



April 2024

COMMERCIAL SPACE TRANSPORTATION

How FAA Considers Environmental and Airspace Effects

Accessible Version

GAO Highlights

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Highlights of [GAO-24-106193](#), a report to congressional requesters

April 2024

COMMERCIAL SPACE TRANSPORTATION

How FAA Considers Environmental and Airspace Effects

Why GAO Did This Study

Commercial space transportation enables essential activities such as digital communications, navigation, and weather forecasting. Since the first U.S.-licensed commercial space launch in 1989, the industry has expanded into a multibillion-dollar enterprise. U.S.-licensed launches and reentries have grown from 9 in 2012 to 124 in 2023. There are many benefits of commercial space transportation; however, its growth has implications for how FAA manages airspace around launches and reentries, and affects other airspace users, such as commercial airlines. Further, rocket launches emit gases and particles into the air, which can affect the environment.

GAO was asked to review the factors FAA considers as part of its licensing of commercial space launch and reentry operations. This report describes how FAA: (1) conducts environmental reviews for commercial space operations and what those reviews have found, and (2) considers the impacts on airspace users of airspace closures during licensing and launch and reentry operations.

GAO reviewed statutes, regulations, FAA guidance, and documentation from environmental reviews associated with each domestic commercial space vehicle launch and reentry license as of July 2023. GAO also interviewed FAA officials and commercial space stakeholders, including the National Aeronautics and Space Administration, the Department of Defense, and five associations representing the aviation and commercial space industries.

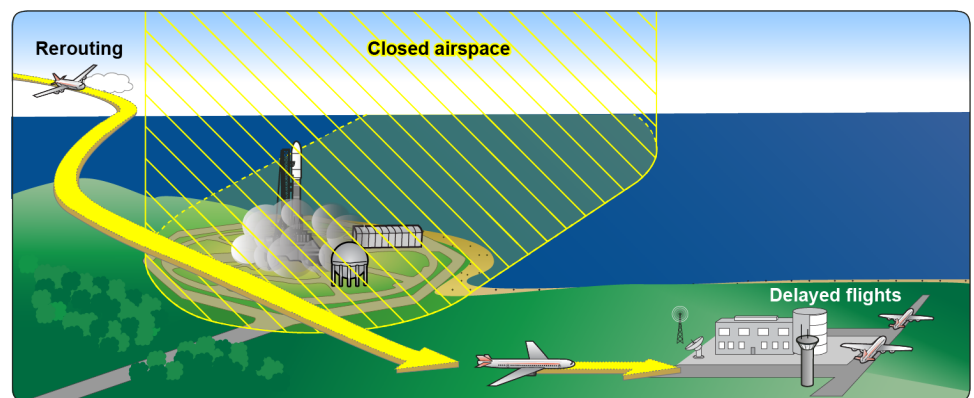
What GAO Found

As part of its oversight of the commercial space transportation industry, the Federal Aviation Administration (FAA) assesses the potential effects that launch or reentry activities would have on the environment. These environmental reviews are required by the National Environmental Policy Act and conducted before FAA issues a commercial space license. FAA policy requires these reviews to assess 14 categories, such as noise, coastal resources, and land use, for potentially significant impacts on the environment. To assess significance, FAA may conduct new reviews or reevaluate and use reviews that were previously completed for launch sites or other activities. GAO found that 19 of the 22 reviews FAA prepared for

current launch and reentry license applications were based on previous environmental reviews for the original licensing effort. FAA concluded that the potential environmental impacts of these launch and reentry activities were either below significant levels or were mitigated to be below significant levels overall. For example, in one review, FAA found that emissions from fuel burn during takeoff could produce short-term air-quality impacts, but these impacts would be indistinguishable from the impacts of ongoing flight operations in the area.

According to FAA officials, approving or denying a license application based on the effects on other airspace users is not within FAA's statutory authority. However, during the licensing process, FAA begins to identify and plan for these effects while still ensuring operations meet safety criteria. These planning efforts include establishing procedures for communicating closures. Also, before granting a licensed operator's request for a specific launch time, FAA estimates the impact on other airspace users by using historical air traffic data to identify affected routes and the number of affected aircraft. In addition, FAA has reported decreasing the amount of time airspace is closed by using time-based management procedures. These procedures attempt to more efficiently identify aircraft projected to enter a hazard area when space operations occur to reduce re-routing.

Example of Airspace Closure for Commercial Space Launch



Source: GAO. | GAO-24-106193

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Abbreviations

FAA	Federal Aviation Administration
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act

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April 24, 2024

The Honorable Rick Larsen
Ranking Member
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Steve Cohen
Ranking Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

In the United States, commercial space transportation enables essential activities such as digital communications, navigation, and weather forecasting; ferrying astronauts and supplies to the International Space Station; and enhanced national security capabilities. Commercial space transportation uses orbital and suborbital launch vehicles owned and operated by private companies to transport cargo, such as satellites, and people to and from space. Since the first U.S.-licensed commercial space launch in 1989, the industry has expanded into a multi-billion-dollar enterprise. There has been a marked increase in the number of U.S.-licensed commercial launches and reentries, with 124 in 2023, compared with 9 in 2012. Total launch and reentry operations are forecast to rise as high as 288 in 2027.

While commercial space transportation brings many benefits, its growth has implications for the Federal Aviation Administration's (FAA) management of the airspace around launches and reentries, as well as for the physical environment where they take place. FAA may have to close airspace to safely accommodate launch and reentry activities, which can create flight disruptions such as delays and re-routes for airlines. These disruptions can be particularly challenging in the congested airspace of Florida, where a large number of space launches occur. Further, we have reported that rocket launches emit gases and

particles into the air which can have environmental effects such as changing the Earth's temperature and depleting ozone.¹

FAA is charged with overseeing the commercial space transportation industry, including licensing and monitoring launch and reentry operations. You asked us to review the factors FAA considers as part of its licensing of commercial space launch and reentry operations. This report describes how FAA:

- Conducts environmental reviews for commercial space operations and what those reviews have found, and
- Considers the impacts on airspace users of airspace closures during licensing and launch and reentry operations.

To address both objectives, we reviewed relevant statutes and regulations governing FAA's regulation of the commercial space transportation industry. In addition, we interviewed FAA officials from the Office of Commercial Space Transportation and the Air Traffic Organization. We also interviewed federal and industry stakeholders for background information on these objectives. These stakeholders included the National Aeronautics and Space Administration (NASA), the Department of Defense, associations representing the aviation and commercial space industries,² and selected launch and reentry operators, site operators, and contractors who have assisted selected operators with these licenses.³

To determine how FAA conducts environmental reviews for commercial space operations and what those reviews have found, we reviewed FAA's order on implementation of the National Environmental Policy Act's

¹See GAO, *Satellite Licensing: FCC Should Reexamine Its Environmental Review Process for Large Constellations of Satellites*, [GAO-23-105005](#), (Washington, D.C.: Nov. 2, 2022) and GAO, *Large Constellations of Satellites: Mitigating Environmental and Other Effects*, [GAO-22-105166](#) (Washington, D.C.: Sept. 29, 2022).

²We interviewed five associations with members that take part in or are affected by commercial space operations: Commercial Spaceflight Federation, Airlines for America, Air Line Pilots Association, Airports Council International, and the National Air Traffic Controllers Association.

³We interviewed nine operators that conducted a launch or reentry from 2018 to 2023. In addition, we spoke with one launch and reentry license applicant whose application was being evaluated by FAA in April 2023. We also spoke with seven operators taking part in pre-application consultation during our review. We interviewed two site operators and four contractors that assisted applicants in completing their license applications.

(NEPA) requirements and implementing regulations issued by the Council on Environmental Quality (FAA’s environmental impact order).⁴ We also reviewed the documentation from 22 environmental reviews that had been completed as of July 2023 associated with each current commercial space vehicle operator license.⁵ In this report, we describe the conclusions FAA reached in these reviews.⁶ We did not assess FAA’s NEPA review documents for accuracy, completeness, or compliance with NEPA’s requirements. To determine how FAA considers the impact on other airspace users—including commercial airlines, business aircraft operators, and general aviation operators—when issuing licenses and implementing airspace closures for launch and reentry operations, we reviewed FAA internal guidance on safety standards and procedures for airspace closures.

We conducted this performance audit from August 2022 to April 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Key parts of commercial space transportation include:

- Commercial launch or reentry operators, who conduct the launch or reentry of a vehicle and the cargo it carries,
- Commercial launch or reentry site operators, who host the launch or reentry of vehicles from launch sites, and

⁴Fed. Aviation Admin., Ord. 1050.1F *Environmental Impact: Policies and Procedures*, (2015).

⁵We did not review the NEPA reviews from two current commercial space vehicle operator licenses that operate exclusively outside of the United States.

⁶A legal challenge claimed FAA failed to comply with NEPA when it issued a commercial space transportation license to SpaceX for the Starship-Super Heavy Launch Program. *Ctr. for Biological Diversity v. Fed. Aviation Admin.*, No. 23-1204 (D.D.C. May 1, 2023). As of April 1, 2024, the litigation was ongoing. Our review included publicly available environmental documents developed during this licensing process.

- Federal launch and reentry site operators (also known as federal range facilities), such as Air Force and NASA, that may also host commercial space launches and reentries.

Commercial launch operators currently use, and are developing for future use, a variety of vehicles. Historically, these vehicles were expendable, meaning that they launch only once and are then discarded. Since 2015, some operators have started using vehicles that can be reused for multiple launches. These include SpaceX's Falcon 9 and Blue Origin's New Shepard, wherein one part or all of the launch vehicle returns to a landing pad—either on land or on a converted barge offshore—after the payload is launched into orbit. Some commercial space operators also use vehicles that launch horizontally.

FAA's Licensing of Commercial Space Launch and Reentry Operations

FAA regulates the safety of the commercial space transportation industry primarily through licensing vehicle operators and site operators.⁷ FAA issues two types of commercial space licenses:

1. A vehicle operator license that enables an entity to conduct multiple launches and reentries using the same vehicle or family of vehicles. The scope of the license includes authorized pre- and post-flight ground operations.
2. A license to operate a launch or reentry site that enables an entity to host vehicle launches or reentries.⁸

FAA's licensing process includes an initial discussion phase followed by three additional phases, according to FAA's guidance for FAA personnel

⁷FAA currently has two sets of commercial space licensing regulations: (1) a set of legacy regulations, applicable generally to licenses issued prior to March 2021; and (2) a set of updated regulations implemented in 2021 as part of extensive revisions to its legacy regulations. Under a five-year transition period, all FAA-issued licenses for launch and reentry operations will be subject to the set of updated regulations no later than March 10, 2026. Streamlined Launch and Reentry License Requirements, 85 Fed. Reg. 79,566, 79,567 (Dec. 10, 2020).

⁸FAA also issues experimental permits for reusable suborbital rockets. Federal operators of launch and reentry sites are not required to have an FAA site operator license.

and operators.⁹ Actions related to identifying potential environmental impacts of the operation and the amount of airspace that may need to be closed for public safety occur during these phases,¹⁰ including the following:

- **Initial discussions.** When a potential operator is considering a commercial space operation, it meets with FAA to discuss information related to vehicle design, flight safety, potential environmental concerns; type of license potentially required; and potential airspace integration issues, among other topics. These discussions occur prior to an operator deciding to enter into the licensing application process.
- **Phase 1: Pre-application.** According to FAA guidance, prior to submitting an application, operators consult with FAA on how they intend to meet the safety criteria set in licensing regulations, the scope of the license, and application time frames. During this stage, the operator and FAA also identify potential environmental and safety concerns and discuss integrating the operation with airspace traffic.¹¹ Once the operator and FAA have agreed that enough of the application is complete, FAA then accepts the application for evaluation.
- **Phase 2: Evaluation.** By statute, FAA has 180 days to evaluate an application to determine if the operator has met all applicable licensing requirements. According to FAA, this process begins when the application is deemed complete enough by FAA. As part of its evaluation, FAA reviews operator safety analyses that are used to identify potential airspace closures. FAA also determines potential environmental impacts and any necessary environmental mitigations or monitoring at this stage. If an operator has met all the requirements, FAA issues the license.
- **Phase 3: Vehicle License.** According to FAA's airspace management procedures, after a license has been issued, the operator and FAA collaborate on an ongoing basis about scheduling

⁹FAA's SOP-002: License and Permit Application Reviews and Issuance Procedures sets forth the agency's internal procedures for reviewing applications and issuing licenses. In addition, FAA's website includes guidance for operators on the phases of licensing.

¹⁰Other factors in the licensing process include evaluations of financial responsibility, and policy and payload reviews.

¹¹In May 2023, FAA announced changes to the pre-application phase to ease the process for operators. Specifically, agency officials told us that they clarified application submission policies and that they are developing an automated system that can tell applicants whether their application is ready for FAA to review.

and safely carrying out launch or reentry operations and informing other airspace users.¹² FAA also conducts any necessary environmental monitoring activities as determined during the environmental review, according to FAA's environmental impact order. A license lasts for up to 5 years, as determined by FAA.

The National Environmental Policy Act and Commercial Space Operations

NEPA requires federal agencies to evaluate the potential effects on the environment of proposed major federal actions prior to taking those actions and to obtain information from the public to inform the decision-making process.¹³ FAA has determined that the licensing of commercial space operations is an action that requires environmental review under NEPA. To grant commercial space licenses, FAA must comply with the procedures and policies of NEPA and other applicable environmental laws and regulations.

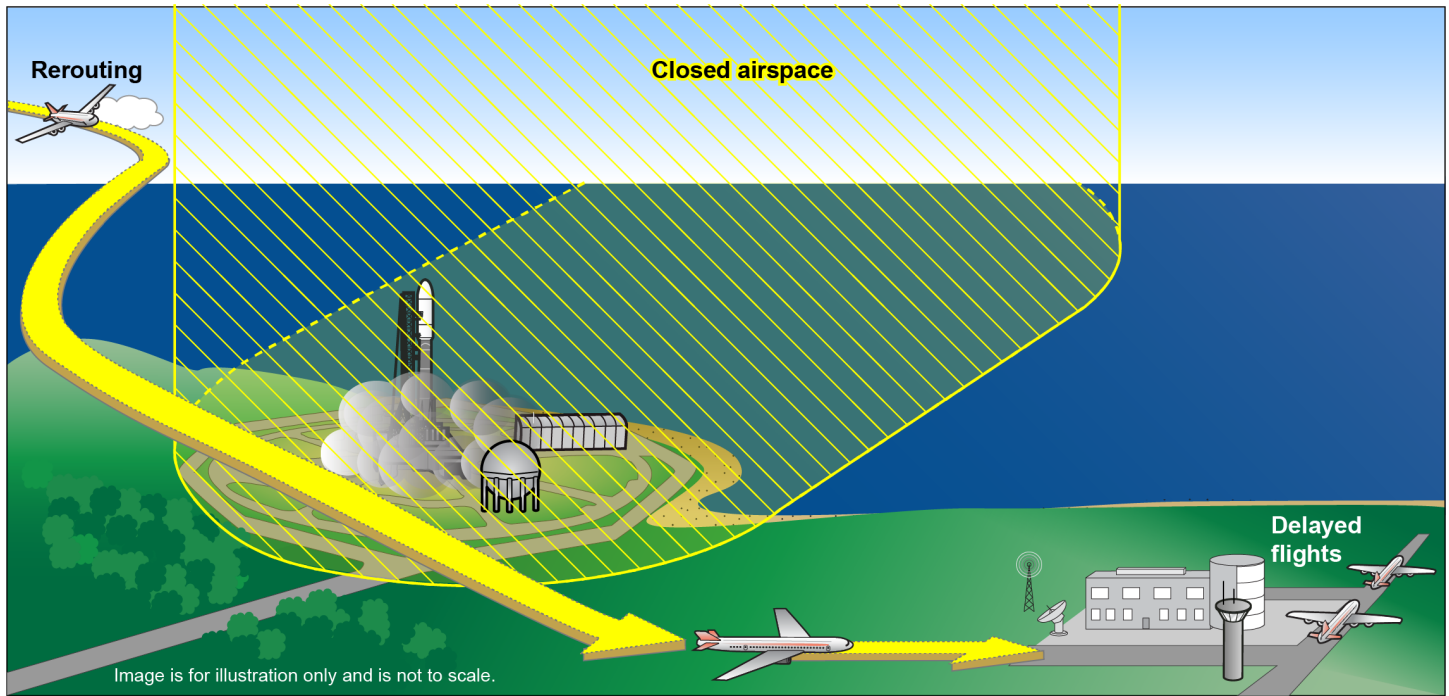
FAA's Airspace Management Related to Commercial Space Operations

FAA is responsible for providing safe and efficient air navigation services within the national airspace. To this end, FAA operates air traffic control facilities throughout the nation and issues notices to inform aircraft pilots of any changes to operating conditions. It may also close airspace to accommodate a commercial space launch or reentry. Airspace closures may cause other airspace users to delay their planned takeoff time, or to fly around the closure area, requiring additional time and distance. See figure 1.

¹²Fed. Aviation Admin., *Procedures for Handling Airspace Matters*, Order JO 7400.2P (Washington, D.C.: April 20, 2023).

¹³The Council on Environmental Quality is the entity responsible for overseeing the implementation of NEPA, which it does in part through its implementing regulations.

Figure 1: Example of Airspace Closure for Commercial Space Launch



Source: GAO. | GAO-24-106193

FAA Has Conducted Environmental Reviews in a Number of Ways and Determined That Potential Effects of Current Launch and Reentry Activities Are Not Significant Overall

While the Form of FAA's Environmental Reviews May Vary, All Reviews Must Address the Same Potential Impact Categories

Under NEPA and its implementing requirements, FAA is responsible for considering the environmental impacts that result from licensed launch and reentry activities before issuing a license. FAA's environmental review can be conducted in a number of ways depending on factors outlined in its environmental impact order. These factors include the following: which federal agency leads the NEPA review and which agency acts as a cooperating agency, the level of NEPA review needed, and

whether there are related NEPA reviews already completed. As part of its review of commercial space licenses, FAA must ensure that its environmental review assesses the potential impact of licensed activities on the 14 environmental impact categories that FAA has identified.

Identifying Lead and Cooperating Agencies

More than one federal agency can be involved in an action that requires environmental review under NEPA. For example, FAA grants licenses for commercial space operations, but the launches may take place at sites owned by Air Force or NASA, as well as at sites owned by private or state government entities. FAA officials told us that FAA, Air Force, and NASA have identified the lead agency for the environmental review for commercial space activities on a case-by-case basis, but generally the decision has depended on the site of the activities. Also in certain cases, the lead agency identifies actions to minimize any potential environmental impacts, according to Council on Environmental Quality regulations.¹⁴

FAA has also taken steps to further clarify responsibilities. In particular, FAA and the Air Force signed a Memorandum of Understanding on NEPA reviews for commercial launch and reentry operations in January 2023 to help clarify lead agency decisions. The agreement states that for launch or reentry operations using the Cape Canaveral Space Force Station in Florida or Vandenberg Space Force Base in California, the Air Force will be the lead agency for the NEPA review, unless the agencies decide otherwise. FAA officials said that they will likely develop a Memorandum of Understanding with NASA in the future for commercially licensed activities that occur on NASA sites.

Agencies not designated as the lead may be invited by the lead agency to be involved in the NEPA process as cooperating agencies. When FAA is the lead agency for a NEPA review, it should invite federal agencies with jurisdiction or special expertise to be cooperating agencies early in the review process, according to FAA's environmental impact order. When FAA is a cooperating agency for a commercial space NEPA review, FAA officials said that they participate in assessing potential environmental impacts.

¹⁴Council on Environmental Quality regulations use the term "lead agency" in relation to certain NEPA reviews, specifically for environmental impact statements and complex environmental assessments. 40 C.F.R. § 1501.7. The term is used when more than one agency is involved or proposes to be involved. 40 C.F.R. §§ 1501.7; 1508.1(o).

Determining What Level and Form the Review Will Take

Public Involvement in National Environmental Policy Act (NEPA) Reviews for Commercial Space

For environmental impact statements, NEPA requires publication of a draft of the statement in the Federal Register and public review. For environmental assessments, under the Federal Aviation Administration's (FAA) environmental impact order, the level of public involvement varies based on the proposed action, potential impacts, and community controversy. For commercial space licensing, seeking public comment on an environmental assessment is optional, at the discretion of FAA. FAA has a public review period if the environmental assessment is likely to become an environmental impact statement or if many mitigations will be needed, according to FAA officials.

FAA often conducts early public engagement for launches at new sites to help educate the public about space launches, according to FAA officials. FAA also puts information on the FAA website about the proposed commercial space operation and reaches out to airspace users to inform them about license applications that may affect them.

Sources: NEPA, GAO analysis of the FAA's environmental impact order, and interviews with FAA officials. | GAO-24-106193

When FAA is the lead agency, it determines the level of NEPA review needed. FAA bases this determination on preliminary information from applicants, such as whether the licensed activities will require construction on undeveloped land, according to FAA's environmental impact order. Under NEPA, FAA may use the following three levels of environmental review.

- **Categorical Exclusions.** A categorical exclusion refers to any category of actions that a federal agency has determined in its NEPA procedures normally do not individually or cumulatively have a significant effect on the environment.¹⁵ FAA has not established a categorical exclusion that applies to the issuance of commercial space licenses, according to FAA officials.
- **Environmental Assessments.** If an applicable categorical exclusion does not exist, NEPA's implementing regulations require FAA to (1) prepare an environmental assessment when the proposed action is not likely to have significant effects or (2) determine whether a proposed action has the potential to significantly affect the environment. In the context of commercial space licensing, an environmental assessment is normally required when an operator is applying for a license to operate a vehicle to or from an existing launch or reentry site, according to FAA's environmental impact order. If FAA determines in its environmental assessment that the action will

¹⁵FAA's environmental impact order contains a comprehensive list of FAA categorical exclusions. For example, FAA has established a categorical exclusion for the issuance of specified type certificates for aircraft manufacturers. Actions that fall within the scope of a categorical exclusion usually do not require an environmental assessment or environmental impact statement.

not have significant effects, or that mitigation measures will result in the action having no significant effects, FAA prepares a Finding of No Significant Impact. This finding briefly presents the reasons why the action would not have a significant impact. FAA may also identify mitigation measures that will be sufficient to reduce potential impacts below significance thresholds and may include these measures as a condition of its approval of the proposed action.¹⁶

- **Environmental Impact Statements.** NEPA's implementing regulations require FAA to conduct an environmental impact statement when one or more environmental impacts would be significant and mitigation measures cannot reduce the impacts below significant levels.¹⁷ For commercial space licenses, environmental impact statements are normally required for a license application requiring the construction of a new commercial space launch site on undeveloped land, according to FAA's environmental impact order.

FAA may build upon previously completed environmental assessments or environmental impact statements from the original licensing effort as the basis for the NEPA review required for a subsequent license application, according to FAA's environmental impact order. The order encourages officials to build upon prior NEPA reviews to the extent that data and analysis in those reviews remain valid. When building on prior NEPA reviews for a license application, FAA can prepare written re-evaluations of or adopt those prior reviews, as described below.

- **Written Re-evaluations.** FAA may prepare a written re-evaluation of previous NEPA reviews to determine whether the contents remain valid for the license application under review, or whether a new or supplemental NEPA review is required. The level of analysis in written re-evaluations depends on the potential for environmental impacts that were not evaluated in the original NEPA review, according to FAA's environmental impact order. For example, an application for a launch and reentry license could use a previous NEPA review conducted for the site operator license at the location where operations are planned to occur. In this case, FAA would conduct a written re-evaluation of the previous NEPA review. The written re-

¹⁶If significant impacts are found in an environmental assessment, an environmental impact statement must be prepared.

¹⁷The June 2023 amendments to NEPA state that an environmental impact statement should be issued "with respect to a proposed agency action requiring an environmental document that has a reasonably foreseeable significant effect on the quality of the human environment." 42 U.S.C. § 4336(b)(1).

evaluation for the launch and reentry license would address FAA's 14 impact categories (outlined below) to the degree that the potential impact differs from what was detailed in the original site review. In some cases, FAA may conduct a written re-evaluation of multiple previous NEPA reviews to support a single license application.

- **Adoptions.** FAA may adopt another federal agency's NEPA review after independently finding that it adequately addresses the relevant FAA actions and meets the standards of the NEPA implementing regulations and FAA's environmental impact order that are applicable to the proposed license. When FAA is in a cooperating—rather than lead—role, it independently reviews and typically adopts the NEPA document prepared by the lead agency, according to FAA officials. FAA may also conduct written re-evaluations of its previously adopted NEPA reviews.

Addressing FAA's Environmental Impact Categories

Regardless of the form they take, all NEPA reviews for commercial space licensing must address FAA's 14 environmental impact categories, as outlined in FAA's environmental impact order (see table 1). For each license application, FAA determines whether potential effects in each category are significant to the environment.

Table 1: The Federal Aviation Administration's (FAA) Environmental Impact Categories

Environmental Impact Category

- Air quality
 - Biological resources (including fish, wildlife, and plants)
 - Climate
 - Coastal resources
 - Certain public and private lands
 - Farmlands
 - Hazardous materials, solid waste, and pollution prevention
 - Historical, architectural, archeological, and cultural resources
 - Land use
 - Natural resources and energy supply
 - Noise and compatible land use
 - Socioeconomics, environmental justice, and children's environmental health and safety risks
 - Visual effects (including light emissions)
 - Water resources (including wetlands, floodplains, surface waters, groundwater, and wild and scenic rivers)
-

Source: FAA's environmental impact order. | GAO-24-106193

^a49 U.S.C. § 303 (c) protects publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance, and publicly or privately owned land from an historic site of national, state, or local significance.

FAA must determine whether each environmental impact category is relevant to the proposed operations being evaluated, according to FAA's environmental impact order. If an impact category is not relevant, the order requires FAA officials to briefly note in the NEPA review the reason it is not relevant, and no further analysis is required. For example, if a launch site is not near farmland, that category would not be relevant to the NEPA review. When FAA determines there are potential environmental impacts for a particular category based on the nature of the proposed operations, the order requires FAA officials to evaluate the impacts using thresholds that indicate significant impact. In its evaluation, FAA considers both the context and intensity of the potential impacts, as outlined in the FAA environmental impact order. Depending on the proposed action, the context may be society as a whole, an affected region, or a locality. Intensity generally refers to the severity of the impacts.

FAA has established significance thresholds for six of the 14 impact categories.¹⁸ For example, the proposed activity in a license application has a significant impact on air quality if it would cause pollutant concentrations to exceed certain air quality standards.¹⁹ For the noise and noise-compatible land use category, as an example, FAA considers a

¹⁸FAA has established significance thresholds for wetlands, floodplains, surface waters, and groundwater. FAA has not established a significance threshold for wild and scenic rivers. Since most of these categories under water resources have a significance threshold, we have counted it with the six impact categories with significance thresholds.

¹⁹The Clean Air Act, as amended, requires the Environmental Protection Agency to set National Ambient Air Quality standards for pollutants which can be harmful to public health and the environment. 42 U.S.C. § 7409. As established, these pollutants include carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution, and sulfur dioxide. 40 C.F.R. pt. 50.

proposed activity to have significant impacts if it will increase average noise levels by a certain amount in noise-sensitive areas.²⁰

Other impact categories do not have quantitative thresholds. For these, FAA has identified factors that should be considered when evaluating the significance of potential environmental impacts. For example, for the hazardous materials, solid waste, and pollution prevention category, FAA's environmental impact order notes that FAA should determine whether the proposed activity in a license application would involve a contaminated site, produce hazardous waste, or adversely affect human health and the environment.

FAA Largely Based Its Assessments on Prior NEPA Reviews and Determined that Proposed Activities Under Current Licenses Were Not Expected to Have Significant Environmental Impacts

Nineteen of the 22 NEPA reviews FAA prepared in support of launch and reentry license applications active as of July 2023 were based on previous environmental assessments or environmental impact statements, as shown in table 2.

²⁰The significance threshold is the Day-Night Average Sound Level of 1.5 decibels or more for a noise-sensitive area (an area where noise interferes with normal activities associated with its use such as a residential or educational sites) that is exposed to noise at or above the Day-Night Average Sound Level of 65 decibels (or that will be exposed at or above the Day-Night Average Sound Level of 65 decibels due to an increase of 1.5 decibels). The Day-Night Average Sound Level is the 24-hour average sound level, in decibels, for the period from midnight to midnight, obtained after the addition of ten decibels to sound levels for the periods between midnight and 7 a.m., and between 10 p.m. and midnight.

Table 2: National Environmental Policy Act (NEPA) Reviews Supporting Active Launch and Reentry Licenses as of July 2023

These reviews supported 22 active domestic launch and reentry licenses issued by the Federal Aviation Administration (FAA).

Level of NEPA review	Number of Licenses Using this Form of NEPA Documentation				Totals
	New NEPA review	Written re-evaluation of previous FAA NEPA review(s)	Adoption of another federal agency's NEPA review(s)	Written re-evaluation of an adoption of another federal agency's NEPA review(s)	
Environmental Assessment	3a	8	3	3	17
Environmental Impact Statement	0	3b	1	1	5
Totals	3	11	4	4	22

Source: GAO summary of FAA information. | GAO-24-106193

Note: Written re-evaluations can be completed based on multiple previous NEPA assessments. One license was supported by a written re-evaluation of two environmental assessments, and another was a written re-evaluation of an adoption of two environmental impact statements.

^aTwo licenses were supported by the same new environmental assessment, counted separately in this table.

^bOne of the written re-evaluations was of an environmental assessment and an environmental impact statement. That review is counted here with the written re-evaluations of an environmental impact statement.

In these 22 NEPA reviews, FAA concluded that the potential environmental impacts of the launch and reentry activities are either below significant levels or are mitigated to be below significant levels, overall.

Environmental Assessments. All 17 of the NEPA reviews that were environmental assessments or based on previous environmental assessments resulted in a finding of no significant impact. Table 3 provides two examples of FAA's assessments for reaching that conclusion.

Table 3: Examples of Proposed Launch or Reentry Operations and the Federal Aviation Administration’s (FAA) Environmental Assessment Findings

Proposed operation	Environmental assessment findings
<p>Northrup Grumman’s license to launch Pegasus at Cape Canaveral Space Force Station. The Pegasus is an expendable rocket that is launched from an aircraft in flight. The aircraft takes off from a runway, and the rocket is released about 90 nautical miles offshore at an altitude of 40,000 feet.</p>	<p>In its 2021 written re-evaluation of a 2011 environmental assessment, FAA determined that 10 of the 14 impact categories applied to the proposed operations. FAA analyzed each of these categories for potential impacts and determined none would be significant. For example, in assessing air quality impacts, FAA found that the impacts would include a temporary increase at ground level in some pollutants, including carbon monoxide and nitrogen oxide. However, FAA noted that the impacts would be intermittent and temporary and that the impact of a single aircraft on local air quality would be indistinguishable from the impact of the ongoing flight operations in the area.^a</p> <p>FAA determined that the four remaining impact categories would not be affected by the proposed operation. Since no substantial changes to these impact categories had occurred since the 2011 environmental assessment, FAA did not re-evaluate them. For example, regarding the farmlands category, FAA noted in the original 2011 environmental assessment that there is no farmland on Cape Canaveral and therefore no possibility that the launch would convert farmlands to nonagricultural uses.^b</p>
<p>SpaceX’s license to launch Falcon 9 at Vandenberg Air Force Base. The Falcon 9 is a reusable, vertical launch vehicle. The reusable portion lands at Vandenberg Air Force Base (or on a contingency landing area offshore).</p>	<p>In its 2018 adoption of a U.S. Air Force environmental assessment, FAA determined that nine of the 14 impact categories applied to the proposed operations. For these, FAA analyzed the potential impacts and determined none would be significant. For example, in assessing the light emissions category, FAA found that Falcon 9 operations would result in light emissions.^c However, FAA noted that these would not substantially degrade the existing visual character of the area, as other launches regularly occur at Vandenberg Air Force Base.</p> <p>FAA determined that the other five impact categories would not be affected and therefore did not describe them in detail. For example, regarding the natural resources and energy environmental impact category, FAA found that the operations would not require the use of scarce materials and would not measurably increase demand on local natural resources.^d</p>

Source: GAO summary of FAA information. | GAO-24-106193

^aFAA’s guidance on determining significance for the air quality impact category states that the action would be significant if it caused pollutant concentrations to exceed one or more of the National Ambient Air Quality Standards, as established under the Clean Air Act, as amended, or increase the frequency or severity of an existing violation.

^bFAA’s guidance on determining significance for the farmlands impact category states that a review should consider whether the action would have the potential to convert important farmlands to non-agricultural uses, among other factors.

^cFAA’s guidance on determining the significance for the light emissions impact category requires the office to consider whether the action would (1) have the potential to create annoyance or (2) affect the visual character of the area due to the light emissions.

^dFAA’s guidance on determining significance for the natural resources and energy supply category requires the office to consider whether the action would have the potential to cause demand to exceed available or future supplies of these resources.

Environmental Impact Statements. In the five NEPA reviews we reviewed that were built or partially built on previous environmental impact statements, FAA also concluded that, overall, the environmental impacts would not be significant. These reviews discussed the degree to which impacts found in the original environmental impact statements still

applied and whether conditions established in the original NEPA review were still required, as the below examples show:

- To determine the potential environmental impact of renewing the license of Exos Aerospace's SARGE launch vehicle, in 2022, FAA conducted a written reevaluation of an existing environmental impact statement. SARGE is a suborbital vehicle that launches vertically at Spaceport America in New Mexico and lands at an undeveloped area near the launch site. In 2008, FAA prepared an environmental impact statement for the licensing of Spaceport America. At the time of the original environmental impact statement, Spaceport America had not been constructed, and FAA assessed the impact of the construction of the site as well as conceptual launch vehicles that might operate there.

The original NEPA review for Spaceport America's license found the potential for adverse impacts to historic properties, including visual effects to historic properties during launch activities. FAA's written reevaluation found that launch activities being proposed at this facility would not result in significant impacts because of mitigation measures already in place. For example, security and safety lighting was designed to keep lighting impacts to a minimum and the facility was designed with no runway lights or night-time launches.

- FAA independently reviewed and adopted a previous environmental impact statement that NASA had conducted for the launch site at Wallops Flight Facility in Virginia. FAA adopted this environmental impact statement to issue, renew, or modify licenses for commercial space launch operations at this facility. Specifically, FAA's assessment focused on the environmental consequences of commercial launch activities at Wallops Flight Facility over a 20-year planning horizon.

In its adoption of NASA's environmental impact statement, FAA determined that the mitigation measures outlined in that environmental impact statement—which included requiring operators to obtain local permits and approvals prior to launch—would help preserve and protect the environment. In particular, according to the original NEPA review, NASA determined launches at this facility could have effects on Virginia's coastal area. Thus, NASA determined that permits and approvals would be needed prior to activities that might affect coastal resources, consistent with Virginia's program to manage the coast. FAA concluded that launch activities being proposed at this facility would not result in significant impacts on coastal resources,

provided operators obtained the needed permits and approvals prior to launch.

FAA Considers the Impacts of Airspace Closures at Multiple Points in the Licensing and Launch and Reentry Processes

FAA Determines the Size, Duration, and Impacts of Airspace Closures Necessary to Protect Public Safety

Identifying and Planning for Potential Airspace Closures During Licensing

According to FAA officials, approving or denying an application for a launch and reentry license based on the potential effects on other airspace users is not within FAA's statutory authority. However, FAA begins to identify and plan for the effects of airspace closures on other airspace users during licensing, while still ensuring operations meet safety criteria.

FAA launch and reentry licensing regulations direct operators to determine the amount of airspace that needs to be closed to control the potential safety risks posed by the operations.²¹ Such risks include hazardous debris from normal launch and reentry operations as well as failed operations. Operators conduct the analysis necessary to identify this airspace—known as a “flight hazard area”—as part of the safety analysis required for a launch and reentry license application.²² The flight hazard area informs what portion of airspace will be closed to other airspace users during the proposed operation.²³ As part of their analysis to identify the flight hazard area, operators also identify other parts of airspace exposed to lower levels of risk from the operation. The airspace

²¹14 C.F.R. § 450.133.

²²14 C.F.R. § 450.133(a). A flight hazard area analysis will identify any region of air that must be surveyed, publicized, controlled, or evacuated to control the risk to the public. Prior to initiating a launch or reentry, the operator will publicize, survey, control, or evacuate each flight hazard area identified during the flight hazard area analysis to the extent necessary to meet safety criteria.

²³14 C.F.R. § 91.143.

at the lower level of risk does not need to be closed, according to FAA officials.

FAA officials told us they work with operators throughout the licensing process to identify ways to limit the effects of flight hazard areas on other airspace users, though FAA's decision whether to grant a license is not based on these discussions. FAA officials said they provide operators with preliminary estimates of air traffic impacts of proposed flight hazard areas. They said they also discuss potential mitigations to reduce the impact of the operation on other airspace users. For example, FAA officials said that instead of representing the flight hazard area as a standard rectangle, the corners may be trimmed to fit more closely to the contours of risk. As a result, the flight hazard area could look more like an octagon than a rectangle.

FAA regulations require operators to document, as part of their application, the process for informing aviation stakeholders about flight hazard areas for a particular operation. FAA includes this information in a letter of agreement. To develop the letter of agreement, FAA holds meetings with stakeholders having responsibilities relevant to the operations to discuss the vehicle and expected procedures for launches or reentries. The letters of agreement establish and document procedures for:

- Issuing a Notice to Air Missions prior to a launch or reentry, which is used to inform airspace users of the closure,
- Communicating and coordinating with affected air traffic control facilities leading up to and during the launch or reentry, and
- Determining (1) how operators will request a launch or reentry time from FAA and (2) FAA's responsibilities for scheduling operations based on anticipated air traffic or safety concerns.

Assessing the Impacts of Airspace Closures and Finalizing the Hazard Area

After FAA grants a launch and reentry license, the operator must also submit a request to FAA to conduct each specific launch or reentry operation, according to FAA's order on airspace handling procedures and as outlined in the operator's letter of agreement.²⁴ According to FAA

²⁴FAA, *Procedures for Handling Airspace Matters*, Order JO 7400.2P (Washington, D.C.: April 20, 2023).

officials, licensing decisions do not consider the effect of the proposed operation on other airspace users; however, decisions to grant approval for specific launch or reentry times do, according to FAA's airspace procedures order.

In determining whether to approve a requested launch or reentry time, FAA must assess how the timing, location, and size of the flight hazard area will affect the national airspace system. As part of this assessment, FAA does the following: evaluates historical air traffic data to identify affected air traffic routes; estimates the number of aircraft affected; and calculates the reroute mileage or delay time required for each flight to avoid the flight hazard area. For example, according to one airspace impact analysis that we reviewed, FAA examined 30 days of historical flight data to identify effects from a proposed 16-nautical mile radius airspace closure. FAA concluded that the closure could result in aircraft reroutes of less than 5 nautical miles, on average.

FAA's decision to approve or deny a proposed launch or reentry time also takes into account the individual circumstances of the mission. For example, typically, cargo resupply missions to the International Space Station have launch windows of short duration, which FAA can successfully integrate into the airspace. Similarly, FAA typically does not deny launch times for Department of Defense missions.

If FAA determines it cannot accommodate the launch at the requested time due to airspace impacts, it works with the operator to identify alternatives that reduce the effects on other airspace users, according to FAA guidance. FAA officials told us they have denied launch times that operators requested based on the effect the launch would have on other airspace users. Though FAA does not retain records on the number of times such denials have occurred, they provided us with two examples, both related to peak holiday travel. First, FAA received a request from an operator to launch on a Presidents' Day holiday, which would have affected FAA's ability to manage peak holiday air traffic. Instead, FAA offered the days before and after the holiday as an alternative, which were satisfactory to the operator. Second, FAA officials said that they denied an operator's request to launch during the days immediately before Thanksgiving, as that is a time of high commercial airline traffic and the impact on other users would have been significant.

FAA officials stated that the final airspace closure area is a size that encompasses areas at risk from the launch or reentry and that meets safety standards set in FAA regulations. Depending on circumstances,

the flight hazard area may be smaller or larger than the area identified in the license application as described below.

- In operations that occur on federal launch sites, the hazard area may be larger because FAA must take into account the special use airspace that the federal launch sites have traditionally closed for their missions, according to FAA officials. These federal launch sites established the special use airspace areas to accommodate all possible initial launch directions; as a result, they are larger than the airspace closure required for a specific mission with a specific initial launch direction. FAA officials told us that they have worked with federal launch sites to reduce the additional restricted areas. For example, FAA officials stated they worked with Cape Canaveral Space Force Station to only close the relevant portions of airspace during commercial space launches, as opposed to a larger area. According to FAA, this approach opens airspace used by two airports and results in reduced congestion and miles flown by aircraft.
- In their license application, operators are required to identify airspace at different levels of risk. To reduce the size of the flight hazard area, FAA officials told us they may not close areas identified in the license application as being at lower risk than the parts of the flight hazard area required to be closed by regulation.

Communicating Airspace Closures

After finalizing the size and duration of the airspace that will be closed during a launch or reentry operation, FAA communicates information about the operation to air traffic control facilities and other airspace users, as described in the letter of agreement. FAA issues an airspace management plan to affected air traffic control facilities, notifies other airspace users, and operates a hotline during the operation to help implement the flight hazard area.²⁵

- **Airspace management plan:** As part of this plan, FAA identifies how the launch vehicle operates, the approximate size and duration of the flight hazard area and the anticipated reroute distance for airspace users. According to FAA officials, 3 to 5 days before the operation, FAA completes the plan and communicates it to airspace users and

²⁵A Notice to Air Missions is a notice containing information essential to personnel concerned with flight operations but not known far enough in advance to be publicized by other means. It states the abnormal status of a component of the National Airspace System, including flight hazard areas.


air traffic control facilities so that they are aware that they may have to reroute traffic to accommodate a launch or reentry.

- **Notices to Airspace Users:** FAA issues notices before closing airspace for a launch or reentry to inform airspace users of the impending closure, which these users must avoid per FAA regulations.²⁶ FAA communicates these notices (i.e., Notice to Air Missions) via its aviation data sharing system, over a toll-free phone number, and on its public website. The notices include the time and geographical coordinates of the flight hazard area and the reason for the closure. Figure 2 shows a representation of a Notice to Air Missions with a closure due to a space launch.

²⁶14 C.F.R. § 91.143.

Figure 2: Representation of a Notice to Air Missions Announcing Airspace Closure Due to Commercial Space Launch

NOTAM		FDC 8/2164 Download shapefiles	
Number :			
Issue Date:	April 03, 2018 at 1927 UTC		
Location:	KODIAK, Alaska		
Beginning Date and Time:	April 05, 2018 at 2000 UTC		
Ending Date and Time:	April 06, 2018 at 0200 UTC		
Reason for NOTAM:	DUE TO ROCKET LAUNCH ACT		
Type:	Space Operations		
Replaced NOTAM(s):	N/A		
Jump To:	Affected Areas Operating Restrictions and Requirements Other Information Airspace Closure Coordinates		
Affected Area(s)		Top	
Airspace Definition:			
Region bounded by:			
	<u>Latitude:</u>	<u>Longitude:</u>	<u>FRD:</u>
From:	57°29'00"N	152°21'00"W	
To:	57°21'00"N	152°10'00"W	
To:	57°10'22"N	152°11'29"W	
To:	57°09'46"N	152°18'15"W	
To:	57°09'58"N	152°23'47"W	
To:	56°59'21"N	152°38'31"W	
To:	56°57'45"N	152°42'50"W	
To:	56°56'01"N	152°48'13"W	
To:	56°55'26"N	152°53'07"W	
Altitude: From the surface up to Unlimited			



Click for Sectional

NOTAM Text

Legend

- Airspace closure area
- Airspace closure duration
- Airspace closure coordinates

Source: FAA Notice to Air Missions. | GAO-24-106193

Note: This image is a representation of a Notice to Air Missions from FAA’s publicly available temporary flight restriction search tool.

- **Hotline:** During a launch or reentry operation, FAA communicates with the vehicle operator, site operator, and air traffic control facilities over a hotline. FAA and these stakeholders use the hotline to share information about the status of the operation, decreasing the amount of time airspace is closed. It also allows FAA to communicate information about potential vehicle anomalies.

Other FAA Efforts to Address the Impact of Commercial Space Operations on Airspace Users

FAA has reported decreasing the amount of time airspace is closed by using time-based traffic management procedures. These procedures

attempt to more efficiently identify aircraft projected to enter a hazard area when space operations occur to reduce re-routing. In a report to Congress that FAA officials stated they provided in 2023, FAA found that 143 aircraft were delayed an average of 32 minutes in 2022, representing 0.04 percent of total minutes of delays that year.²⁷ FAA also noted that the majority of launch and reentry impacts to other airspace users are associated with additional distance and time flown, rather than delays.

In this report to Congress, FAA described taking other steps to better balance the needs of airspace users during a launch or reentry. For example, FAA is pursuing technological solutions to mitigate effects of flight hazard areas on other national airspace system users. In 2021, FAA began using the Space Data Integrator operational prototype. According to FAA, the Space Data Integrator provides a near real-time capability to receive and monitor launch and reentry vehicle location and mission event status, and hazard area time updates. In addition, the Space Data Integrator enables data exchange with an FAA traffic flow management tool and automation of some manual processes. In the future, the Space Data Integrator may increase the distribution of launch and reentry data to additional air traffic automation systems.

According to a June 2023 report from DOT's Office of the Inspector General, the Space Data Integrator, along with additional air traffic control procedures, is expected to help FAA decrease the amount of time that restricted airspace is needed for commercial space operations.²⁸ To improve FAA's ability to provide information on its efforts to integrate commercial space operations into the national airspace system, the report recommended that FAA determine the workload impact and specific tasks related to commercial space operations on air traffic facilities, among other things. FAA concurred with these recommendations and is working to complete actions needed to implement them.

According to FAA officials and stakeholders, FAA also convenes the Space Collaborative Decision-Making Group, where the aviation and commercial space industries can communicate with FAA about flight

²⁷Congress directed FAA to report on the agency's efforts to integrate commercial space into the national airspace system and data on delays to commercial airline flights resulting from commercial space operations, and an evaluation of the impact of commercial space operations on the environment and communities. H.R. Comm. on Appropriations, 117th Cong., Consolidated Appropriations Act, 2023 (Comm. Print 2023).

²⁸Office of Inspector General, U.S. Department of Transportation, *FAA Has Deployed a Prototype System for Monitoring Commercial Space Operations but Faces Integration Challenges* (Washington, D.C.: June 21, 2023).

hazard areas and their effects. According to FAA officials, this group solicits feedback from both industries, allows for the exchange of information, and helps develop airspace integration strategies and capabilities. Based on this feedback, FAA officials told us, they may choose to hold commercial space operations at times of day and days of the week with less air traffic.


According to FAA officials, FAA also reviews any aviation industry stakeholder comments on the effects of airspace closures on airlines provided as part of the NEPA review public comment period on certain license applications. FAA officials also stated that they hold public events and post information online to collect public comments on airspace issues related to launch and reentry operations, among other issues.

Agency Comments

We provided a copy of this report to DOT for review and comment. DOT provided technical comments, which we incorporated as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until after 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Secretary of Transportation, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact Heather Krause at (202) 512-2834 or KrauseH@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix I.



Heather Krause
Managing Director, Physical Infrastructure

Appendix I: GAO Contact and Staff Acknowledgments

GAO Contact

Heather Krause, (202) 512-2834 or KrauseH@gao.gov

Staff Acknowledgments

In addition to the contact named above, Heather Halliwell (Assistant Director), Susan Zimmerman (Assistant Director), Amy Higgins (Analyst in Charge), Erin Villareal (Analyst in Charge), Madeline Barch, Laura Bonomini, Jason Coates, Nathan Hanks, Suzanne Kaasa, Kieran Pierce, Malika Rice, Amelia Weathers, and Alicia Wilson made key contributions to this report.

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