] AST works closely with NASA and other commercial space transportation stakeholders to develop U.S. positions and recommendations on international standards associated with space systems and operations.

III.III.II. International Aerospace Quality Group (IAQG)

AST also actively participates in the IAQG Americas Aerospace Quality Group (AAQG), a cooperative organization of stakeholders seeking to set quality standards for space, aviation, and defense products and services.[18]

IV. POTENTIAL AREAS OF FOCUS FOR U.S. STANDARDS DEVELOPMENT

IV.I Human Spaceflight Safety Standards

The U.S. has exercised great care and patience in its approach to regulating commercial human space flight, in particular occupant safety. In recognition of the need to address the safety of crew and passengers aboard launch vehicles, the FAA, U.S. industry, and other stakeholders have worked closely to explore and discuss future regulations. These discussions proved to be instrumental in helping AST develop a draft set of "Established Practices for Human Space Flight Occupant Safety."[19] AST produced the draft set of established practices with the intent in mind to gain the consensus of government, industry, and academia on cost-effective, performance-based safety approaches that would promote the continuous improvement of the safety of launch vehicles intended to carry humans.[20]

More directly, the established practices identified by AST are areas that could benefit from U.S. development or adoption of industry consensus standards. These areas include the following:

- Design
  - Human Needs and Accommodations
  - Human Protections
  - Flightworthiness
  - Human Vehicle Integration
  - System Safety
  - Design Documentation
- Manufacturing
- Operations
  - Management
  - System Safety
  - Planning, Procedures, and Rules
  - Medical Considerations
  - Training

IV.II. Spaceports

The FAA's Center of Excellence (COE) for Commercial Space Transportation recently established a draft framework capturing a "Body of Knowledge for Commercial Spaceport Practices". The COE's work captures and offers a consolidated listing of practices conducted at U.S. spaceports and launch sites. The work further provides insight into the varying degrees of commonality amongst U.S. spaceports. Considering the long-term viability and economic sustainability of these facilities,

the practices captured by the COE offer focus areas for future standards development and adoption that could help open market opportunities for these facilities.

The practices captured include:

- Airfield & Operations
  - Operational Infrastructure
  - Ground Operations and Services
  - Flight Operations and Services
- Site Security
  - Fencing and Barriers
  - Spaceport Access
  - Restricted Area Access
  - Security Systems
- Emergency Response Support
  - Law Enforcement
  - Aircraft Rescue and Firefighting
  - Medical Services
  - Evacuation Procedures
- Visitor Management
  - Visitor Accommodations and Services
  - Special Events
- Flight Safety
  - Safety Management System
  - Air Traffic Coordination
- Environmental Management
- Mission Readiness

IV.III Airspace Integration

One of the enduring challenges faced by all users of the U.S. national airspace system is making cost effective use of airspace by flying optimal flight paths that save fuel and flight times. Given the potential hazards associated with traditional expendable launch vehicles and the unproven and less than completely predictable nature of newer reusable launch vehicles, commercial space transportation operations in the U.S. are segregated from other operations that occur in the airspace to ensure safety.

This practice of segregating space launch operations through the use of temporary flight restrictions and activation of special warning areas, which disallow non-participating aircraft to enter therein, is not considered practical as the number of launch and reentry operations increases to a level of several per week, as some forecasts predict.[21] While the FAA explores ways to transition to a new paradigm that enables a less impactful, seamless integration of commercial space transportation operations into the national airspace, standards that set performance-based separation criteria between vehicles and other aircraft operating in the airspace are needed.

VII. CONCLUSION

U.S. commercial space transportation is experiencing unprecedented growth and expansion as new vehicles offer opportunities to space tourists and researchers alike, both public and private. While the U.S. industry's growth continues to trend upward, both in terms of the number of launch and reentry operations, and in the overall diversity of its capabilities, safety remains a top priority.

U.S. launch vehicle developers and manufacturers are now beginning to embrace the prospect of the development and use of voluntary consensus standards, particularly in the area of occupant safety, as a means of self-regulation. While it is yet to be determined how FAA/AST's regulatory program will eventually address human space flight safety, specifically occupant safety, the FAA views the industry's proactive approach to address critical issues by means of standards development as a positive step in the right direction.

REFERENCES

[1] Commercial Space Launch Act of 1984, Pub. L. No. 98-575, 98 Stat. 3942 (hereinafter CSLA)

[2] Title 14 Code of Federal Regulations (CFR) chapter III, Commercial Space Transportation, Federal Aviation Administration, Department of Transportation. http://www.faa.gov/about/office_org/headquarters_offices/ast/regulations/

[3] CSLA, *supra* note 1

[4] Suborbital Reusable Vehicles: A 10-Year Forecast of Market Demand, The Tauri Group (hereinafter, Tauri Study). http://www.faa.gov/about/office_org/headquarters_offices/ast/reports_studies/forecasts/

[5] "Atlantis Blasts Off on Final Flight for Space Shuttle Program" http://www.foxnews.com/scitech/2011/07/08/atlantis-blasts-off-on-final-flight-for-space-shuttle-program/

[6] "FAA issues first commercial re-entry license to SpaceX" http://spaceflightnow.com/falcon9/002/101122license/

[7] Tauri Study, supra note 4

[8] P.L. 104-113, the "National Technology Transfer and Advancement Act of 1995" (NTTAA) https://standards.gov/nttaa/agency/index.cfm?fuseaction=documents.PL104113

[9] *Id*

[10] *Id*

[11] http://www.whitehouse.gov/omb/circulars_a119/

[12] Commercial Space Launch Amendments Act of 2004, Pub. L. No. 108-492, 118 Stat. 3978

[13] Listner, Michael J., Sbogga, Tomasso, and Kunstadter, Christopher, "Taking a Page from Maritime Practice to Self-Regulate the Commercial Space Industry," The Space Review, March 4, 2013. http://www.thespacereview.com/article/2252/1

[14] *Id*

[15] http://waynehale.wordpress.com/ http://www.commerce.senate.gov/public/index.cfm?p=Hearings

[16] *Id*

[17] http://www.iso.org/iso/home.html

[18] http://www.sae.org/iaqg/

[19] http://www.coe-cst.org/research.html

[20] *Id*

[21] Tauri Study, *supra* note 4