MISSION

• To ensure protection of the public, property, and the national security and foreign policy interests of the United States during a commercial launch or reentry activity

• To encourage, facilitate, and promote U.S. commercial space transportation

Title 51 U.S. Code Subtitle V, Chapter 509
Commercial Space Launch Act
Who Needs a License?

• Any person must obtain a license:
  • To launch a launch vehicle from the United States;
  • To operate a launch site within the United States;
  • To reenter a reentry vehicle in the United States; or
  • To operate a reentry site within the United States.

• 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 site outside of the United States;
  • To reenter a reentry vehicle outside of the United States; or
  • To operate a reentry site outside of the United States.
Types of Licenses

• Launch License (ELVs)
  • Launch specific: authorizes a specific launch or multiple launches with nearly identical parameters (vehicle design, launch location, trajectory, payload, etc.).
  • Launch operator: authorizes launches of a range of payloads and trajectories for a family of vehicles from the same site

• Launch License (RLVs)
  • Mission specific: authorizes a licensee to launch and reenter one model (may authorize more than one RLV mission, but identifies each flight)
  • Operator license: authorizes a licensee to launch and reenter any of a designated family of RLVs within authorized parameters, including launch sites and trajectories, transporting specified classes of payloads to any reentry site or other location designated in the license

• Experimental Permits (Suborbital RLVs)
  • An experimental permit authorizes launch or reentry of a reusable suborbital rocket.
  • An experimental permit provides an optional alternative to licensing for the purpose of R&D, showing compliance with requirements to obtain a license, or crew training.

• Reentry License (RVs)
  • Reentry specific or Reentry operator

• Launch or Reentry Site Operator License
  • Authorizes operation of a launch or reentry site
General Licensing Process

Pre-application Consultation → Application → Policy Review

- Payload Review
- MPL Determination
- Environmental Determination

Safety Review → License: 180 day process

License
Safety Review
Typical Requirements

- Safety Organization
  - Safety Official
- Acceptable Flight Risk
  - Flight Safety Analysis
  - Hazard Identification and Risk
  - Flight Safety System (if necessary to mitigate risk)
- Flight Readiness
- Communications Plan
- Safety At End of Launch
- Accident Investigation Plan
Safety Review - Safety Organization
§ 415.33(a) for ELVs and similar to § 431.33(a) for RLVs

Applicant must maintain a safety organization and document it by identifying lines of communication and approval authority for all launch safety decisions.

- Lines of communication within applicant’s organization and between applicant and any federal launch range providing launch services must be employed to ensure that personnel perform launch safety operations in accordance with range safety requirements.
Safety Review - Safety Official
§ 415.33(b) for ELVs and similar to § 431.33(b) for RLVs

• Applicant must identify by name, title, and qualifications, a qualified safety official authorized to examine all aspects of applicant's launch safety operations and to monitor independently personnel compliance with applicant's safety policies and procedures.

• Safety official must report directly to person responsible for an applicant’s licensed launches, who shall ensure that safety official’s concerns are addressed prior to launch.
Safety Review - Acceptable Flight Risk
§ 415.35(a) for ELVs and § 431.35(a) for RLVs

• Public risk [417.107(b)]
  – Launch operator may initiate the flight of a launch vehicle only if flight safety analysis demonstrates that any risk to the public satisfies the public risk criteria
    • Excludes persons in waterborne vessels and aircraft [417.107(b)(1)]

• Criteria (expected casualties) [417.107(b)(1)-(2)]
  – Total $E_c \leq 30 \times 10^{-6}$
  – Individual $E_c \leq 1 \times 10^{-6}$

• $E_c$ criterion for each hazard applies to each launch from lift-off through orbital insertion, including each planned impact, for an orbital launch, and through final impact for a suborbital launch [417.107(b)(1)]
Safety Review
Risk and Expected Casualty

- Risk is defined by the safety community as the product of the probability of occurrence of an event and the consequences of that event
- Expected casualty is used in the space transportation industry as a measure of risk to public safety
  - Expected casualty is the expected average number of casualties per mission
  - Casualty is a fatality or serious injury
- \( E_{Ci} = \sum P_i \times A_{Ci} \times P_{Di} \)
  - Where
    - \( i \) denotes each specific overflight or impact population center
    - \( P_i = \) probability of occurrence of \( i^{th} \) event
    - \( A_{Ci} = \) casualty area of impacting debris
    - \( P_{Di} = \) population density of area at risk
- \( E_C \) will be the sum for all values of \( (i) \)
Acceptable Flight Risk - Hazard Identification and Risk Assessment
§ 415.35(b) for ELVs and similar to § 431.35(c) for RLVs

Applicant must submit an analysis that identifies hazards and assesses risks to public health and safety and safety of property associated with nominal and non-nominal flight under its launch proposal.
Acceptable Flight Risk – Design
§ 415.35(c) for ELVs and similar to § 431.35(d) for RLVs

• Launch vehicle must be designed to ensure that flight risks meet the $E_c$ criteria. Applicant must identify and describe the following:
  • Launch vehicle structure, including physical dimensions and weight;
  • Hazardous and safety critical systems, including propulsion systems; and
  • Drawings and schematics for each system identified.
• $E_c$ typically met through use of a Flight Safety System (FSS) for ELVs
  • Sea Launch used an autonomous Flight Safety System (Thrust Termination System)
Flight Safety

• Must use flight safety system (FSS) for each launch vehicle, vehicle component, and payload
  – In vicinity of launch area when [417.107(a)(1)]
    • Any hazard from a launch vehicle, vehicle component, or payload can reach any protected area at any time during flight

    or

    • A failure of the launch vehicle would have a high consequence to the public
Flight Safety (cont.)

• Must use flight safety system (FSS) for each launch vehicle, vehicle component, and payload
  – In downrange area [417.107(a)(2)]
    • If absence of a flight safety system would significantly increase the accumulated risk from debris impacts
Safety Review - Flight Readiness
§ 415.37 for ELVs and similar to § 431.37 and § 431.39 for RLVs

- Applicant must designate a person responsible for flight readiness.
- Applicant must submit procedures that ensure:
  - A launch readiness review is conducted so that judgment as to mission readiness can be made.
  - Mission constraints, rules, and abort procedures are listed and consolidated in a safety directive or notebook approved by licensee flight safety and Federal launch range personnel.
  - Currency and consistency of licensee and Federal launch range countdown checklists.
  - Dress rehearsals are held to ensure crew readiness under nominal and non-nominal flight conditions.
  - Flight safety personnel adhere to crew rest rules.
Safety Review - Communications Plan
§ 415.37(b)&(c) for ELVs and similar to § 431.41(a)&(b) for RLVs

Applicant must submit a communications plan providing vehicle safety personnel communications procedures during the mission

- Include hold/resume, go/no go, and abort commands.
- Describe the authority of licensee personnel and any Federal launch range personnel by individual or position, to issue these commands.
- Ensure that communication networks are assigned so that these personnel have direct access to real-time safety-critical information for issuing hold/resume, go/no go, and abort decisions and commands.
- Ensure that these personnel monitor common intercom channel(s)
- Ensure a protocol is established for utilizing defined radio telephone communications terminology.
- Ensure that licensee and Federal launch range personnel receive a copy of communications plan and Federal launch range concurs in the communications plan.
Safety At End Of Launch
§ 415.39 for ELVs and similar to § 431.43(c)(3) for RLVs

For launch vehicle stages or components that reach Earth orbit, applicant must demonstrate that:

- There is no unplanned physical contact between vehicle or its components and payload after payload separation;
- Debris generation does not result from conversion of energy sources into energy that fragments the vehicle or its components; and
- Stored energy is removed by depleting residual fuel and leaving fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy.
Accident Investigation Plan
§ 415.41 for ELVs and similar to § 431.45 for RLVs

Applicant must submit:
• Accident investigation plan (AIP) containing procedures for reporting and responding to launch accidents, launch incidents, or other mishaps. An AIP must contain procedures for:
  • Ensuring containment and minimization of consequences of a launch accident, launch incident, or other mishap.
  • Ensuring preservation of data and physical evidence.
  • Investigating cause of a launch accident, launch incident, or other mishap.
  • Reporting investigation results to FAA.
  • Reporting to and cooperating with FAA and NTSB investigations.
  • Identifying and adopting preventive measures to avoid recurrence.
FAA Technical Evaluation and Independent Analyses

• FAA’s internal *technical evaluation* of an applicant’s license application *forms the basis for* making a *license determination*. This evaluation involves technical analyses:
  
  • **Quantitative analyses** focus on the reliability and functions of safety-critical systems, and the hazards associated with the hardware, and the risk those hazards pose to public property and individuals near the launch site, along the flight path, and upon reentry
    • Flight safety risk analysis is a primary example
  
  • **Qualitative analyses** focus on the organizational attributes of the applicant such as launch safety policies and procedures, communications, qualifications of key individuals, and critical internal and external interfaces
Elements of a Typical Flight Safety Risk Analysis

1. The Risk Computation Tool
2. Region of Interest
   • Population Data
3. Probabilities of failure
   • Failure modes
   • Conditional probabilities
4. Debris models
   • Inert debris
   • Explosive debris
   • Debris Survivability
5. Trajectory analysis
   • $3\sigma$ dispersed trajectories
   • Malfunction turns (TT/RA)
6. Expected casualty
   • Uncertainties
Example of a Risk Computation Tool

- Trajectory Data: Nominal, Uncertainty, and/or Malfunction
- Aborted/Malfunction Trajectory Modeling
- Breakup State Vectors and/or Uncertainty
- Vehicle Failure Event Tree
- Breakup Debris List
- Vehicle Data Drawings Analysis
- History

RRAT
- GUI input – graph & map input
- CRTF computation
- Display output: text & maps

- Population/Sheltering Database
- Destruct Criteria
- Human & Structure Vulnerability Models
- Structure Cost Database

- Failure Probability
- Wind with Uncertainty
- Aircraft Definition
- Aircraft Flight Paths
ELV Ground Safety Regulations

Subpart E – Ground Safety

§417.401 Scope
§417.402 Compliance
§417.403 General
§417.405 Ground safety analysis
§417.407 Hazard control implementation
§417.409 Safety clear zones for hazardous operations
§417.413 Hazard areas
§417.415 Post-launch and post-flight-attempt hazard controls
§417.417 Propellants and explosives
ELV Ground Safety Regulations

- Focus is on public safety – not necessarily safety of employees or contractors of the licensee
- Most ground safety hazards can be controlled by restricting public access “inside the fence-line”
- FAA accepts a ground safety process provided by a Federal launch range

§417.402 Compliance
(b) *Ground safety analysis conducted for launch at a Federal launch range.* This provision applies to all sections of this subpart. The FAA will accept a ground safety process conducted for a launch from a Federal launch range without need for further demonstration of compliance to the FAA if:

1. A launch operator has contracted with a Federal launch range for the provision of the ground safety process; and
2. The FAA has assessed the Federal launch range, through its launch site safety assessment, and found that the Federal launch range's ground safety process satisfies the requirements of this subpart. In this case, the FAA will treat the Federal launch range's process as that of a launch operator.
Compliance Monitoring and Safety Inspections

- AST performs compliance monitoring for licensed or permitted activities to ensure compliance with:
  - Statute
  - Regulations
  - Representations made in a license or permit application
  - Terms and conditions of a license or permit
- Some compliance monitoring activities take place at a site used by the licensee or permit recipient for manufacturing or launching.
  - May include an on-site safety inspection of hardware, tests, processes, or procedures.
  - FAA safety inspectors typically attend rehearsals and FTS installations and testing, and have always attended licensed launches to verify representations made in the license application and safe launch conduct.
Compliance Monitoring and Safety Inspection (cont.)

§ 417.23 for ELVs and similar to § 431.83 for RLVs

• Launch operator must allow access by, and cooperate with, Federal officers or employees or other individuals authorized by the FAA to observe any of its activities, or of its contractors or subcontractors, associated with the conduct of a licensed launch.

• For each licensed launch, launch operator must provide FAA with a console for monitoring progress of countdown and communication on all channels of countdown communications network [§ 417.23(b)]

• Launch operator must provide FAA with capability to communicate with an employee of launch operator who has launch operator’s final approval authority for launch.
Regulations

SUBCHAPTER A - GENERAL
• Part 400 - Basis and Scope
• Part 401 - Organization and Definitions

SUBCHAPTER B - PROCEDURE
• Part 404 - Regulations and Licensing Requirements [Waivers and Rulemaking]
• Part 405 - Investigations and Enforcement [Enforcement]
• Part 406 – Investigations, Enforcement, and Administrative Review

SUBCHAPTER C - LICENSING AND PERMITTING
• Part 413 – License Application Procedures
• Part 414 - Safety Approval
• Part 415 - Launch License
• Part 417 - Launch Safety
• Part 420 - License to Operate a Launch Site
• Part 431 - Launch and Reentry of a Reusable Launch Vehicle
• Part 433 - License to Operate a Reentry Site
• Part 435 - Reentry of a Reentry Vehicle Other Than a RLV
• Part 437 - Experimental Permits for Reusable Suborbital Rockets
• Part 440 - Financial Responsibility
• Part 460 - Human Space Flight Requirements for Crew and Space Flight Participants
Licensing - Expendable Launch Vehicle Safety Review

- Launch Operator Must Satisfy Part 415 and Part 417 Requirements
  - *Part 415 – Launch License*: Contains responsibilities and requirements to obtain a launch license
  - *Part 417 – Launch Safety*: Contains responsibilities and requirements to comply with in order to keep license
    - Includes post-licensing requirements and responsibilities
- Part 417 contains 5 Subparts and 8 Appendices
  - Subpart A: General and License Terms and Conditions
  - Subpart B: Launch Safety Responsibilities
  - Subpart C: Flight Safety Analysis
  - Subpart D: Flight Safety System
  - Subpart E: Ground Safety
Licensing - Expendable Launch Vehicle
Safety Review

• Part 417 Appendices
  • (A) Flight Safety Analysis Methodologies and Products for a Launch Vehicle Flown with a Flight Safety System
    • Methodologies in this appendix represent an acceptable means of satisfying the flight safety analysis requirements of subpart C.
  • (B) Flight Hazard Analysis for Aircraft & Ship Protection
    • Methodologies in this appendix represent an acceptable means of satisfying flight safety and flight hazard area analysis requirements as they pertain to ship, aircraft, and land hazard areas.
  • (C) Flight Safety Analysis Methodologies and Products for Unguided Suborbital Launch Vehicle Flown With Wind Weighting System
    • Appendix contains methodologies for performing flight safety analysis for unguided suborbital launch vehicle flown with a wind weighting system.
Licensing - Expendable Launch Vehicle (cont.)

Safety Review

• Part 417 Appendices
  • (D) Flight Termination System (FTS) Components, Installation and Monitoring
    • Appendix applies to each FTS and the components that make up the FTS for each launch.
  • (E) FTS Component Testing & Analysis
    • Appendix contains requirements for tests and analyses that apply to an FTS and its components
  • (G) Natural Triggered Lightning Flight Commit Criteria
    • Appendix provides flight commit criteria to protect against natural lightning and lightning triggered by flight of a launch vehicle.
Licensing - Expendable Launch Vehicle (cont.)
Safety Review

• Part 417 Appendices
  • (I) Methodologies for Toxic Release Hazard Analysis and Operational Procedures
    • Appendix provides methodologies for performing toxic release hazard analysis for flight of a launch vehicle and for launch processing at a launch site in the U.S.
  • (J) Ground Safety Analysis Report
    • Appendix provides content and format requirements for a ground safety analysis report for launch processing and post-launch operations at a launch site in the U.S.
      • Launch processing and post-launch operations at launch point outside the U.S. may be subject to requirements of the governing jurisdiction.
Amateur Rocket Activities

• No license or permit is required to conduct amateur rocket activities.

• An air traffic regulation applies – 14 CFR part 101.

• An amateur rocket is an **unmanned rocket** that:
  • Is propelled by a motor or motors having a combined total impulse of 889,600 Newton-seconds (200,000 pound-seconds) or less; and
  • Cannot reach an altitude greater than 150 kilometers (93.2 statute miles) above the earth's surface.

• Amateur rockets are further broken down into three classes
  • Model Rocket
  • High Power Rocket
  • Advanced High Power Rocket
Amateur Rocket Activities

• Persons planning to launch unmanned rockets into controlled airspace must apply to the nearest air route traffic control center for a 14 CFR Part 101 for authorization.

• Certain amateur rockets proposals are reviewed by AST:
  • Advanced High Power Rockets (>40,960 Newton-seconds, 9208 Pound-seconds).
  • Any rocket planned to reach > 25,000 feet.

• Amateur flights from controlled airspace (e.g. KSC) are the controlling agency’s responsibility.