

The Regulatory Role of the U.S. Federal Aviation Administration in Debris Mitigation—with Notes on Other Agencies



**Federal Aviation
Administration**

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Overview

- **U.S. regulatory structure**
- **FAA's authority and role**
- **FCC's authority and role**
- **NOAA's authority and role**

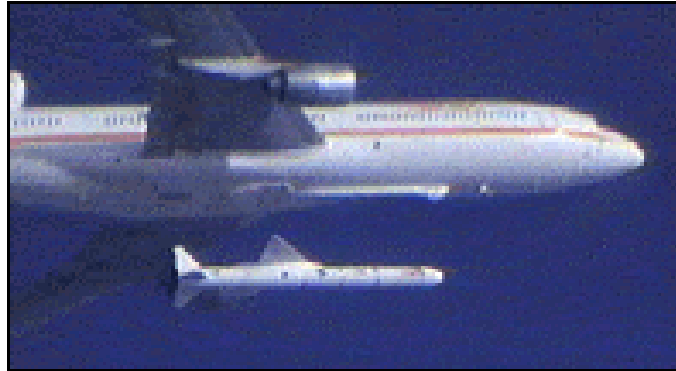


Regulatory Structure

- **Congress**
- **Executive Branch**
 - Federal Aviation Administration (FAA) – space transportation
 - Federal Communications Commissions (FCC) – space communications (Independent Commission)
 - National Oceanic and Atmospheric Administration (NOAA) – remote sensing
- **Judiciary**



FAA Mission



Air Launch



Launch & Reentry Sites



Launch & Reentry



Sea Launch



Human Space Flight

Statutory Authority

- **49 U.S.C. Subtitle IX, chapter 701 (Ch. 701)**
 - Authorizes the Secretary of Transportation to authorize launch and reentry and operation of launch and reentry sites as carried out by U.S. citizens or within the United States.
 - Directs the Secretary to
 - Exercise this responsibility consistent with public health and safety, safety of property, and national security and foreign policy interests of the United States.
 - Encourage, facilitate and promote commercial space launches and reentries by the private sector.

Statutory Requirements

- **Any person must obtain a license to launch a launch vehicle or reenter a reentry vehicle from or into the United States; and**
- **A U.S. citizen or entity must obtain a license to launch or reenter outside the United States.**

Scope of Launch and Reentry

- **Launch means to place or try to place a launch vehicle or reentry vehicle and any payload from Earth**
 - In a suborbital trajectory,
 - In Earth orbit in outer space, or
 - Otherwise in outer space.
 - Launch includes the flight of a launch vehicle and pre-flight ground operations beginning with the arrival of a launch vehicle or payload at a U.S. launch site.
- **Reentry means to return or attempt to return, purposefully, a reentry vehicle and any payload, crew, or space flight participants.**

Scope of Launch and Reentry (cont'd)

- **For an ELV launch, flight ends after the licensee's last exercise of control over its launch vehicle.**
 - For orbital, this is usually safing of the upper stage.
 - For suborbital, it is impact.
- **For an orbital RLV launch, flight ends:**
 - After deployment of any payload, or
 - When there is no payload, upon completion of the first sustained, steady-state orbit at an RLV's intended location.
- **For a suborbital RLV, flight ends upon landing when the vehicle comes to a stop.**

Licensing

- **Elements of a license review for launch and reentry**
 - Policy
 - Payload review
 - Environmental
 - Safety review
 - Financial responsibility

- **180 days**

Licensing—Payload Review

- **A payload review includes**
 - Payload safety issues
 - Classes of payloads
 - Interagency review
- **Relationship to jurisdiction of other agencies**
 - The FAA does not routinely review payloads that are subject to regulation by FCC or NOAA, or that are owned and operated by USG
 - Except for issues relating to safety of launch itself

Application Requirements for Debris

- **A license applicant must demonstrate that it will satisfy the debris requirements of the FAA's rules**
 - “for any launch of a launch vehicle with a stage or component that will reach Earth orbit.” 14 C.F.R. § § 415.39, 415.133.
 - For launch and reentry of a reusable launch vehicle. 14 C.F.R. § 431.43(c)(3).

Debris Requirements

- **For all launch vehicle stages or components that reach Earth orbit, an operator must ensure**
 - No unplanned physical contact between the vehicle or any of its components and the payload after separation;
 - No debris generation from the conversion of energy sources into energy that fragments the vehicle or its components.
 - Energy sources include chemical, pressure and kinetic energy; and

Debris Requirements (cont'd)

- Stored energy is removed by depleting residual fuel and leaving all fuel line valves open,
 - venting any pressurized system,
 - leaving all batteries in a permanent discharge state, and
 - removing any remaining source of stored energy.

- This final requirement is a prescriptive means of fulfilling the first two performance requirements.

Conjunction on Launch

- **Conjunction on launch means the approach of a launch vehicle or any vehicle component or payload within 200 km of a manned or mannable orbiting object-**
 - During the flight of an unguided suborbital rocket; or
 - For an orbital launch vehicle during-
 - The ascent to initial orbital insertion and through at least one complete orbit; and
 - Each subsequent orbital maneuvering or burn from initial park orbit, or direct ascent to a higher or interplanetary orbit.

Collision Avoidance

- **An operator must determine the launch holds (“waits”) in a launch window to protect any manned or mannable orbiting object.**
 - The calculation must account for uncertainties in vehicle performance.
 - The waits are incorporated into the flight commit criteria.
- **There is a 200 km limit for orbital launches during ascent, for an orbital RLV through one complete orbit, and throughout flight for a suborbital launch.**

Collision Avoidance (cont'd)

- **A COLA analysis is not required for an unguided suborbital launch vehicle if its maximum altitude is less than the altitude of the lowest habitable orbiting object.**
 - The maximum altitude attainable must be determined using an optimized trajectory, assuming 3-sigma maximum performance.

Enforcement

- **A license or permit may be**
 - Modified
 - Suspended
 - Revoked
- **Emergency orders - the FAA may “immediately terminate, prohibit, or suspend” an authorized activity, if it is**
 - “detrimental to public health and safety, the safety of property, or any national security or foreign policy interest of the United States”
- **Civil penalties for**
 - Failure to comply with statute or regulations
 - Failure to comply with license terms

Legal Issues for FAA Oversight on Orbit

- **Treaty obligations**
 - Art. VI of the Outer Space Treaty
- **Legislative history**
 - H. Rep. No. 105-347 (Oct. 24, 1997)
- **Reach of payload review**

Financial Responsibility

- **The FAA imposes financial responsibility requirements under 14 C.F.R. part 440 for maximum probable loss:**
 - By requiring insurance or other means
 - Up to statutory limits
 - Third party claims--\$500,000,000.00
 - USG--\$100,000,000.00

Duration of Insurance Coverage

- **Coverage must remain in effect until:**
 - For ELVs on orbit: 30 days from separation or from ignition, whichever is later; or
 - For reentering RLVs: 30 days from initiation of reentry flight; unless,
 - For aborts where the RLV remains in orbit, until the FAA determines that risk is small enough that financial responsibility is no longer necessary.

FCC – Authority

- **The FCC**

- Authorizes the launch and operation of U.S. spacecraft that are owned and operated by private companies and that use radio frequencies
- Reviews non-US spacecraft that employ commercial radio frequency operations in the United States through licensing earth stations or market access rulings

Debris Requirements

- **The FCC's debris rules, 47 C.F.R. part 25, contain pre-licensing disclosure requirements:**
 - Statement concerning release of debris during normal operations and collisions with small debris
 - Statement concerning assessment and limitation of the probability of accidental explosion
 - Statement concerning assessment and limitation of the probability of collisions with large objects
 - Description of post mission disposal plans

Collision with large objects

- **Three specific scenarios require an FCC applicant to include further discussion:**
 - Co-location of a multiple satellites at a single geostationary location
 - Operation of a LEO satellite or system in an orbit identical or similar to that of another space station
 - Inhabitable orbiting objects

Disclosure of Orbital Parameters – Geostationary Orbits

- **Applicants for Geostationary Satellites must disclose:**
 - Orbital location (longitude)
 - Accuracy with which the orbit inclination and longitudinal drift will be maintained.
- **Applicants must also “assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap.” If there are such satellites, the applicant must identify the measures that will be taken to prevent collisions.**

Disclosure of Orbital Parameters – Non-Geostationary Orbit

- **Applicants for Non-Geostationary Satellites must disclose:**
 - Number of space stations and orbital planes
 - Inclination of orbital planes
 - Orbital period
 - Apogee and perigee
 - Argument of perigee
 - RAAN
 - Accuracy with which orbital parameters will be maintained
 - For satellites lacking propulsion, anticipated evolution of orbits over time.

End-of-Life Disposal

- **All FCC licensed satellites must discharge all stored energy sources at end of life, unless prevented by technical failures beyond the licensee's control.**
- **Geostationary satellites must be disposed to an altitude consistent with IADC/ITU formula, and are authorized to do so.**
 - Geostationary satellites launched prior to March 18, 2002, are grandfathered, and must obtain individual authorization for any disposal below the IADC/ITU minimum.

End-of-Life Measures for Geostationary Satellites

- **Operators must disclose the calculations used to derive the minimum perigee for disposal.**
 - Simplifying assumptions may be used, but should be made so as to over-estimate the required minimum increase in perigee, as compared to higher fidelity methods.
- **Operators must disclose the quantity of fuel reserved for post-mission disposal, and the methodology used to determine and address fuel gauging uncertainty.**

End-of Life Measures for Non-geostationary Satellites

- **The FCC will evaluate NGSO license requests based on the IADC 25 year guideline.**
- **Operators must provide a casualty risk assessment for disposal involving atmospheric reentry.**

Casualty Risk Assessment

- **For controlled re-entry, the assessment must include:**
 - The projected geographic region of the debris field of the surviving components/fragments, if any
 - Warning measures for people in the geographic region during the re-entry.
- **For uncontrolled re-entry, the assessment must include:**
 - An estimate of the number of components/fragments, and their estimated dimensions and mass, likely to survive to the Earth's surface;
 - An estimate of the probability of human casualty resulting from surviving components/fragments of the satellite;
 - A full description of the assumptions and parameters used in developing the estimate
- **In the event information on satellite design characteristics, satellite components and satellite ground track during re-entry are not yet known, the applicant must provide information based on assumptions and parameters of a “worst-case” scenario.**

NOAA Authorization

- **NOAA licenses the operation of private Earth remote sensing systems**
- **15 C.F.R. part 960 contains NOAA's licensing requirements**

Debris Requirements

- **NOAA requires that a licensee**
 - Dispose of any satellites operated by the licensee upon termination of operations under the license in a manner satisfactory to the President.
 - Obtain approval from NOAA of all plans and procedures for the disposition of a satellite as part of the license application process.
- **NOAA reviews an applicant's post-mission disposal plan on a case by case basis.**