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FAA SAFETY APPROVALS IN COMMERCIAL SPACE TRANSPORTATION

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A regulatory tool used by the United States called a safety approval may be appropriate for use internationally to enhance safety, enable the commercial space transportation industry, achieve greater interoperability, and streamline license applications. In the United States, the Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses, regulates, and promotes U.S. commercial space transportation including launch and reentry operations and the operation of spaceports. A safety approval can be issued by the FAA for a particular safety element of: a launch vehicle, a reentry vehicle, a safety system, process, service, or any identified component thereof, and qualified and trained personnel performing a process or function related to licensed launch activities. The FAA determines whether use of a safety element will jeopardize public health and safety, or safety of property, when used or employed within a defined envelope, parameter, or situation. A safety approval is voluntary. It does not provide any authority to conduct activities for which an FAA commercial space transportation license is required. One of the primary advantages of a safety approval is that launch and reentry vehicle operators can use an approved safety element without having to go through a re-examination of the element's fitness and suitability for a proposed launch or reentry operation as part of a license application process. This also allows a company or organization to develop an element independently as a potential business product and obtain a government stamp of approval. From a business perspective, an FAA Safety Approval can aid in the marketing of a unique space product that might traditionally be seen as an ordinary component or process in the larger scheme of a government space program. It can also spur innovation by creating a path for alternative approaches and enable a second tier supplier or service new industry growth opportunities in commercial space transportation. From an international perspective, adopting a safety approval regulation similar to the FAA's may increase interoperability with U.S. vehicles including spaceports operations. There are seven active FAA safety approvals in the U.S. in areas such as training for crew and spaceflight participants and technician credentialing. This paper will provide an overview of the FAA's safety approval regulation and its potential advantages, details of the FAA guide to apply for a safety approval, and examples of existing safety approvals.

I. INTRODUCTION

Historically in the U.S. commercial launch business, the cost of proposing a new safety system, process or service was the responsibility of the launch operator. The benefits of proving a new safety system with a relatively small number of launches did not necessarily outweigh the costs. Under an optional process called a Safety Approval established by the U.S. Congress in a 1998 amendment to the Commercial Space Launch Act, the monetary risk for approving a safety system or process can be borne by an individual component provider.

This enables a component manufacturer or service company to provide safety products to multiple launch or reentry providers and be approved in advance for use in future launches or reentries that are licensed by U.S. Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST).

Use of a voluntary Safety Approval can potentially spread financial risk, increase innovation, enable growth opportunities for component, process, and service providers, and streamline launch and reentry licensing for launch providers.

Safety Approvals can be used for a vehicle, safety system, process, service or a component; or for qualified personnel performing a process related to a launch license. Illustrations of component hardware could include telemetry and tracking systems, flight termination systems, a centrifuge, or an altitude chamber. A potential service could be training for flight crew and spaceflight participants.

Under the Commercial Space Launch Act of 1984, as amended (51 U.S.C. Chapter 509),[1] the Department of Transportation (through delegation to the FAA) is authorized to oversee, license, and regulate commercial launch and reentry activities and the operation of launch and reentry sites as carried out by United States citizens or within the United States.

The Commercial Space Launch Act directs the FAA to exercise this responsibility consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. The FAA is also responsible for encouraging, facilitating, and promoting commercial space launches by the private sector.

This paper will provide an overview of the FAA's safety approval regulation, potential advantages and benefits, details of an FAA guide for applicants, a list of active safety approvals, and considerations for regulators in international use.

II. SAFETY APPROVAL REGULATION

Authority for the FAA to issue Safety Approvals comes from a1998 amendment to the Commercial Space Launch Act which stated that the Secretary of Transportation may establish procedures for safety approval of launch vehicles, reentry vehicles, safety systems, processes, services, or personnel for use in conducting licensed commercial space launch or reentry activities.

After passage of another amendment to the Commercial Space Launch Act in 2004 related to human space flight, the FAA issued a Notice of Proposed Rulemaking. Following a public comment period, the final rule for Safety Approvals was published in 2006.

The text of the regulation for Safety Approvals is contained in U.S. Code of Federal Regulations (CFR), Part 414 and available on the FAA website.[2]

Also available on the FAA website for additional context is the Final Rule and Notice of Proposed Rulemaking.[3]

As defined in the regulation, a *Safety Approval* is an FAA determination that one or more safety elements, when used or employed within a defined envelope, parameter, or situation, will not jeopardize public health and safety, or safety of property. A safety approval may be issued independent of a license, and it does not confer any authority to conduct activities for which a license is required under 14 CFR chapter III.

A Safety Approval does not relieve its holder of the duty to comply with all applicable requirements of law or regulation that may apply to the holder's activities.[4]

A S*afety Element* is defined as a launch or reentry vehicle, safety system, process, service, or any identified component thereof; or qualified and trained personnel, performing a process or function related to licensed launch activities or vehicles.[5]

Eligibility for a Safety Approval is as follows:

"(a) There is no citizenship requirement to obtain a safety approval.
(b) You may be eligible for a safety approval if you are—
(1) A manufacturer or designer of a launch or reentry vehicle or component thereof;
(2) The designer or developer of a safety system or process; or
(3) Personnel who perform safety critical functions in conducting a licensed launch or reentry.
(c) A safety approval applicant must have sufficient knowledge and expertise to show that the design and operation of the safety element for which safety approval is sought qualify for a safety approval.
(d) Only the safety elements defined under this part are eligible for a safety approval."[6]

It is important to note that a Safety Approval is voluntary. The FAA does not charge fees for licensing, permits, or Safety Approvals.

Applicants can designate proprietary information in their applications as confidential.[7]

Criteria for reviewing a Safety Approval application are as follows:
"(a) The FAA will determine whether a safety element is eligible for and may be issued a safety approval. We will base our determination on performance-based criteria, against which we may assess the effect on public health and safety and on safety of property, in the following hierarchy:
(1) FAA or other appropriate Federal regulations.
(2) Government-developed or adopted standards.
(3) Industry consensus performance-based criteria or standard.
(4) Applicant-developed criteria. Applicant-developed criteria are performance standards customized by the manufacturer that intends to produce the system, system component, or part. The applicant-developed criteria must define—
(i) Design and minimum performance;
(ii) Quality assurance system requirements;
(iii) Production acceptance test specifications; and
(iv) Continued operational safety monitoring system characteristics.
(b) The applicant must allow the FAA to make its proposed safety approval criteria available to the public as part of the approval process."[8]

Once approved by the FAA, a Safety Approval is valid for five years and can be renewed. It can also be transferred. A holder of a Safety Approval is required to cooperate with compliance monitoring responsibilities of the FAA such as access to inspect manufacturing or assembly. FAA inspection ensures that operational and safety obligations, as outlined in each Safety Approval, are adhered to.

III. ADVANTAGES OF A SAFETY APPROVAL

One of the primary advantages of a Safety Approval is that in most cases, launch and reentry vehicle operators can use an approved safety element without having to go through a re-examination of the element's fitness and suitability for a proposed launch or reentry operation as part of a license application process. This can potentially reduce the time it takes the FAA to issue a launch or reentry license.

For example, development of a new flight termination system (FTS) for an expendable launch vehicle takes a significant amount of time for both the FAA and a commercial provider to review and approve design, test environments, test plans and procedures, and final test results. Components are tested in the flight representative configuration with all mounting hardware (such as shock isolators, brackets, and bolts).

Once approved by the FAA, the FTS can be used on another launch vehicle if: the new launch environments are less severe than previously qualified environments; the component is mounted in the same manner; and other factors are reviewed, such as cable thickness and clamp location. Otherwise, additional acceptance and qualification testing can be performed to satisfy the new environments, mounting configurations, or cable harness configurations.

Risk analysis required by the FAA in its regulations could also be looked at in advance with a Safety Approval.

Another advantage of a Safety Approval is that it allows a company or organization to develop an element independently as a potential business product and obtain a government stamp of approval. The holder of a Safety Approval will be able to market their component or process as approved by the FAA and offer it to multiple launch or reentry providers.

Safety Approvals may also spur innovation by creating a path for alternative approaches and enable a second-tier supplier or service new industry growth opportunities in commercial space transportation. These potential products may traditionally have been

viewed as an ordinary component or process in the larger scheme of a government or commercial space program.

Development cost may also be shared through spread risk rather than borne by a single launch operator. Other federal agencies that operate federal ranges or provide related support equipment or services may also be customers of products that come from Safety Approvals.

Furthermore, enabling other companies, as holders of Safety Approvals, to provide specialized and approved components or services such as safety training for space flight participants may allow a space transportation vehicle operator to focus resources on their vehicle.

Voluntary consensus standards prepared by industry could also be reviewed by the FAA through a Safety Approval. FAA/AST has an interest in seeing industry succeed in developing voluntary consensus standards.

An FAA/AST Safety Approval is not an FAA "certification" in the traditional aviation sense because the FAA does not certify launch or reentry vehicles or spaceports, but instead licenses their operation for public safety reasons.

IV. GUIDE FOR APPLICANTS

To help industry apply for a Safety Approval, the FAA published a 21-page "Safety Approval Guide for Applicants" that is publicly available on the FAA website.[9]

The guide covers several topics including: who and what is eligible to obtain a Safety Approval, what a safety approval does not cover, how applications are screened, performance and verification requirements that may be required, and other details on how to prepare an application.

An applicant may need to provide information on potential hazards and risks to public safety posed by use of the approved safety element or provide engineering and safety analysis or test results. The FAA determines on a case-by-case basis whether a safety element is eligible for a safety approval.

The FAA will verify and validate performance before issuing a safety approval. Applicants may need to identify methods of verification such as demonstration, analysis, inspection, and testing, and develop other procedures or reports as documentation.

Similar to FAA permit and license applications, the FAA requires a "pre-application consultation" before an application is submitted. Consultation is beneficial to both the FAA and the applicant and in general can increase the speed of the FAA determination.

The guide identifies some widely available sources of standards and practices (such as those used by the Air Force or the American Society of Mechanical Engineers) that the FAA may rely upon in its evaluation. However, the guide also notes that appropriate standards and practices may not exist (or may not be feasible to develop) and therefore it may be necessary to follow an "individualized approach" to safety approvals.[10]

V. ACTIVE SAFETY APPROVALS

As of fall 2015, there are seven active Safety Approvals that have been granted by the FAA (See Table 1). The FAA website provides details for each Safety Approval.[11]

The published Safety Approval for the Zero Gravity Corporation, as an example, lists a scope of three separate parabolic flight profiles and requirements for maintenance, calibration of accelerometers and recording devices, and reporting of anomalies affecting their acceleration measurement system.

The SpaceTEC Safety Approval covers a certified aerospace technician credentialing process including aerospace vehicle processing, aerospace manufacturing, and aerospace composites.

Many active Safety Approvals are related to the emerging commercial human space flight industry. Virgin Galactic and XCOR Aerospace combined have reported over 1,000 tickets sold or deposits received for commercial suborbital space flight as of mid-2015. Several other companies are developing new expendable and reusable launch vehicles and services.[12]

Other technologies that may be appropriate for Safety Approvals include mobile tracking and telemetry ranges for spaceports or flight termination systems.

In addition to those listed in Table 1, the FAA is currently working with several new potential applicants in the pre-application consultation phase.

Company	*Purpose*	*Expiration*	*Type*
National Aerospace Research and Training Center	Space Training System Model 400 to replicate flight profiles	April 6, 2020	Simulation
Waypoint 2 Space, Incorporated	Commercial Space Training Service	January 22, 2019	Training
Black Sky Training	Crew and Spaceflight Participant Training	January 21, 2019	Training
Black Sky Training	Scenario Based Physiology Training	March 27, 2018	Training
National Aerospace Training and Research Center	Falcon 12/4 Altitude Chamber to replicate pressure	September 10, 2017	Simulation
Space TEC Partners Incorporated	Certified Aerospace Technician Credentialing Process	June 9, 2016	Certification
Zero Gravity Corporation	Reduced Gravity Parabolic Flight	April 19, 2016	Flight Test

Table 1. Active FAA Safety Approvals

VI. The NASTAR Center

The National Aerospace Research and Training (NASTAR) Center, located in Southampton, Pennsylvania, is an example of how use of FAA Safety Approvals has expanded business opportunities.[13] The NASTAR Center, owned by Environmental Tectonics Corporation, was granted the first FAA Safety Approval in 2010 for a centrifuge used to simulate flights called the Space Training System: Model 400. A second Safety Approval for a high altitude chamber was also granted.

Using flight profile and gravity load data from launch operators, the NASTAR Center provides simulated space flight training using a centrifuge, along with other training to meet applicable FAA suborbital and orbital crew qualification and training requirements (as detailed in 14 CFR § 460.5) for human space flight crew qualification and training.

The NASTAR Center's FAA Safety Approval has enabled the company to attract suborbital and orbital space flight companies, increasing their business base that also specializes in providing civil and military aviation training, research testing and educational programming for teachers and students. The company is the only non-government facility in the world that specializes in the application of acceleration and g-force exposure.

Nearly 500 future commercial crew and space flight participants have been trained at the NASTAR Center since 2007, including 350 that have signed up after the 2010 FAA Safety Approval designation.[14] In addition to courses in space suit and systems training, suborbital payload specialist training, and other advanced training, NASTAR offers a two-day basic training class for suborbital travelers in such areas as life support systems and suits, g-tolerance flights and simulated space flights, space safety and emergency procedures, and physiological and psychological effects of space flight.

Holding a Safety Approval, according to NASTAR, "benefits the entire Commercial Space Industry by having a pre-approved program that meets the Crew Qualification and Training Requirements rather than spending the time and cost involved in doing it themselves. It also paves the way for other organizations in obtaining launch license approvals quicker."[15]

VII. INTERNATIONAL CONSIDERATIONS

For countries considering development of commercial space transportation regulations or development of new spaceports or vehicles, a Safety Approval could be a useful tool. As commercial industry expands, compatibility between nations will become more valuable to government regulators and industry operators. Recognition of existing U.S. safety approvals or adopting a safety approval regulation similar to the FAA's may increase

interoperability with U.S. vehicles and/or spaceport operations.

In addition to increasing safety overall, a commercial approach that has undergone a safety approval in one country could have potential for faster adoption in another country, especially if no equivalent government standard or approach is established. Similar to the FAA approach, having a safety approval regulation in place may enable domestic industry to further promote the sale of their products and potentially streamline some regulatory procedures for domestic launch vehicle or spaceport applicants that use pre-approved products.

Non-U.S. citizens and non-U.S. companies can apply for a Safety Approval from the FAA. The FAA makes Safety Approval determinations on a case-by-case basis.

Because the commercial space transportation industry is constantly changing, the FAA encourages international space agencies and regulators to meet with the FAA to learn more about its regulations that continue to evolve as the industry grows and develops.

VIII. CONCLUSION

An FAA Safety Approval has the potential to increase safety and technical innovation, expand an existing business, and streamline FAA licensing for launch and reentry providers in commercial space transportation. Cost risk for some safety components and processes or training may be able to be borne by the holder of a Safety Approval to the later benefit of multiple launch providers or spaceports.

A Safety Approval is a relatively new regulatory tool that international regulators may consider adopting for use in the commercial space transportation industry, not only for traditional expendable launch vehicles and space launch sites, but also for new space vehicles that carry people.

The FAA encourages spaceports and launch and reentry vehicle providers to in turn encourage their component suppliers and other service providers to apply for Safety Approvals.

[1] See Commercial Space Act, as amended (51 USC Ch. 509).Available at : http://uscode.house.gov/view.xhtml?path=/prelim@title51/subtitle5/chapter509&edition=prelim

[2] See Title 14 CFR, Chapter III, Part 414 available at http://www.faa.gov/about/office_org/headquarters_offices/ast/regulations/ See also the Federal Register, Vol. 71, No. 157, August 15, 2006, page 46853.

[3] See the Final Rule, NPRM and other documents at: http://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/safety_approvals/

[4] Title 14 CFR, Chapter III, Part 414 available at http://www.faa.gov/about/office_org/headquarters_offices/ast/regulations/ See also the Federal Register, Vol. 71, No. 157, August 15, 2006, page 46853, Section 414.3.

[5] Ibid. Section 414.3.

[6] Ibid. Section 414.7.

[7] According to the FAA regulation in Part 414.13(c) "Data or information for which confidential treatment is requested or data or information that qualifies for exemption under section 552(b)(4) of Title 5, U.S.C., will not be disclosed to the public unless the Associate Administrator determines that withholding the data or information is contrary to the public or national interest.

[8] FAA CFR Part 414.19, "Technical criteria for reviewing a safety approval application." Available at http://www.faa.gov/about/office_org/headquarters_offices/ast/regulations/

[9] "Safety Approval Guide for Applicants," Version 1.1, Federal Aviation Administration, July 20, 2012. Available at:

http://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/safety_approvals/

[10] Ibid. Page 6.

[11] See: http://www.faa.gov/data_research/commercial_space_data/safety_approvals/

[12] For more information about U.S. commercial vehicles and launch sites, see the "Annual Compendium for Commercial Space Transportation," available at: http://www.faa.gov/about/office_org/headquarters_offices/ast/reports_studies/

[13] http://www.nastarcenter.com

[14] NASTAR Center, electronic mail, September 2015.

[15] NASTAR, April 7, 2010, http://www.nastarcenter.com/about-us/faa-approval/