Draft Guidelines for Commercial Suborbital Reusable Launch Vehicle Operations with Space Flight Participants

Federal Aviation Administration
Office of Commercial Space Transportation
800 Independence Avenue, Room 331
Washington, DC 20591

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1. Introduction

On December 23, 2004, President Bush signed into law the Commercial Space Launch Amendments Act of 2004 (CSLAA). The CSLAA promotes the development of the emerging commercial space flight industry and makes the Department of Transportation and the Federal Aviation Administration (DOT/FAA) responsible for regulating commercial human space flight under 49 U.S.C. Subtitle IX, Chapter 701 (Chapter 701).

The CSLAA requires a phased approach to regulating commercial human space flight; that is, regulatory standards governing human space flight must evolve as the industry matures. Because the commercial human space flight industry is in its early stages, the CSLAA is based on principles of informed consent and voluntary assumption of risk by space flight participants. A reusable launch vehicle (RLV) operator must inform any space flight participant of the risks associated with launch and reentry activities. In turn, a space flight participant must provide written, informed consent as a way of showing that he or she understands and voluntarily accepts the risks associated with participating in space launch activities.

In the near term, the CSLAA requires that the DOT/FAA: (1) issue guidelines or advisory circulars to guide the implementation of the CSLAA as soon as practical after the date of its enactment on December 23, 2004; (2) issue proposed regulations that include those relating to crew, space flight participants, and permits for launch or reentry of reusable suborbital rockets not later than December 23, 2005; and (3) issue final regulations not later than June 23, 2006.

2. Purpose

These guidelines fulfill the DOT/FAA's requirement to provide guidance on the implementation of the CSLAA before the agency issues regulations related to space flight participants. These guidelines address what the DOT/FAA may expect to review and evaluate in an application for a license or permit for a launch of any space flight participant.[1]

3. Scope

These guidelines address space flight participants on a suborbital RLV. Guidelines concerning flight crew are issued separately in "Guidelines For Commercial Suborbital Reusable Launch Vehicle Operations With Flight Crew," dated February 11, 2005.

[1] Under the CSLAA, a person may apply for an experimental permit for reusable suborbital rockets for purposes of research and development, and to test new design concepts, equipment, or operating techniques. An RLV operator may also use an experimental permit to show compliance with regulatory requirements or to train crew before obtaining a license. The DOT/FAA must decide whether to issue a permit within 120 days after receipt of an application. In contrast, the agency has 180 days to make a licensing determination. Because a permit is expected to be granted more quickly and with fewer requirements than a license, no person may operate a reusable suborbital rocket under a permit for carrying any property or human being for compensation or hire. No such restriction applies for a license.

4. Applicability

These guidelines apply to any RLV operator licensed or permitted under Chapter 701 who proposes to carry a space flight participant. The guidelines also apply to any space flight participant on board a suborbital RLV.

5. Definitions

Space flight participant	An individual, who is not crew, carried within a launch vehicle or reentry vehicle. 49 U.S.C. § 70102(17).
Flight crew[2]	Any employee of a licensee or transferee, or of a contractor or subcontractor of a licensee or transferee, who is on board a launch or reentry vehicle and performs activities in the course of that employment directly relating to the launch, reentry, or other operation of the launch vehicle or reentry vehicle. See 49 U.S.C. § 70102(2) (defining crew).
Suborbital rocket	A vehicle, rocket-propelled in whole or in part, intended for flight on a suborbital trajectory, and the thrust of which is greater than its lift for the majority of the rocket-powered portion of its ascent. 49 U.S.C. § 70102(19).
Suborbital trajectory	The intentional flight path of a launch vehicle, reentry vehicle, or any portion thereof, whose vacuum instantaneous impact point does not leave the surface of the Earth. 49 U.S.C. § 70102(20).

6. Informing Space Flight Participant of the Risks

a. The CSLAA requires that a licensed or permitted RLV operator inform a space flight participant in writing about the risks of the launch and reentry, including the safety record of the launch or reentry vehicle type. 49 U.S.C. § 70105(b)(5)(A).

(1) An RLV operator should disclose to a space flight participant in writing the known hazards and risks associated with a mission, and should include nominal and non-nominal launch operations. The RLV operator should describe these hazards and risks in a manner that is understandable to the space flight participant. This description should include the likelihood and consequences of any reasonably foreseeable hazardous event and safety-critical system failures that could result in a serious injury or death to the space flight participant. The RLV operator should inform any space flight participant

[2] The CSLAA defines crew as "any employee of a licensee or transferee, or of a contractor or subcontractor of a licensee or transferee, who performs activities in the course of that employment directly relating to the launch, reentry, or other operation of or in a launch vehicle or reentry vehicle that carries human beings.'' 49 U.S.C. § 70102(2). Because this definition in the CSLAA does not distinguish between ground crew and crew on board a vehicle, these guidelines use the term "flight crew" to distinguish between the two types of crew.

that the space flight may result in his or her death, serious injury, disability, and total or partial loss of physical and mental function.

Rationale: To be fully informed, a space flight participant must be aware of the possible consequences. The FAA's recommended description encompasses those consequences. Presenting the information in a manner that is understandable to the space flight participant helps the space flight participant make an informed decision on whether to be on board a launch or reentry vehicle.

(2) An RLV operator should describe to each space flight participant the safety record of all launch or reentry vehicles that have carried one or more persons on board, including both U.S. government and private sector vehicles. The safety record should not be limited to only the vehicles of a particular RLV operator.

An RLV operator should also describe the safety record of its vehicle to each space flight participant. The RLV operator's safety record should include vehicle ground-test and flight-test information. This information should describe all safety-related anomalies or failures that occurred and corrective actions taken to resolve the anomalies or failures.

Rationale: The development of commercial launch vehicles to carry space flight participants is in the embryonic or early stages. Consequently, newly developed launch vehicles will not have the extensive flight-test history or operational experience that exists for commercial airplanes. Because of the lack of flight-test and operational experience, the risks of the RLV operator's particular launch vehicle and of vehicles like it, including both government and private sector vehicles, should be disclosed. The House Committee on Science report, H. Rep. 108-429, clarifies that Congress intended all government and private sector vehicles to be included in this description. Because most human space flight to date has taken place under government auspices, the government safety record provides the most data. The RLV operator should provide a record of all vehicles that have carried a person because they are the most relevant to what the RLV operators propose. Regardless of whether humans traveled to space on board a vehicle destined for a suborbital or orbital mission, those persons traveled on vehicles based on technology as new then as what may be developed now. It was therefore as risky. Likewise, because it was intended for a human on board, greater care was likely to have been taken in its design and construction. The same should be expected for commercial human space flight.

(3) The RLV operator should provide space flight participants an opportunity to ask questions orally to acquire a better understanding of the hazards and risks of the mission.

Rationale: An opportunity to ask questions allows a space flight participant a chance to get clarification on any information that may be confusing or unclear.

b. The CSLAA requires that before receiving compensation from a space flight participant or making an agreement to fly a space flight participant, an RLV operator inform the space

flight participant in writing that the U.S. Government has not certified the launch vehicle as safe for carrying crew or space flight participants. 49 U.S.C. § 70105(b)(5)(B).

In addition, the RLV operator should have a placard displayed in the launch vehicle in full view of all space flight participants to warn that the launch vehicle does not meet aircraft certification standards.

Rationale: The CLSAA requires that an RLV operator provide a space flight participant the information regarding the lack of government certification. Additionally, a warning placard emphasizes or notifies a space flight participant about the risky nature of the launch vehicle by differentiating it from certificated aircraft.

7. Written Informed Consent and Compliance

a. The CSLAA requires that each space flight participant provide written informed consent to participate in the launch and reentry. 49 U.S.C. § 70105(b)(5)(C).

The RLV operator should prepare a written informed consent for the review and signature of a space flight participant. The written informed consent should:

(1) State when the RLV operator informed the space flight participant in writing about the hazards and risks of the mission, including the safety record of the launch vehicle type.
(2) Identify the specific launch vehicle to which it applies.
(3) State that space flight participant presence on board the launch vehicle is voluntary.
(4) Be written in plain language.
(5) Be signed and dated by the space flight participant at the time of consent.
(6) Specify conditions under which informed consent remains valid (e.g., as long as the information provided by the RLV operator, which the informed consent is based on, does not change substantially).
(7) Not relieve the RLV operator of responsibility for gross negligence.

Rationale: The informed consent document needs to be written in a manner that the space flight participant can understand. It should also clearly identify that to which the space flight participant consents. The date that the space flight participant signs the written consent form is necessary because if the launch vehicle or other information changes the informed consent process should be updated and repeated.

b. Each space flight participant should provide written certification of compliance with the physical examination described in paragraph 8 below. 49 U.S.C. § 70105(b)(5)(C).

8. Physical Examination

Each space flight participant should provide his or her medical history to a physician experienced or trained in the concepts of aerospace medicine. The physician should determine whether the space flight participant should undergo an appropriate physical examination before boarding a vehicle licensed or permitted under chapter 701. 49 U.S.C. § 70105(b)(6)(A).

Guidance for the medical assessment of space flight participants is provided in a memorandum[3], "Guidance for Medical Screening of Commercial Aerospace Space Flight Participants," dated March 31, 2003. This guidance was developed by the Civil Aerospace Medical Institute (CAMI) of the FAA's Office of Aerospace Medicine (AAM).

Rationale: Medical conditions that may contraindicate individuals from participating in a mission should be identified so that participation may be avoided where a space flight participant's involvement in a mission could aggravate or exacerbate a pre-existing medical condition that could put the flight crew or other space flight participants at risk.

9. Reciprocal Waiver of Claims

The CSLAA requires that each space flight participant execute a reciprocal waiver of claims with the DOT/FAA. 49 U.S.C. § 70112(b)(2).

10. Training

The RLV operator should provide safety training to each space flight participant prior to flight on how to respond to any credible emergency situations, which may include but are not limited to cabin depressurization, fire, smoke, and emergency egress.

Rationale: Where emergency situations may be reasonably foreseen, the RLV operator should have provisions for mitigating the effects of such emergencies. Providing safety training to space flight participants can ensure that, should an emergency situation arise, the space flight participants will have a chance of survival. Furthermore, proper training can reduce the chances of panic occurring, which could interfere with the flight crew's response to emergency situations.

11. Security

The RLV operator should implement security requirements to prevent any space flight participant from jeopardizing the safety of the crew, any other space flight participant on board, and the uninvolved public.

Rationale: Security restrictions apply to passengers for airlines where a person carrying explosives, firearms, knives, or other weapons is not permitted on board an airplane. Similar

[3] This guidance was provided to the Associate Administrator for Commercial Space Transportation in a memorandum from the Civil Aerospace Medical Institute (CAMI) Director and Federal Air Surgeon of the FAA's Office of Aerospace Medicine (AAM).

types of security restrictions for RLVs would contribute to the safety of the uninvolved public by preventing a space flight participant from potentially interfering with the crew's operation of the vehicle. Any such interference might jeopardize the crew's ability to protect the public.

12. Verification Program

A verification program sufficient to verify the integrated performance of a vehicle's hardware and any software in an operational flight environment should be successfully completed before allowing any space flight participant on board during a flight. The verification program should include flight testing.

Rationale: The initial flights and envelope expansion flights of a new vehicle typically pose the highest risk. Although flight testing does not eliminate risk, it does mitigate risk by potentially uncovering some safety-related problems that may go undetected if only analyses and ground testing were conducted. Verification of performance by flight testing can provide more information than ground testing and analyses and should be conducted to the maximum extent possible. Ground testing and analyses are often based on estimates and approximations, and may not fully simulate possible subsystem interactions in flight environments or may not accurately simulate actual flight conditions. Flight testing is necessary to verify the integrated performance of the vehicle's hardware and software in the operational flight environment. Furthermore, flight testing provides data to validate mathematical tools and models used to predict environments and responses.

Detailed descriptions of what constitutes a successful verification program exceed the scope of these guidelines.[4] The FAA will initially determine the amount of verification and, specifically, flight testing of RLVs on a case-by-case basis. The appropriate level of testing depends on many factors, including the vehicle's mission profile, operational restrictions, test and flight history, component and subsystem heritage, and design and operating margins.

[4] Information and guidance regarding RLV safety validation and verification planning are provided in the FAA/AST document, "Guide to Reusable Launch Vehicle Safety Validation and Verification Planning," Version 1.0, September 2003.