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Overview of FAA Commercial Human Space Flight (HSF) Regulations

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Purpose

Provide overview of commercial human space flight (HSF) requirements:

- Background (statutory authority on FAA regulating commercial HSF, legislative moratorium, and definitions).
- 14 CFR part 460 HSF regulations for crew and space flight participants (SFPs).
- Preparation for future HSF regulations.

Background

Statutory Authority

- Commercial Space Launch Act of 1984 (CSLA)—
  - Authorized Secretary of Transportation to license launches and operation of launch sites as carried out by U.S. citizens or within the United States.
  - Initially drafted with commercial expendable launch vehicle (ELV) operations in mind.
  - Was subsequently amended.
- CSLA Amendments of 1988—
  - Revised insurance requirements and created a framework to govern third-party liability compensation.
- Commercial Space Act of 1998—
  - Extended licensing authority under CSLA to reentry vehicle operations and operation of reentry sites by non-Federal entities.
- Commercial Space Launch Amendments Act of 2004 (CSLAA) —
  - Made FAA responsible for regulating commercial human space flight but with restrictions.
  - Established an experimental permit regime for developmental reusable suborbital rockets.
- Commercial Space Launch Competitiveness Act (CSLCA) of 2015
  - Added government astronaut as a new category of person on board vehicle where launch or reentry is licensed by FAA.
  - Required licensee to enter into a reciprocal waiver of claims agreement with SFP.

HSF Moratorium

- **Since passage of 2004 CSLAA, a "learning period" referred to as a "moratorium" has limited FAA's authority to regulate occupant safety.**
  - Prohibited FAA from promulgating any regulations governing design or operation of a launch vehicle intended to protect health and safety of crew, government astronauts, and SFPs, absent a serious or fatal injury, or an unplanned event during a launch or reentry.
  - However, FAA has authority to protect crew when they are needed to perform safety critical roles to protect the public.
- **Congress extended this legislative "moratorium" multiple times.**
  - Therefore, current FAA HSF regulatory framework is based on informed consent and protecting the public (those not involved with the launch or reentry).

Who Needs License or Permit from FAA

- **An entity must obtain a license:**
  - To ***launch*** a launch vehicle from the United States;
  - To ***operate*** a launch or reentry site within the United States;
  - To ***reenter*** a reentry vehicle in the United States.
- **An entity must obtain an experimental permit:**
  - To launch a reusable suborbital vehicle from the United States for research and development, or prior to obtaining a launch license, to show compliance with requirements for a license or crew training.
- **A U.S. citizen or an entity organized under the laws of the United States or any State must obtain a license:**
  - To launch a launch vehicle outside the United States;
  - To operate a launch or reentry site outside of the United States; or
  - To reenter a reentry vehicle outside of the United States.
- **FAA does not license launches or reentries carried out by and for the US Government**
  - NASA and the Department of Defense often carry out their own launches.

Key Launch and Reentry Regulations

Parts 415–Launch License
Parts 417–Launch Safety } ELV Launches

Part 431–Launch and Reentry of a Reusable Launch Vehicle (RLV)

Part 435–Reentry of a Reentry Vehicle Other than a Reusable Launch Vehicle (RLV)

Part 437–Experimental Permits

Part 440–Financial Responsibility

Part 450–Launch and Reentry License Requirements

Part 460–Human Space Flight Requirements

Notes:

1. *Part 460 applies to other parts if HSF is involved. For example, an applicant applying for a vehicle operator license under part 450 would also have to comply with part 460 if it proposes to carry crew or SFP on its vehicle.*
2. *Parts 415, 417, 431, and 435 will be removed from the CFR on March 10, 2026. After that time, all operators must demonstrate compliance with part 450. See 85 FR 79566.*

HSF Definitions

§ **401.7 Definitions**

- ***Crew*** – any employee or independent contractor of a licensee or permittee, or of a contractor or subcontractor of a licensee or permittee, who performs activities in the course of that employment or contract directly relating to launch, reentry, or other operation of or in a launch vehicle or reentry vehicle that carries human beings. Crew consists of flight crew and any remote operator.
- ***Flight Crew*** – crew on board a vehicle during a launch or reentry.
- ***Pilot*** – flight crew member with ability to control, in real time, a launch or reentry vehicle's flight path.
- ***Remote Operator*** – crew member who (1) has ability to control, in real time, a launch or reentry vehicle's flight path; and (2) is not on board controlled vehicle.
- ***Space Flight Participant (SFP)*** – an individual, who is not crew, carried aboard a launch vehicle or reentry vehicle.

Government Astronaut

- **Under 51 U.S.C. § 50902, government astronaut means an individual who—**

  (a) is designated by NASA under section 20113(n)

  (b) is carried within a launch vehicle or reentry vehicle in the course of their employment, which may include performance of activities directly relating to the launch, reentry, or other operation of the launch vehicle or reentry vehicle; and

  (c) is either—

  (i) an employee of the United States Government, including the uniformed services, engaged in the performance of a Federal function under authority of law or an Executive act; or

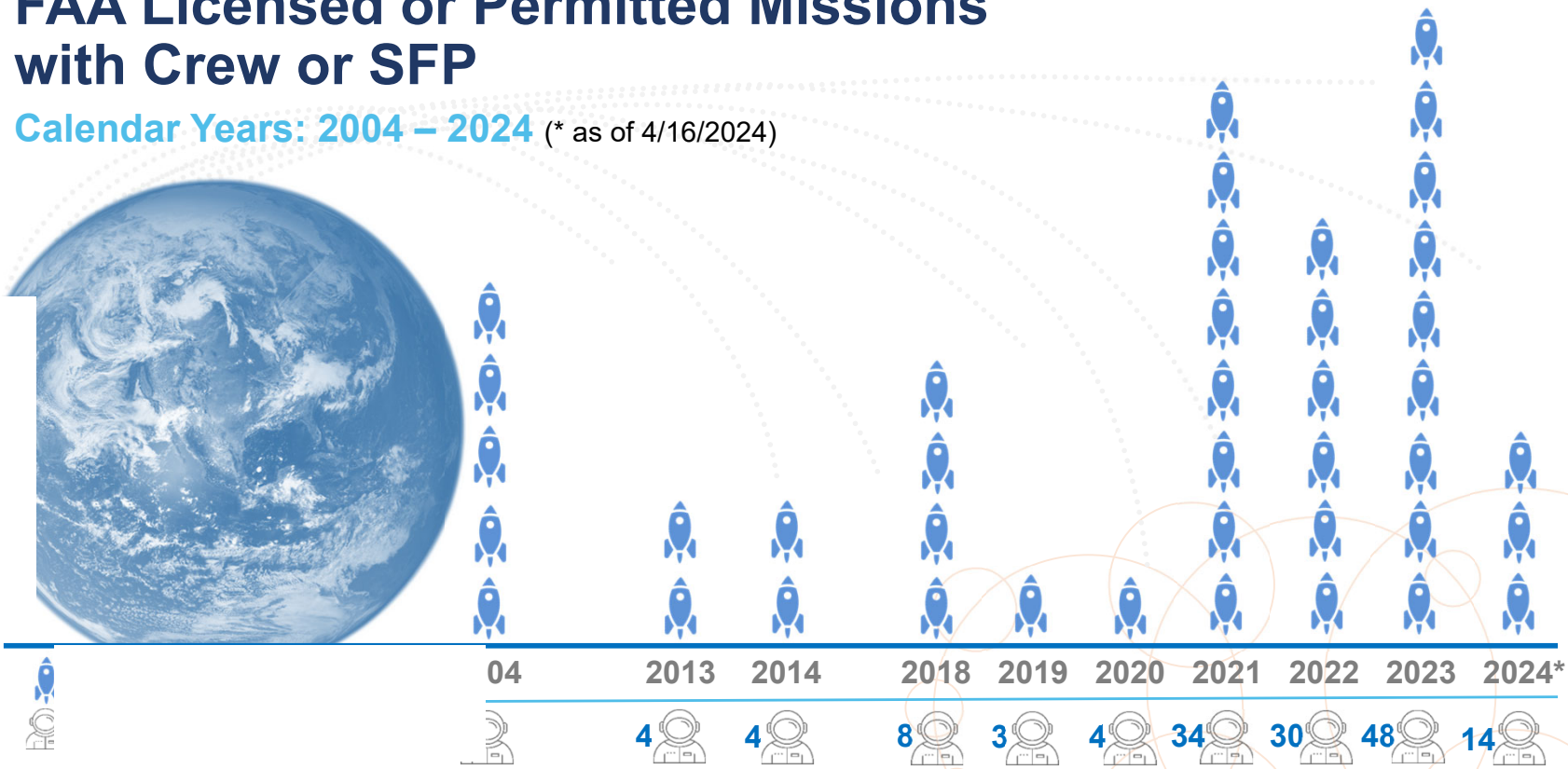
  (ii) an international partner astronaut.

Government Astronaut (continued)

- **Prior to CSLCA of 2015, government astronauts were categorized as SFPs and not crew because they were not employees of the licensee or transferee or of a contractor or subcontractor of a licensee or transferee.**
  - This categorization, however, presented issues (e.g., signing of waiver of claims by SFP but not by government astronaut).
- **FAA published Notice of Proposed Rulemaking (NPRM) in Federal Register on 8/18/2023 (88 FR 56546), to incorporate various changes required by CSLCA.**
  - Proposed rule is to provide regulatory clarity to applicants seeking licenses for space flight operations involving government astronauts.

FAA Licensed or Permitted Missions with Crew or SFP

Calendar Years: 2004 – 2024 (* as of 4/16/2024)



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Launch and Reentry With Crew

Subpart A of part 460 applies to launch and reentry with flight crew or employs a remote operator of a vehicle with a human on board.

- § 460.5 Crew qualifications and training
- § 460.7 Operator training of crew
- § 460.9 Informing crew of risk
- § 460.11 Environmental control and life support systems
- § 460.13 Smoke detection and fire suppression
- § 460.15 Human factors
- § 460.17 Verification program
- § 460.19 Crew waiver of claims against U.S. Government

Crew Training

§ 460.5(a): Each crew member must—

- Complete training on how to carry out their role so that vehicle will not harm the public.
- Train for their role in nominal and non-nominal conditions that include abort scenarios and emergency operations.

Note: Crew training is focused on protecting the public.

Pilot and Remote Operator Qualifications

- **§ 460.5(c)(1) and (2):** Pilot and remote operator of a launch or reentry vehicle must—
  - Possess and carry an FAA pilot certificate with an instrument rating.[1]
  - Possess aeronautical knowledge, experience, and skills necessary to pilot and control launch or reentry vehicle in National Airspace System (NAS).

[1]Remote operator may demonstrate an equivalent level of safety.

Pilot and Remote Operator Training

- **Vehicle and mission-specific training:**
  - Only possessing a pilot certificate may not be sufficient to pilot a launch vehicle that has operational and vehicle specific characteristics different from those of an aircraft.
    - Hence, **§ 460.5(c)(3)** also requires a pilot and remote operator to receive vehicle and mission-specific training that includes simulation training, training on a similar aircraft, flight testing, or another training method approved by the FAA.

Pilot and Remote Operator Training (continued)

- **§ 460.5(c)(4) and (5):** Pilot and remote operator must—
  - Train in procedures that direct vehicle away from the public if flight crew abandons vehicle during flight; and
  - Train for each mode of control or propulsion, including any transition between modes, such that pilot or remote operator is able to control vehicle.

Medical Requirements for Crew

- **§ 460.5(e):** Each crew member with a safety-critical role must possess and carry an FAA second-class airman medical certificate issued in accordance with 14 CFR part 67, no more than 12 months prior to month of launch and reentry.
- **Additional Requirement:** Because 2nd class medical certification may not be sufficient for space flight, FAA also established a performance standard with § 460.5(b) that requires flight crew to demonstrate an ability to withstand stresses of space flight so that vehicle will not harm the public.
  - Stresses experienced in space flight may include high acceleration or deceleration, microgravity, and vibration.

Operator Training of Crew

- **§ 460.7:** Operator must—
  - Train each crew member and define standards for successful completion in accordance with § 460.5.
  - Ensure crew-training device realistically represents vehicle's configuration and mission, or inform crew of the differences.
  - Update crew training by incorporating lessons learned from training and operational missions and document completed training for each crew member.
  - Establish recurrent training schedule and ensure § 460.5 crew qualifications and training are current before launch and reentry.

Environmental Control and Life Support Systems (ECLSS)

- **§ 460.11(a):** Operator must provide atmospheric conditions adequate to sustain life and consciousness for all inhabited areas within a vehicle, and operator or flight crew must monitor and control atmospheric conditions in inhabited areas.

> *Note: Proper environmental control is essential for flight crew to perform their safety critical roles and for functioning of safety-critical equipment on board a vehicle.*

ECLSS (continued)

- **§ 460.11(b):** Operator must provide redundant or secondary oxygen supply for flight crew.
  - Flight crew need to have sufficient oxygen to function if primary atmospheric control system were to fail.
- **§ 460.11(c):** Operator must—
  - Provide redundant means of preventing cabin depressurization; or
  - Prevent incapacitation of flight crew if loss of cabin pressure occurs.
    - This performance standard may be satisfied by different means (e.g., use of dual pane windows, dual seals on cabin pass-throughs, pressure suit).

Informing Crew of Risk

- **§ 460.9 Informing crew of risk:** Operator must inform crew in writing that U.S. Government has not certified launch or reentry vehicle as safe for carrying flight crew or SFPs).
  - Operator must provide this notification before employing someone as crew or, if individual is already employed by operator, as soon as possible and before any launch in which that person will serve as crew.

Smoke Detection and Fire Suppression

- **§ 460.15 Smoke Detection and Fire Suppression:** Operator or crew must have ability to detect smoke and suppress a cabin fire to prevent incapacitation of flight crew.
  - Prior to a fire occurring, smoke can rapidly incapacitate a pilot or obscure the pilot's vision such that the vehicle cannot be flown safely.
  - Crew should be able to respond to a vehicle fire so as not to risk the public.

Human Factors

- **§ 460.15 Human Factors:** Operator must account for human factors that can affect a crew's ability to perform safety-critical roles, including in the following areas:
  - Design and layout of displays and controls;
  - Mission planning, which includes analyzing tasks and allocating functions between humans and equipment;
  - Restraint or stowage of all individuals and objects in a vehicle; and
  - Operation of vehicle in a manner that flight crew can withstand any physical stress factors, such as acceleration, vibration, and noise.

Note: Safety critical roles refer to crew being able to safely carry out their duties so that vehicle will not harm the public.

Human Factors (continued)

- **Experiencing Weightlessness:** § 460.15(c) requires restraint of individuals but does not prevent an operator from allowing SFPs to experience weightlessness during part of a mission.
  - Operator must ensure that SFPs (free floating) do not interfere with flight crew activities, and SFPs are able to return to their seats and be restrained as necessary such as before reentry or landing to not distract or interfere with flight crew activities.

Verification Program

- **§ 460.17 Verification Program:** Operator must successfully verify integrated performance of a vehicle's hardware and any software in an operational flight environment before allowing any SFP on board during a flight. Verification must include flight testing.
  - An operator needs to establish a safety record to disclose to an SFP per § 460.45.
  - Furthermore, an SFP could not be present during flight testing in order to avoid distracting flight crew from its public safety mission.

Crew Waiver of Claims Against U.S. Government

- **§ 460.19:** Each flight crew member and any remote operator must execute a reciprocal waiver of claims with the U.S. Government in accordance with the requirements of 14 CFR part 440.
  - Requires crew member to waive any claims they may have against the U.S. Government for participation in a launch or reentry in which the U.S. Government, any of its agencies, or its contractors and contractors is involved.
  - FAA signs waivers of claims on behalf of U.S. Government.

Launch and Reentry With an SFP

Subpart B of part 460 applies to launch and reentry with an SFP on board a vehicle.

- § 460.45 Operator informing SFP of risk
- § 460.49 SFP waiver of claims against U.S. Government
- § 460.51 SFP training
- § 460.53 Security

Inform SFP of Risks and Provide Informed Consent By SFP

- **§ 460.45(a):** Before receiving compensation or making an agreement to fly a SFP, an operator must—
  - Inform each SFP in writing about the risks of the launch and reentry.
  - Inform each SFP that the U.S. Government has not certified the launch vehicle as safe for carrying flight crew or SFPs.
  - Describe and provide safety record of its vehicle to each SFP.
- **§ 460.45(f):** Before flight, each SFP must—
  - Provide informed consent in writing to participate in a launch or reentry.

Inform SFP of Risks and Provide Informed Consent By SFP (continued)

- **§ 460.45:** Operator must provide:
  - Information presented in a manner that can be readily understood by SFP with no specialized education or training.
  - Information disclosing known known hazards that could result in serious injury or death and that there are unknown hazards;
  - Safety record of all launch and reentry vehicles that have carried humans on a suborbital or orbital space flight, including both U.S. government and private sector vehicles;
  - Safety record of the operator's vehicle; and
  - Opportunity for crew and SFPs to ask questions before SFP provides consent to participate in a launch or reentry.

Informed Consent Guidance and U.S. HSF Safety Record

- **Informed Consent:** "Guidance on Informing Crew and Space Flight Participants of Risk," Version 1.1, April 4, 2017, is provided by FAA to help comply with § 460.9 and § 460.45.

  https://www.faa.gov/sites/faa.gov/files/space/legislation_regulation_guidance/Guidance_on_Informing_Crew_and_Space_Flight_Participants_of_Risk.pdf
- **Safety Record:** U.S. Human Space Flight Safety Record data is provided by FAA to help comply with § 460.45(c). https://www.faa.gov/sites/faa.gov/files/HSF%20Safety%20Record%20Data%20with%20footnotes%20-%20Final_9%20Feb%202024.pdf

Waiver of Claims Against U.S. Government

- **§ 460.49:** Each SFP must execute a reciprocal waiver of claims with the U.S. Government in accordance with the requirements of 14 CFR part 440.
  - Requires SFP to waive any claims they may have against the U.S. Government for participation in a launch or reentry in which the U.S. Government, any of its agencies, or its contractors and contractors is involved.
  - FAA signs waivers of claims on behalf of U.S. Government.

SFP Training

§ 460.51 SFP Training: Operator must train each SFP before flight on how to respond to emergency situations, including loss of cabin pressure, fire, smoke, and emergency egress.

- Without this training, an SFP might interfere with crew's ability to protect public safety.

Security

§ 460.53 Security: Operator must implement security requirements to prevent any SFP from jeopardizing safety of flight crew or public. An SFP may not carry on board any explosives, firearms, knives, or other weapons.

- These restrictions prevent an SFP from potentially interfering with flight crew's operation of vehicle that might jeopardize flight crew's ability to protect the public.

Medical Considerations for SFPs

- Part 460 HSF regulations do not have specific medical requirements for SFPs.
  - Instead, FAA issued guidelines recommending that SFPs obtain an evaluation of their medical history to determine whether a physical examination might be appropriate.
    - Guidelines recommend that SFP provide a medical history to a physician experienced or trained in the concepts of aerospace medicine.
    - Physician would determine if SFP should undergo an appropriate physical examination before boarding a launch or reentry vehicle.


Preparing for Future
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Preparing for Future HSF Regulations

- As Congress noted in **51 U.S.C. § 50901(a)(15),** regulatory standards governing HSF must—
  - Evolve as industry matures so that regulations neither stifle technology development
  - Nor expose crew, government astronauts, or SFPs to avoidable risks as the public comes to expect greater safety for crew, government astronauts, and SFPs from industry.
- In accordance with **51 U.S.C. § 50905(c)(3),** FAA continues to work "…to facilitate development of voluntary industry consensus standards based on recommended practices to improve safety of crew, government astronauts, and SFPs as commercial space sector continues to mature."

Preparing for Future HSF Regulations (continued)

- In April 2023, FAA established an Aerospace Rulemaking Committee **(SpARC)** to collaborate with industry on development and cost of possible future regulations for commercial HSF occupant safety. https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/Final-ARM-220523-001_S1%20Signed.pdf
- In September 2023, FAA issued ***"Recommended Practices for Human Space Flight Occupant Safety,"*** *Version 2.0.*
  - This update of FAA's 2014 recommended practices (Version 1.0) incorporated lessons learned from commercial HSF experiences. https://www.faa.gov/media/71481
- FAA participates in voluntary consensus standards development through organizations like ASTM International and International Organization for Standardization.
  - Standards could be used by operators when designing and operating HSF vehicles.

Summary

- FAA's HSF requirements are based on informed consent and voluntary assumption of risk by participants.
  - Because of legislative moratorium, occupant safety is not currently regulated except as necessary such as when crew is needed to perform safety critical roles to protect the public.
- Commercial HSF requirements are expected to evolve as industry matures or if moratorium were to expire.
  - FAA is working with industry to prepare and plan on how HSF should be regulated beyond informed consent if occupant safety were to be regulated in the future.


Questions?
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