



**Federal Aviation
Administration**

Final Environmental Assessment and Finding of No Significant Impact for Issuing a Launch Operator License to Virgin Orbit, LLC for LauncherOne Operations from Andersen Air Force Base, Guam

August 2021



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**Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for
Issuing a Launch Operator License to Virgin Orbit, LLC (VO) for LauncherOne Operations from
Andersen Air Force Base (AFB), Guam**

AGENCIES: Federal Aviation Administration (FAA), lead federal agency; 36th Wing, Andersen AFB, cooperating agency.

This Final EA is submitted pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S. Code 4321, et seq.); Council on Environmental Quality NEPA-implementing regulations (40 Code of Federal Regulations Parts 1500-1508)¹; and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*.

DEPARTMENT OF TRANSPORTATION, FAA: The FAA's Proposed Action is to issue a launch operator's license to allow Virgin Orbit (VO) to conduct launches using its Boeing 747-400 carrier aircraft and LauncherOne rocket from Anderson AFB, Guam over the Pacific Ocean east of Guam. The Proposed Action also includes the FAA's issuance of temporary airspace closures. VO proposes to conduct a maximum of 25 launches over the next 5 years (2021-2025), with a maximum of 10 launches in any 1 year during the 5 year period. Issuing a license is considered a major federal action subject to environmental review under NEPA.

The Final EA considers the potential environmental impacts from the Proposed Action and No Action Alternative on air quality; climate; noise and noise-compatible land use; cultural resources; Section 4(f) resources; water resources; biological resources; and hazardous materials, solid waste, and pollution prevention. Potential cumulative impacts are also addressed in the Final EA.

PUBLIC REVIEW PROCESS: In accordance with the applicable requirements, the FAA conducted a public review and comment period for the Draft EA. The public comment period began with the issuance of the Notice of Availability in the Pacific Daily News on October 16, 2020 and in the *Federal Register* on October 19, 2020. The public comment period ended on November 18, 2020. The FAA received nine public comment submissions (refer to Appendix C of this Final EA).

CONTACT INFORMATION: Questions regarding the Final EA can be addressed to Leslie Grey, Environmental Protection Specialist, FAA, 800 Independence Avenue SW, Suite 325, Washington, DC 20591; leslie.grey@faa.gov.

This EA becomes a Federal document when evaluated, signed, and dated by the responsible FAA Official.

Responsible FAA Official:

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Daniel Murray
Executive Director, Office of Operational Safety

¹The Council on Environmental Quality (CEQ) amended its regulations implementing NEPA effective September 14, 2020. Under section 1506.13 of the amended regulations, agencies have discretion to apply the amended regulations to NEPA processes that were begun before September 14, 2020. FAA initiated its NEPA process for this action on February 7, 2020 and has decided not to apply the amended regulations. Therefore, the prior 1978 CEQ regulations continue to apply to this NEPA process.

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U.S. DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Office of Commercial Space Transportation
Finding of No Significant Impact for
Issuing a Launch Operator License to Virgin Orbit, LLC for LauncherOne
Operations from Andersen Air Force Base, Guam

Summary

The Federal Aviation Administration (FAA) prepared the attached Final Environmental Assessment (EA) to analyze the potential environmental impacts of issuing a launch operator license to Virgin Orbit, LLC (VO) to conduct launches using its Boeing 747-400 carrier aircraft and LauncherOne rocket from Andersen Air Force Base (AFB), Guam over the Pacific Ocean east of Guam. The EA was prepared in accordance with the National Environmental Policy Act (NEPA), as amended (42 United States Code [USC] § 4321 et seq.); Council on Environmental Quality (CEQ) NEPA implementing regulations (Title 40, Code of Federal Regulations [CFR] Parts 1500 – 1508);⁽²⁾ and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*.

After reviewing and analyzing available data and information on existing conditions and potential impacts, the FAA has determined the Proposed Action would not significantly affect the quality of the human environment. Therefore, the preparation of an Environmental Impact Statement (EIS) is not required, and the FAA is issuing this Finding of No Significant Impact (FONSI). The FAA has made this determination in accordance with applicable environmental laws and FAA regulations. The Final EA is incorporated by reference into this FONSI.

For any questions or to request a copy of the Final EA, contact:

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A copy of the Final EA may also be obtained from the FAA's website:

https://www.faa.gov/space/environmental/nepa_docs/

² The CEQ amended its regulations implementing NEPA effective September 14, 2020. Under section 1506.13 of the amended regulations, agencies have discretion to apply the amended regulations to NEPA processes that were begun before September 14, 2020. FAA initiated its NEPA process for this action on February 7, 2020 and has decided not to apply the amended regulations. Therefore, the prior 1978 CEQ regulations continue to apply to this NEPA process.

Purpose and Need

The purpose of FAA's Proposed Action is to fulfill the FAA's responsibilities as authorized by the Commercial Space Launch Act of 1984, as amended, (51 USC §§ 50901-50923) for oversight of commercial space launch activities, including licensing launch activities. The need for FAA's Proposed Action results from the statutory direction from Congress under the Commercial Space Launch Act of 1984 to *"oversee and coordinate the conduct of commercial launch and reentry operations, issue permits and commercial licenses and transfer commercial licenses authorizing those operations, and protect the public health and safety, safety of property, and national security and foreign policy interests of the United States; and to facilitate the strengthening and expansion of the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities."* (51 USC 50901(b))

The purpose of VO's proposal is to provide a low cost, responsive, and adaptable launch method to place small satellites into a variety of low earth orbits. The demand for smaller launch vehicles is largely due to the development of an emerging market for smaller commercially used satellites, and a national security environment that demands quick launch capabilities. The need for VO's proposal is to fulfill the requirements of clients in the small satellite commercial orbital and suborbital markets.

Proposed Action

The FAA's Proposed Action is to issue a launch operator's license to allow VO to conduct launches using its Boeing 747-400 carrier aircraft and LauncherOne rocket from Anderson AFB, Guam over the Pacific Ocean east of Guam. The Proposed Action also includes the FAA's issuance of temporary airspace closures. VO proposes to conduct a maximum of 25 launches over the next 5 years (2021-2025), with a maximum of 10 launches in any 1 year during the 5-year period. For example, a potential launch scenario could be the following: 1 launch in 2021, 3 in 2022, 5 in 2023, 6 in 2024, and 10 in 2025.

Cooperating Agencies

The U.S. Air Force's (USAF's) 36th Wing, Andersen AFB participated in the EA process as a cooperating agency due to its jurisdiction by law and special expertise.⁽³⁾ Under the proposed action, VO would perform integration, mating, propellant loading operations, and takeoff and landing operations on Andersen AFB; no construction or ground-disturbing activities would occur and there would be no change to existing infrastructure on Andersen AFB. In accordance with NEPA, the 36th Wing prepared an Environmental Impact Analysis and determined that the proposed activities qualified for the following Categorical Exclusion (CATEX) under Chief of Naval Operations Instruction (OPNAVINST) 5090.1D, CH-10 (CATEX 21): Temporary (for less than 30 days) increases in air operations up to 50% of the typical installation aircraft operation rate or increases of 50 operations a day, whichever is greater.

³ A cooperating agency is any federal agency other than the lead agency which has jurisdiction by law or special expertise regarding any environmental impact involved in a proposal or reasonable alternative (40 CFR Part 1508.5) [1978].

Alternatives

Alternatives analyzed in detail in the EA include (1) the Proposed Action and (2) the No Action Alternative. Under the No Action Alternative, the FAA would not issue a launch operator license to VO for LauncherOne operations from Andersen AFB. This alternative provides the basis for comparing the environmental consequences of the Proposed Action. Paragraph 6-2.1 of FAA Order 1050.1F states in part: *“There is no requirement for a specific number of alternatives or a specific range of alternatives to be included in an EA. An EA may limit the range of alternatives to the proposed action and no action when there are no unresolved conflicts concerning alternative uses of available resources. Alternatives are to be considered to the degree commensurate with the nature of the proposed action and agency experience with the environmental issues involved.”*

Public Involvement

In accordance with CEQ’s NEPA-implementing regulations and FAA Order 1050.1F, the FAA conducted a public review and comment period for the Draft EA. The public comment period began with the issuance of the Notice of Availability in the *Pacific Daily News* on October 16, 2020 and in the *Federal Register* on October 19, 2020. The public review and comment period ended on November 18, 2020. The FAA received nine public comment submissions and has provided a response to each comment (refer to Appendix C of the Final EA). The Final EA reflects the FAA’s consideration of comments.

Environmental Impacts

The potential environmental impacts from the Proposed Action and No Action Alternative were evaluated in the attached Final EA for each environmental impact category identified in FAA Order 1050.1F. Chapter 3 of the Final EA describes the affected environment and regulatory setting. Section 3.1 of the Final EA discloses that the following environmental impact categories were not evaluated further because the proposed activities at Andersen AFB and over the Pacific Ocean would not affect these environmental resources: Visual Effects; Coastal Resources; Land Use; Farmlands; Natural Resources and Energy Supply; Socioeconomics, Environmental Justice, and Children’s Health and Safety Risks.

Chapter 3 of the Final EA provides evaluations of the potential environmental consequences of each alternative for each of the environmental impact categories analyzed in detail and documents the finding that no significant environmental impacts would result from the Proposed Action. In addition, Chapter 3 addresses the requirements of special purpose laws, regulations, and Executive Orders.

A summary of the documented findings for each impact category, including requisite findings with respect to relevant special purpose laws, regulations, and executive orders, is presented below.

- **Air Quality**, Final EA Section 3.3. Air pollutant emissions below 3,000 feet (ft) would be of short duration during carrier aircraft operations at Andersen AFB, including takeoffs and landings. Air pollutant emissions would not result in violations of any regional air quality standards, including the National Ambient Air Quality Standards (NAAQS). Rocket activities would occur at altitudes above 35,000 ft above ground level, in the atmospheric layer of the stratosphere. Pollutants that are released in the stratosphere do not mix with ground level emissions and do not have

an effect on ground level air pollutant concentrations in any local area. Additionally, per FAA report number FAA-AEE-00-01 DTS-34, *Consideration of Air Quality Impacts By Airplane Operations at or Above 3000 feet AGL*, dated September 2000, these activities are exempt from analysis for local and regional air quality. Accordingly, rocket activities would have no impact on regional air quality. Therefore, the Proposed Action would not result in significant impacts on air quality. Section 3.3.4.1 of the Final EA indicates while air pollutant emissions the Proposed Action would increase, they would not result in violations of NAAQS because they would not have a measurable impact on air quality.

Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. Minimal, if any, additional emissions would be generated from aircraft departure delays because the FAA rarely receives reportable departure delays associated with commercial space launches. Airspace closures as a result of the Proposed Action could occur up to a maximum of 10 times per year. Thus, any delays in aircraft departures from affected airports would be short-term and any increases in air emissions from grounded aircraft are expected to be minimal and would occur in attainment areas. Therefore, these emissions increases are not expected to result in significant air quality impacts.

Marine vessels in the vicinity of the ship hazard areas (SHAs) would be notified of VO operations by the NOTMAR and possibly incur additional transit time and delays. However, marine vessel density is low in these areas. Given the very low level of shipping traffic underlying the proposed LauncherOne trajectory that could occur within the SHAs, emissions from surface vessels potentially rerouting to avoid the SHAs would not be significantly different from those emissions generated along the original course. The advance notice in the NOTMAR, short duration of the temporary SHAs, and infrequent occurrence of proposed launch activities (i.e., up to a maximum of 10 times per year), surface vessels may be able to make minor course corrections that would not result in additional emissions that would impact ambient air quality. Potential impacts on marine vessel re-routing would be temporary, infrequent, and anticipated to result in a negligible increase in air emissions.

- **Climate**, Final EA Section 3.4. Section 3.4.4 of the Final EA states there are no established significance thresholds for climate and greenhouse gas (GHG) emissions. FAA has not identified specific factors to consider in making a significance determination for GHG emissions, especially as it may be applied to a particular project. The maximum total annual greenhouse gas (GHG) emissions under the Proposed Action is estimated to be 330 metric tons of carbon dioxide equivalent (CO₂e). Though emissions from carrier aircraft and rocket operations would increase the yearly levels of GHGs, the emissions would represent a negligible fraction of GHG emissions from the United States and the world.
- **Noise and Noise-Compatible Land Use**, Final EA Section 3.5. Section 3.5.3 of the Final EA states aircraft operating from both Andersen AFB and the Guam International Airport contribute to

aircraft noise on Guam. The Guam International Airport is operated by the Guam International Airport Authority and handles nearly all of the commercial flights into and out of Guam and is the only civilian air transportation facility on Guam. Carrier aircraft takeoffs and landings are not expected to change the average Day-Night Average Sound Level (DNL) contours at Andersen AFB or elevate the DNL noise level more than 1.5 decibels (dB) over noise-sensitive land uses above the acceptable levels of 65 dB. The Proposed Action would represent a very small increase over the existing air traffic and it is unlikely that these activities would contribute to the overall sound environment. Additionally, the effect of airspace closures due to commercial space operations, causing temporarily grounded aircraft and re-routing of en-route flights on established alternate flight paths, would be negligible. Therefore, noise associated with proposed take off and landings of the carrier aircraft under the Proposed Action would not significantly impact the acoustic environment of Andersen AFB and vicinity. Section 3.5.4.1 of the Final EA addresses noise from the carrier aircraft and the LauncherOne rocket under the Proposed Action. The Launcher One rocket would be released from the carrier aircraft over the ocean away from populated areas south of Guam, at an altitude of 35,000 to 40,000 feet above mean sea level. No sonic boom would intersect with land or human-sensitive receptors. The closest sonic boom to the coast with a magnitude of 1.0 pounds per square foot (psf) or greater is located approximately 75 nautical miles (nm) south-southwest of Guam. Received sonic boom levels at the water's surface would be <1 psf. As none of the sonic boom events that were modeled overlap or otherwise affect the coastal zone, terrestrial areas, sensitive marine habitats, or sensitive receptors, impacts to the marine environment related to sonic booms would be less than significant. Therefore, the Proposed Action would not result in significant noise impacts.

- **Cultural Resources**, Final EA Section 3.6. The Proposed Action would not result in any ground-disturbing activities and would not require any construction or modification of facilities at Andersen AFB. Proposed carrier aircraft operations would occur on existing apron, taxiway, and runway surfaces and there would be no changes to these areas under the Proposed Action. Carrier aircraft operations would be similar to military activities currently conducted on the same aprons, taxiways, and runways. There are no known cultural resources underlying the proposed LauncherOne trajectory that would be potentially impacted by proposed rocket operations. Section 3.6.4.1 of the Final EA discloses that the FAA conducted National Historic Preservation Act Section 106 consultation with the Guam Historic Preservation Division and the State Historic Preservation Officer (SHPO). The SHPO concurred with the FAA's finding that the Proposed Action would not adversely affect any properties listed or eligible for listing on the National Register of Historic Places (see Appendix D.2 of the Final EA). Therefore, the Proposed Action would not result in significant impacts on cultural resources.
- **Department of Transportation Act, Section 4(f)**, Final EA Section 3.7. The Proposed Action does not involve any construction activities and therefore would not require a physical use of a Department of Transportation Act Section 4(f) resource. The Proposed Action would not require a temporary occupancy of a Section 4(f) resource, such as a temporary easement or

right of entry. While the airfield at Andersen AFB is eligible for listing under the National Register of Historic Places and is the site of the Proposed Action, no impacts to the airfield, including visual or noise, would be so severe that the activities, features, or attributes of the airfield would be substantially impaired. The LauncherOne drop point would be located 75 nm south-southwest of Guam and would occur over the Trench Unit of the Marianas Trench Marine National Monument (MTMNM) at an altitude 35,000 to 40,000 ft above sea level. Section 3.7.3.2 of the Final EA identifies the MTMNM as the only Section 4(f) resource within the Pacific Ocean study area. During the expected LauncherOne firing and flight trajectory, the aircraft hazard area (AHA) and SHA for the re-entry of Stage 1 and the payload fairings is 325 nm northeast of the MTMNM. Therefore, there would be no impacts to the MTMNM. In summary, the Proposed Action would not constitute a physical or constructive use of any Section 4(f) property and therefore would not result in significant impacts to Section 4(f) properties.

- **Water Resources (including Wetlands, Surface Waters, and Groundwater)**, Final EA Section 3.8. The Proposed Action does not involve construction activities that would potentially introduce non-point source pollution at Andersen AFB. The potential impact of operations is negligible as the LauncherOne propellants and pressurants are similar to those already in use at Andersen AFB with appropriate safety and pollution control measures in place. First stage and fairings debris, which are comprised of inert materials which are neither chemically nor biologically reactive, are anticipated to sink relatively quickly. The propellant type used by LauncherOne Stage 1 is a mixture of a kerosene-based fuel (known as RP-1) and liquid oxygen (LOX). Any unused RP-1 evaporates quickly when exposed to the air and would completely dissipate into ocean waters within hours due to a combination of wave movement, oxygen exposure, and sunlight. Accordingly, it would not affect water quality in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats). LOX is a non-toxic cryogenic liquid which will evaporate into the air when released. Therefore, implementation of the Proposed Action would not have significant impacts on water resources on Andersen AFB and underlying the Stage 1 and Fairings debris SHA.
- **Biological Resources (including Fish, Wildlife, and Plants)**, Final EA Section 3.9. Implementation of the Proposed Action would not result in significant impacts to wildlife and Endangered Species Act (ESA)-listed mammals, sea turtles, and fish species in the vicinity of the proposed carrier aircraft and LauncherOne activities. These impacts include noise associated with overflights of the carrier aircraft taking off and landing at Andersen AFB, in-air and underwater acoustic impacts from sonic booms under the LauncherOne trajectory, unspent RP-1 fuel from Stage 1 when it impacts the Pacific Ocean, and potential strike of marine species underlying the Stage 1 and Fairings AHA. In accordance with section 7 of the ESA, the FAA conducted consultation with the National Marine Fisheries Service (NMFS) to assess the potential impacts of the Proposed Action on ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory. NMFS issued a letter of concurrence stating that the Proposed Action would not jeopardize the continued existence of a federally listed

threatened or endangered species (see Appendix D.1 of the Final EA). Therefore, the Proposed Action would not result in significant impacts on biological resources.

- **Hazardous Materials, Solid Waste, and Pollution Prevention**, Final EA Section 3.10. All hazardous materials and solid wastes would be handled in accordance with all applicable federal laws and regulations. Section 3.10.2 of the Final EA states Andersen AFB has established plans and procedures to handle and dispose of hazardous materials and solid wastes. Therefore, the Proposed Action would not result in significant impacts related to hazardous materials, solid waste, and pollution prevention.

Please refer to Chapter 3 of the Final EA for a full discussion of the determination for each environmental impact category.

Chapter 4 of the Final EA provides an analysis of the potential cumulative impacts of the Proposed Action when added to other past, present, and reasonably foreseeable future actions. The FAA has determined that the Proposed Action would not result in significant cumulative impacts in any environmental impact category.

Conditions and Mitigation

As prescribed by 40 CFR § 1505.3 [1978], the FAA shall take steps as appropriate to the action, through mechanisms such as the enforcement of licensing conditions, and shall monitor these as necessary to ensure that VO implements avoidance and/or minimization measures as set forth in Chapter 3 of the Final EA under the various impact categories. These measures include:

- handling hazardous materials, hazardous wastes, and solid wastes in accordance with all relevant federal, state, and local regulations pertaining to these substances.

Agency Finding and Statement

The FAA has determined that no significant impacts would occur with implementation of the Proposed Action and, therefore, that preparation of an EIS is not warranted and a FONSI, in accordance with 40 CFR § 1501.4(e) [1978], is appropriate.

After careful and thorough consideration of the facts contained herein, the undersigned finds that the proposed Federal action is consistent with existing national environmental policies and objectives as set forth in Section 101 of NEPA and other applicable environmental requirements and will not significantly affect the quality of the human environment or otherwise include any condition requiring consultation pursuant to Section 102(2)(C) of NEPA.

DANIEL P MURRAY

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Daniel Murray
Executive Director, Office of Operational Safety

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Acronyms & Abbreviations

| | | | |
|----------------------------|--|------------------|---|
| 36 CES/CEV | 36th Civil Engineer Squadron | lb | pound(s) |
| | Environmental Flight | lbm | pound mass |
| AEM | Area Equivalent Method | LEO | low-Earth orbit |
| AFB | Air Force Base | LOX | liquid oxygen |
| AFCEE | Air Force Center for Engineering and the Environment | LTO | landing and take off |
| AGL | above ground level | MMPA | Marine Mammal Protection Act |
| AHA | Aircraft Hazard Area | mph | miles per hour |
| AICUZ | Air Installations Compatibility Use Zones | MSA | Munitions Storage Area |
| ARTCC | Air Route Traffic Control Center | MSL | above mean sea level |
| ATCSCC | Air Traffic Control System Command Center | MT | metric ton(s) |
| CAA | Clean Air Act | MTMNM | Marianas Trench Marine National Monument |
| CEQ | Council on Environmental Quality | N ₂ O | nitrous oxide |
| CERAP | Center Radar Approach Control | NAAQS | National Ambient Air Quality Standards |
| CFR | Code of Federal Regulations | Navy | U.S. Navy |
| CH ₄ | methane | NEPA | National Environmental Policy Act |
| CO ₂ | carbon dioxide | NHPA | National Historic Preservation Act |
| CO ₂ e | carbon dioxide equivalent | nm | nautical mile(s) |
| CSOSA | Commercial Space Operations Service Agreement | NMFS | National Marine Fisheries Service |
| CWA | Clean Water Act | NOAA | National Oceanic and Atmospheric Administration |
| dB | decibel(s) | NOTAM | Notice to Airmen |
| dBA | A-weighted decibel(s) | NOTMAR | Notice to Mariners |
| dB _{rms} re 1 μPa | decibels root mean square reference 1 micropascal | NO _x | nitrogen oxides |
| DNL | day-night average sound level | NRHP | National Register of Historic Places |
| EA | Environmental Assessment | PACAF | Pacific Air Forces |
| EEZ | Exclusive Economic Zone | psf | pounds per square foot |
| EFH | Essential Fish Habitat | RP-1 | rocket propellant 1 |
| EIS | Environmental Impact Statement | SHA | Ship Hazard Area |
| EO | Executive Order | SO ₂ | sulfur dioxide |
| ESA | Endangered Species Act | U.S. | United States |
| FAA | Federal Aviation Administration | USAF | U.S. Air Force |
| ft | foot/feet | USC | U.S. Code |
| GHG | greenhouse gas | USEPA | U.S. Environmental Protection Agency |
| Hz | hertz | USFWS | U.S. Fish and Wildlife Service |
| JRM | Joint Region Marianas | VO | Virgin Orbit, LLC |

Chapter 1. Purpose and Need

1.1 Introduction

The Federal Aviation Administration (FAA) is currently evaluating a proposal by Virgin Orbit, LLC (VO) to conduct launches using its 747 carrier aircraft and LauncherOne rocket from Andersen Air Force Base (AFB), Guam over the Pacific Ocean east of Guam for the purposes of transporting small satellites into a variety of low-Earth orbits (LEOs). As authorized by Chapter 509 of Title 51 of the United States (U.S.) Code (USC), the FAA is to “*oversee and coordinate the conduct of commercial launch and reentry operations, issue permits and commercial licenses and transfer commercial licenses authorizing those operations, and protect the public health and safety, safety of property, and national security and foreign policy interests of the United States; and to facilitate the strengthening and expansion of the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities.*”

To operate LauncherOne from Andersen AFB, VO must obtain a launch license from the FAA Office of Commercial Space Transportation. Issuing launch licenses is considered a major federal action subject to environmental review under the National Environmental Policy Act (NEPA), as amended (42 USC 4321 et seq.). The FAA is the lead federal agency and is preparing this Environmental Assessment (EA) in accordance with NEPA, Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508),⁽⁴⁾ and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*. This EA evaluates the potential environmental impacts of activities associated with the Proposed Action of issuing a launch license to VO at Andersen AFB (see Section 2.1 for more details). The completion of the environmental review process does not guarantee that the FAA will issue a launch license to VO for LauncherOne operations from Andersen AFB. VO’s license application must also meet FAA safety, risk, and financial responsibility requirements (14 CFR Part 400).

1.2 Federal Agency Roles

1.2.1 FAA Office of Commercial Space Transportation

As the lead federal agency, the FAA is responsible for analyzing the potential environmental impacts of the Proposed Action. As authorized by Chapter 509 of Title 51 of the USC, the FAA licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-federal launch and reentry sites. The mission of the Office of Commercial Space Transportation is to ensure protection of the public, property, and the national security and foreign policy interests of the U.S. during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation.

⁴ The CEQ amended its regulations implementing NEPA on September 14, 2020. Agencies have discretion to apply the amended regulations to NEPA processes that were begun before September 14, 2020 (40 CFR § 1506.13). FAA initiated its NEPA process for this action on February 7, 2020 and has decided not to apply the amended regulations. Therefore, the prior 1978 CEQ regulations continue to apply to this NEPA process.

1.2.2 Cooperating Agencies

The U.S. Air Force's (USAF's) 36th Wing, Andersen AFB participated in the EA process as a cooperating agency due to its jurisdiction by law and special expertise.⁽⁵⁾ Under the proposed action, VO would perform integration, mating, propellant loading operations, and takeoff and landing operations on Andersen AFB; no construction or ground-disturbing activities would occur and there would be no change to existing infrastructure on Andersen AFB. In accordance with NEPA, the 36th Wing prepared an Environmental Impact Analysis and determined that the proposed activities qualified for the following Categorical Exclusion (CATEX) under Chief of Naval Operations Instruction (OPNAVINST) 5090.1D, CH-10 (CATEX 21): Temporary (for less than 30 days) increases in air operations up to 50% of the typical installation aircraft operation rate or increases of 50 operations a day, whichever is greater (36th Civil Engineer Squadron Environmental Flight [36 CES/CEV] 2019a, b).

1.3 Purpose and Need

The purpose of FAA's Proposed Action is to fulfill the FAA's responsibilities as authorized by the Commercial Space Launch Act of 1984, as amended (51 USC §§ 50901-50923) for oversight of commercial space launch activities, including licensing launch activities. The need for FAA's Proposed Action results from the statutory direction from Congress under the Commercial Space Launch Act of 1984 to "oversee and coordinate the conduct of commercial launch and reentry operations, issue permits and commercial licenses and transfer commercial licenses authorizing those operations, and protect the public health and safety, safety of property, and national security and foreign policy interests of the United States; and to facilitate the strengthening and expansion of the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities." (51 USC 50901(b))

The purpose of VO's proposal is to provide a low cost, responsive, and adaptable launch method to place small satellites into a variety of low-earth orbits. The demand for smaller launch vehicles is largely due to the development of an emerging market for smaller commercially used satellites, and a national security environment that demands quick launch capabilities. The need for VO's proposal is to fulfill the requirements of clients in the small satellite commercial orbital and suborbital markets.

1.4 Public Involvement

In accordance with CEQ's NEPA-implementing regulations and FAA Order 1050.1F, the FAA conducted a public review and comment period for the Draft EA. The public comment period began with the issuance of the Notice of Availability in the Pacific Daily News on October 16, 2020 and in the Federal Register on October 19, 2020. The public review and comment period ended on November 18, 2020. The FAA received nine public comment submissions and has provided a response to each comment (refer to Appendix C). The Final EA reflects the FAA's consideration of comments.

⁽⁵⁾A cooperating agency is any federal agency other than the lead agency which has jurisdiction by law or special expertise regarding any environmental impact involved in a proposal or reasonable alternative (40 CFR Part 1508.5) (1978).

Chapter 2.

Description of the Proposed Action and Alternatives

2.1 Proposed Action

The FAA's Proposed Action is to issue a launch operator's license to allow VO to conduct launches using its 747 carrier aircraft and LauncherOne rocket from Andersen AFB, Guam over the Pacific Ocean east of Guam. The Proposed Action also includes the FAA's issuance of temporary airspace closures. VO proposes to conduct a maximum of 25 launches over the next 5 years (2021-2025), with a maximum of 10 launches in any 1 year during the 5-year period. For example, a potential launch scenario could be the following: 1 launch in 2021, 3 in 2022, 5 in 2023, 6 in 2024, and 10 in 2025. The following subsections provide a description of the project's location, launch system (carrier and launch vehicle), and proposed launch operations.

2.1.1 Location

Located in the Western Pacific Ocean, Guam is the southernmost and largest island of the Mariana Islands archipelago (Figure 2.1-1). The Mariana Islands include Guam and the Commonwealth of the Northern Mariana Islands (CNMI), both of which are sovereign (self-governing) territories of the U.S. CNMI is comprised of 14 islands, territorial waters, and submerged lands immediately north of Guam. Guam is situated approximately 3,700 miles west-southwest of Hawaii and 1,560 miles south-southeast of Japan (Joint Region Marianas [JRM] 2019).

Andersen AFB encompasses approximately 15,400 acres and is located in northern Guam (Figure 2.1-2). The main operations area of the base is in the eastern third of the installation and includes the main active airfield and an array of operations, maintenance, and community support facilities. The central third of the installation is a Munitions Storage Area. The western third is Northwest Field, which is used for helicopter training, various field exercises, bivouacs, and is the permanent location of the Pacific Air Forces (PACAF) Regional Training Center and the U.S. Army Terminal High-Altitude Area Defense ballistic missile defense battery. The 36th Wing is the host unit to USAF, U.S. Army, U.S. Navy (Navy), and U.S. Marine Corps active forces along with Air Force Reserve and Air National Guard. The Wing's mission is to provide the highest quality peacetime and wartime support from its strategic Pacific location. Guam serves as a stopping point for numerous aircraft *en route* to Japan, Korea, and other Indo-Asian Pacific locations (Navy 2010; JRM 2019).

The Andersen AFB airfield has two parallel runways: one 11,200 feet (ft) long and one 10,527 ft long; both are 200 ft wide. Based on the most current data summarizing flight operations by aircraft type, Andersen AFB supported 23,691 flights annually, or approximately 65 operations per day in 2013 (PACAF and Air Force Center for Engineering and the Environment [AFCEE] 2013). The airfield supports flight operations including takeoffs, landings, and traffic pattern training of all types of based and transient aircraft including B-1, B-2, B-52, C-5, C-17, E-2, EA-18G, F/A-18, F-15, F-16, KC-10, and KC-135 fixed-wing aircraft; CH-53, H-60, and H-1 helicopters; MV-22 tilt rotor aircraft; and B747 fixed-wing aircraft, which is the same aircraft as the carrier aircraft (Wyle 2008; Navy 2010; PACAF and AFCEE 2013).

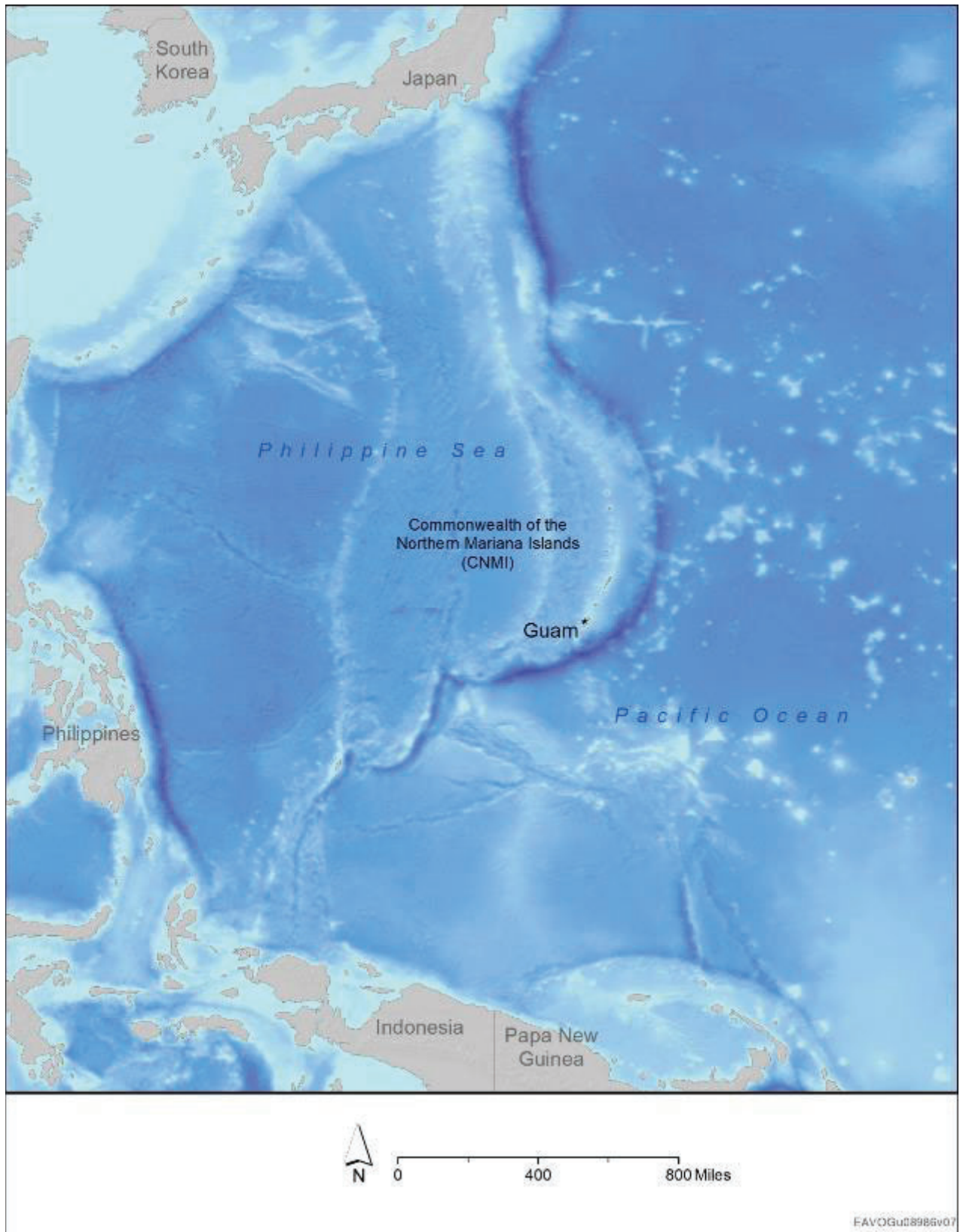


Figure 2.1-1. Regional Location of Guam

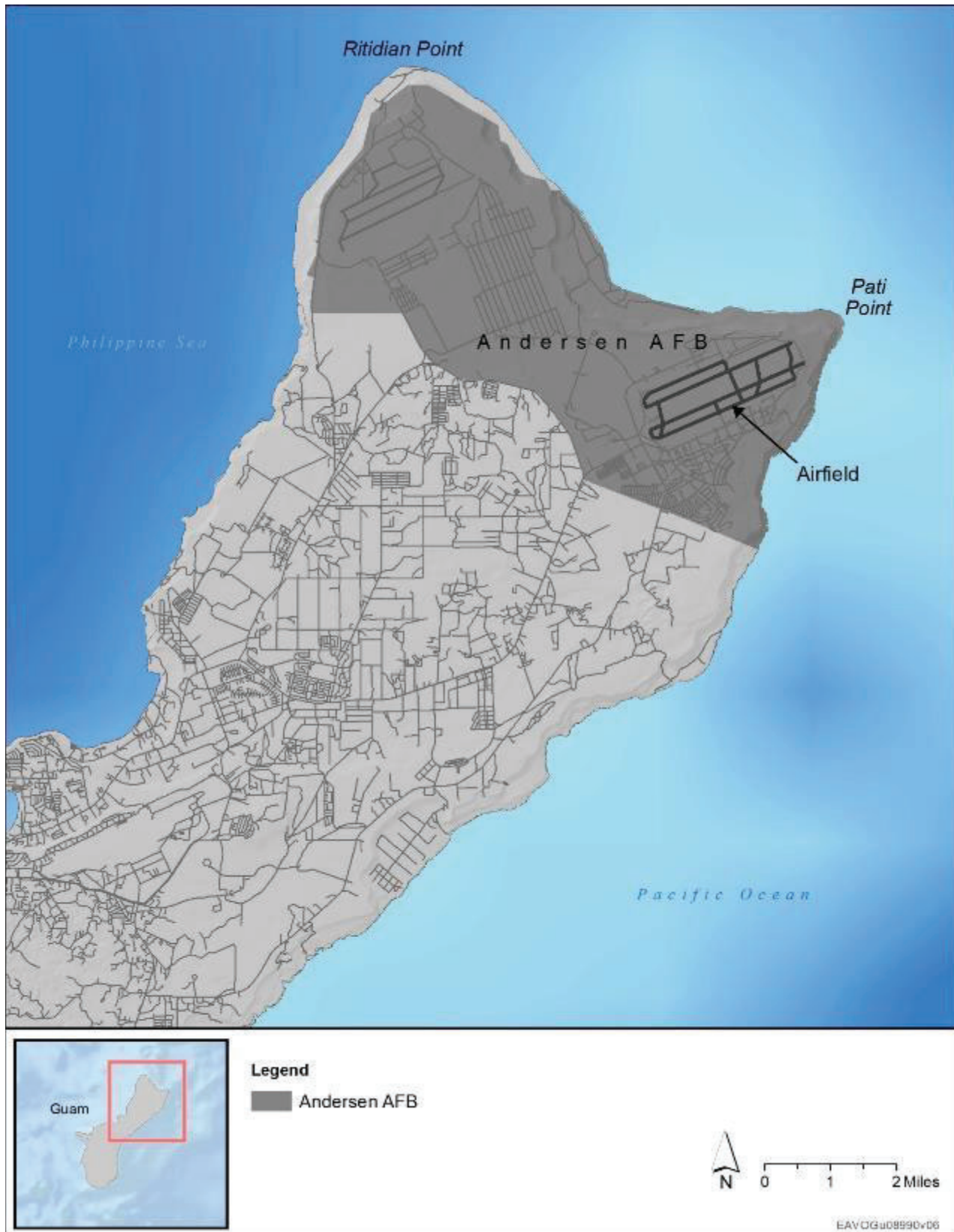


Figure 2.1-2. Andersen AFB and Vicinity, Guam

2.1.2 Launch System

2.1.2.1 Carrier Aircraft

The carrier aircraft, a Boeing 747-400, is a four-engine, wide-body vehicle, similar to other Boeing 747 aircraft that have been extensively used in commercial passenger and cargo transport for the last few decades (Figure 2.1-3). The 747-400 has a non-stop range of over 8,055 miles at almost maximum payload weight. The aircraft itself has the capability to carry over 100 metric tons (MT) of internal payload. To facilitate LauncherOne operations, the port wing of the carrier aircraft has been modified to carry both the rocket and a removable adapter, which houses the structural release mechanism, and quick release electrical and pneumatic connections to the carrier aircraft. The carrier aircraft provides electrical power, purge gasses, and monitoring and control of the rocket by a launch engineer onboard the carrier aircraft. For a round trip flight from the Andersen AFB to the LauncherOne drop point, the carrier aircraft would use approximately 83,775 pounds (lb) of Jet-A fuel.



Figure 2.1-3. Carrier Aircraft with LauncherOne Attached

2.1.2.2 Launch Vehicle: LauncherOne Rocket

The LauncherOne is an expendable, air-launched two-stage rocket (Figure 2.1-4) that is designed to carry small satellites (approximately 661–1,102 lb of payload) into a variety of LEOs. The rocket is a liquid oxygen (LOX)/rocket propellant 1 (RP-1) (kerosene) system comprised of a first stage with 29,215 pound mass (lbm) of LOX and 13,279 lbm of RP-1, and second stage with 3,642 lbm of LOX and 1,683 lbm of RP-1. The thrust of the first stage is 69,298 ft lb.

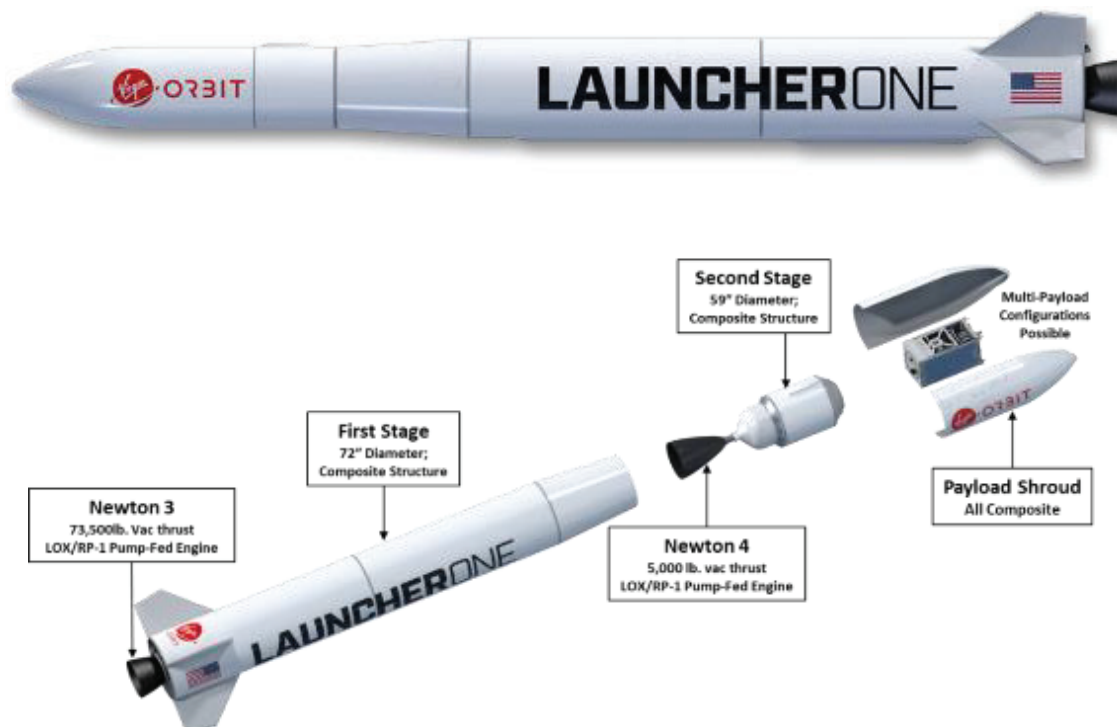


Figure 2.1-4. LauncherOne Rocket

Rather than launching from ground level, the rocket is carried to an altitude of approximately 35,000–40,000 ft above mean sea level (MSL) by the carrier aircraft and released into a flight path angle of approximately 28 degrees. The rocket offers a large fairing with a payload adapter capable of accommodating a variety of standard sizes for one or multiple satellites.

2.1.3 Launch Operations

2.1.3.1 Pre-flight Operations

Pre-flight activities consist of preparing the carrier aircraft and rocket for takeoff and launch, mounting and loading propellants on LauncherOne, and support operations, such as gathering and distributing telemetry. In accordance with Andersen AFB requirements, all hazardous pre-flight ground operations would take place within the eastern third of the base that has established appropriate safety clear zones.

All launch operations would comply with the necessary notification requirements, including issuance of Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs), as defined in agreements required for a launch license issued by the FAA Office of Commercial Space Transportation. A NOTAM provides notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (FAA Order 7930.2S, *Notices to Airmen [NOTAM]*). The FAA issues a NOTAM at least 72 hours prior to a launch activity in the airspace to notify pilots and other interested parties of temporary conditions. Similarly, the National Geospatial-Intelligence Agency (NGA), in conjunction with the U.S. Coast Guard (USCG), publishes NOTMARs weekly and as needed, informing the maritime community of temporary changes in conditions or hazards in navigable waterways. Advance notice via NOTAMs and NOTMARs and the identification of Aircraft Hazard Areas (AHAs) and Ship Hazard Areas (SHAs) would assist pilots and mariners in scheduling around any temporary disruption of flight or shipping activities in

the area of operation. Launches would be infrequent (up to a maximum of 10 per year), of short duration, and scheduled in advance to minimize interruption to air and ship traffic.

Temporary Airspace Closures

To comply with the FAA's licensing requirements, VO has entered into a Letter of Agreement (LOA) with Guam Center Radar Approach Control (CERAP), Oakland ARTCC, Air Traffic Control System Command Center (ATCSCC) Space Operations, and Andersen AFB 36th Operations Group to accommodate the flight parameters of LauncherOne (Guam CERAP et al. 2019). The LOA defines responsibilities and procedures applicable to operations, including the technical procedures to follow when issuing a NOTAM defining the affected airspace prior to launch. The Proposed Action would not require the FAA to alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations.

The FAA conducts an analysis of the constraints on airspace efficiency and capacity for each licensed launch operation. This analysis is documented in an Airspace Management Plan, which is completed approximately 3-5 days prior to launch. This information helps the FAA determine whether the proposed launch would result in an unacceptable limitation on air traffic. If that were the case, the FAA may need to work with the operator to identify appropriate mitigation strategies, such as shortening the requested launch window or shifting the launch time, if possible. The FAA often provides data to launch operators to avoid operations during days with high aviation traffic volume. Prior analyses have concluded that the majority of commercial space launch operations that occur in oceanic regions, such as where VO operations would occur, result in minor or minimal impacts on commercial and private users of airspace. This is largely due to the relatively low aircraft traffic density in oceanic regions and the ability of the FAA to manage the airspace for all users.

The published airways near Guam include the Pacific Region under the Oakland Oceanic Control with 11 jet routes that intersect over the Nimitz Very High Frequency Omni-Directional Radio Range Tactical Air Navigation Aid for in-flight navigation located at the A.B. Won Pat Guam International Airport: A450, G467, M501, R584, R585-595, G339, A597, B586, G205, W21, and A222; 2 additional routes are in the vicinity of Guam: A216 to the west and A337, B452, and G223 to the east (Figures 2.1-5 and 2.1-6).

Prior to each launch, the airspace that must be temporarily closed would be defined and published through a NOTAM. Specific launch trajectories (including latitude and longitude coordinates) for VO operations would be based on mission-specific needs as described in Section 2.1.3.2. The specific launch trajectory and associated Aircraft Hazard Areas (AHAs) would be provided in VO's Flight Safety Data Package and submitted to the FAA in advance of the launch. This information would be used to determine the necessary airspace closures provided in the NOTAM. For the purposes of the environmental review, Figure 2.1-7 provides the proposed AHA for anticipated initial operations.

All launch operations would continue to comply with the necessary notification requirements, including issuance of NOTAMs, consistent with current procedures. Launches would be of short duration and scheduled in advance to minimize interruption to airspace. En-route flights would utilize established alternative routes to minimize interruption to air traffic. Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. Accordingly, regulations applicable to all aircraft are promulgated by the FAA to define permissible uses of designated airspace. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or private aviation enthusiasts.

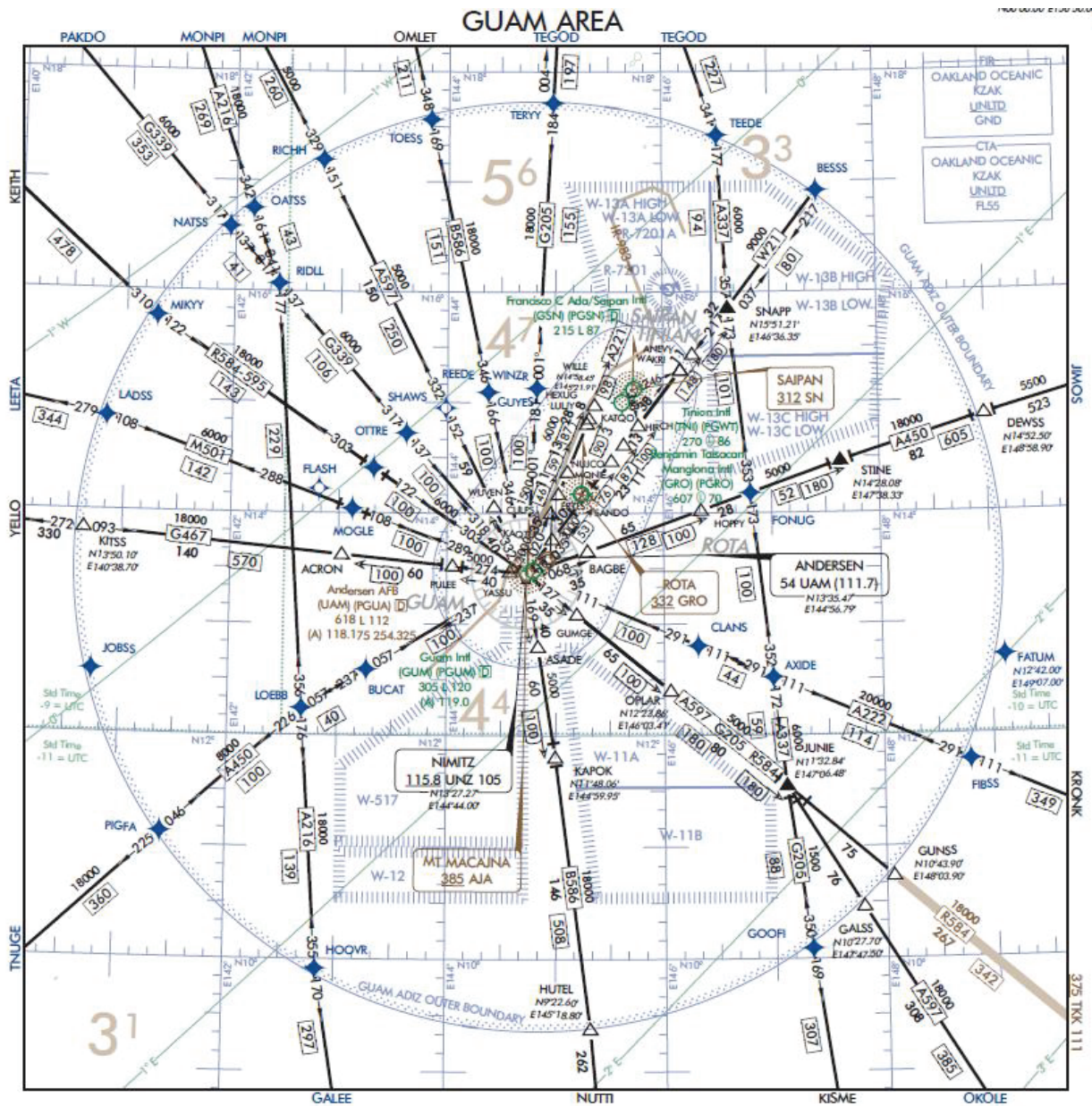


Figure 2.1-5. Air Traffic Routes to and from, and in the Vicinity of, Guam
(Source: FAA, Flight Information Publication, IFR Enroute High/Low Altitude Pacific. 5 November 2020.)

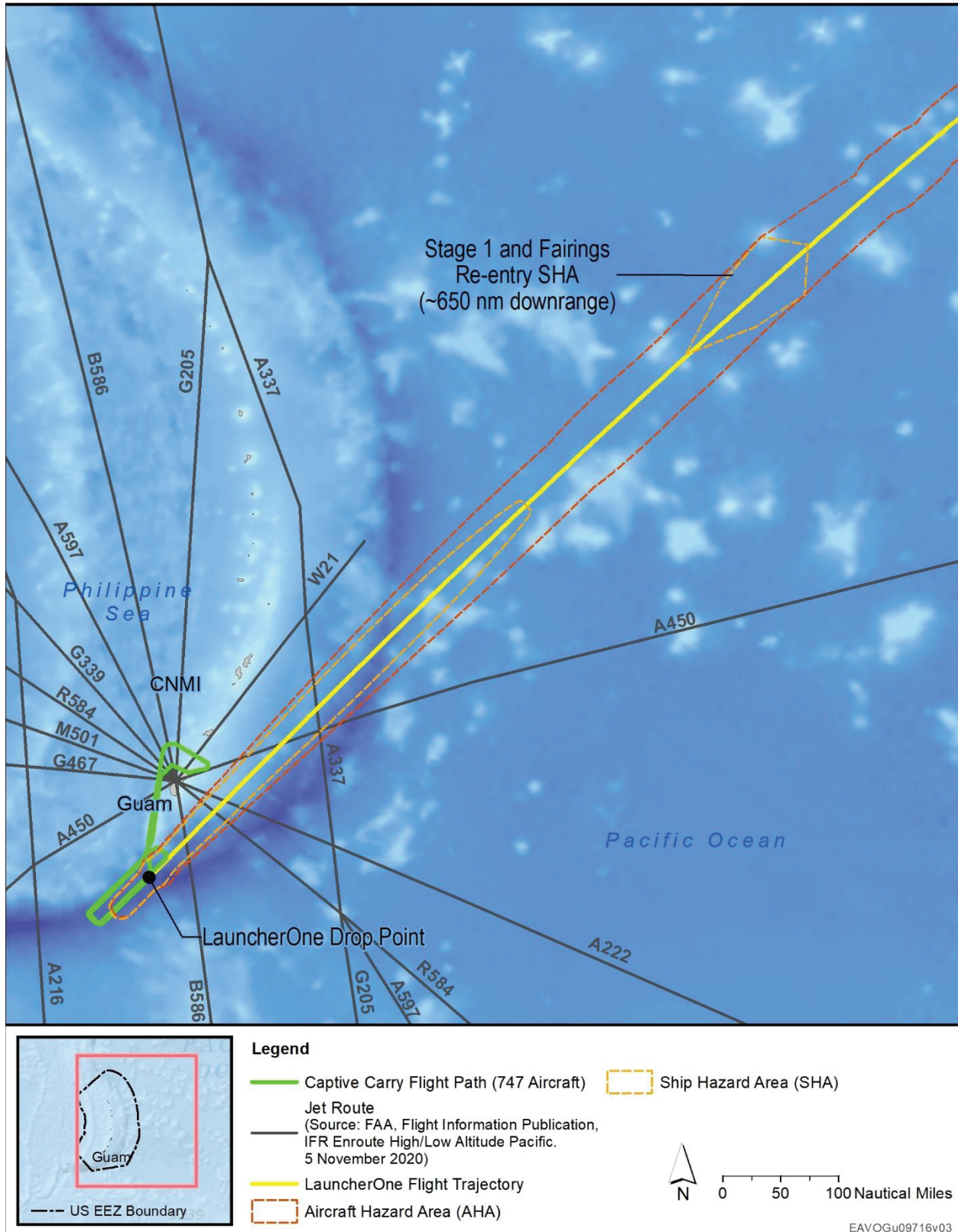


Figure 2.1-6. Air Traffic Jet Routes in the Vicinity of the Proposed LauncherOne Drop Point and AHA and SHAs

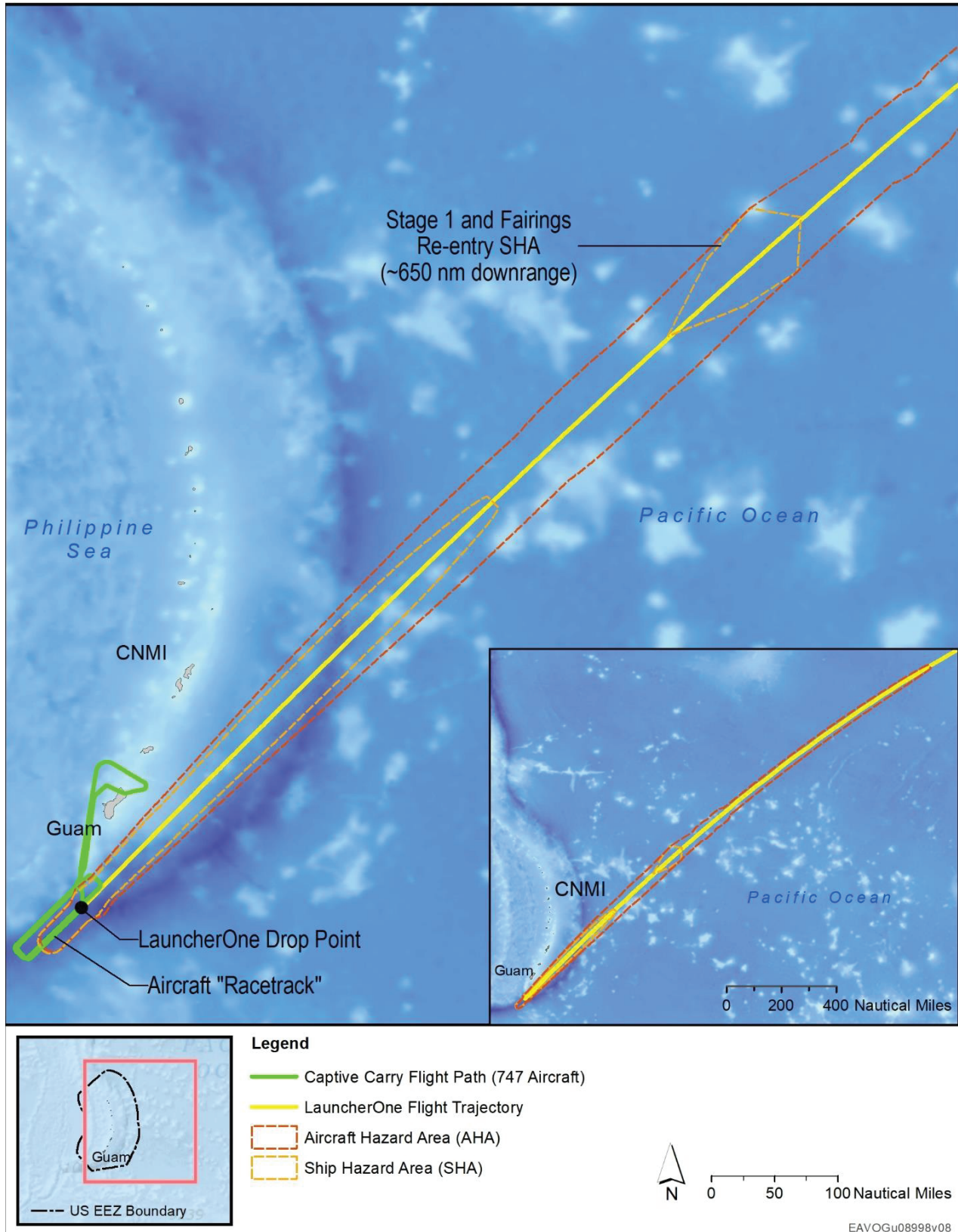


Figure 2.1-7. LauncherOne Flight Trajectory Including Drop Point, AHA, and SHAs

Airspace controlled by the FAA may be restricted specifically through activation of an ALTRV. The FAA generally uses ALTRVs to protect oceanic airspace. The NOTAM would establish a closure window that is intended to warn aircraft to keep out of a specific region throughout the time that a hazard may exist. The length of the window is primarily intended to account for the time needed for the operator to meet its mission objectives. The location and size of the closure area is defined to protect the public. For a launch, typically the closure must begin at the time of launch and must end when any potential debris, including items that are planned to be jettisoned (e.g., stages or fairings) and any debris generated by a failure, has reached the bottom of the affected airspace.

ALTRVs are immediately released once the mission has successfully cleared the area and all planned jettisoned items no longer impose a risk to the public. The actual duration of airspace closure is normally much less than the original planned closure, especially if the launch window is relatively long and the launch occurs at the beginning of the window. The FAA typically begins to clear airspace and reroute aircraft in advance of a launch and directs aircraft back into the released airspace after the launch to recover to normal flow and volume.

The airspace closure duration depends on the mission type. For the proposed VO LauncherOne operations from Guam, the launch window is anticipated to be less than 4 hours. This closure time represents the maximum value for this type of mission. The FAA and the operators take steps to reduce the airspace closure durations as a mission unfolds. For example, VO plans to conduct its rocket release for an air launched system at the beginning of its launch window. Generally, while it may request a window that spans hours in order to have more opportunity to work around weather or technical issues, the operator makes every effort to launch as soon as it is ready in the launch window. While percentages are not readily available, far more launches occur at or near the launch window opening than the closing. Further, as the launch unfolds successfully, the FAA incrementally releases airspace as it is no longer affected. The release of airspace closures will vary, as it will be released based on debris fall calculations, which can change mission to mission. In practice, the FAA attempts to divide airspace closures into subsets that can be released incrementally in time, as well as geographically based on airspace boundaries. In doing so, the actual closure times are often significantly shorter than projected maximum values defined in a given NOTAM.

The location and size of airspace closures for commercial space operations also are influenced by multiple factors, including hardware reliability, and the number and type of items that may be jettisoned. The size of airspace closures in the vicinity of the drop point shrink as reliability is established with results and analysis from each launch. For the initial launch of a new launch vehicle, the hazard areas and associated airspace closures around the drop point are bigger to account for the increased likelihood of a vehicle failure, relative to a mature rocket. Subsequent launches of that launch vehicle will likely include even smaller hazard areas compared to the initial launch.

Issuance of NOTMARs

VO has entered into an LOA with the USCG District 14 in order to safely operate the LauncherOne over open ocean. The LOA describes the required responsibilities and procedures for both VO and USCG during a launch operation, resulting in the issuance of a NOTMAR. USCG will be responsible for issuing NOTMARs for the downrange hazard area south of Guam. USCG will also coordinate issuing NOTMARs with the NGA for stage 1 and fairing splashdown hazard areas in international waters. VO will provide exact hazard area locations prior to launch of the rocket. The Proposed Action would not require the FAA to alter or close shipping lanes. The NOTMAR does not alter or close shipping lanes; rather, the

NOTMAR provides a notification regarding a temporary hazard within a defined area (SHA) to ensure public safety during the proposed operations.

VO uses its internal SHA analysis to help USCG define NOTMARs. The coordinates are sent to the USCG where it is published in the Local Notice to Mariners. For international areas, the coordinates are transmitted to the USCG and NGA. NGA publishes the international notice through the Maritime Safety Office (<https://www.nga.mil/>). The length of the NOTMAR window is primarily intended to account for the time needed for the operator to meet its mission objectives. For a launch, typically the NOTMAR and associated SHA restriction must begin at the time of launch and must end when any potential debris, including items that are planned to be jettisoned (e.g., stages or fairings) and any debris generated by a failure, has reached the ocean surface.

USCG manages the duration, location, and size of its SHA in a way that is similar to how the FAA manages its reserved airspace. For example, the USCG and the operators take steps to reduce the duration of the SHA as a mission unfolds. The launch operator plans to conduct its rocket release for an air launched system at the beginning of its launch window. Generally, while it may request a window that spans hours in order to have more opportunity to work around weather or technical issues, the operator makes every effort to launch as soon as it is ready in the launch window.

The location and size of SHAs for commercial space operations also are influenced by multiple factors, including hardware reliability, and the number and type of items that may be jettisoned. The size of SHA in the vicinity of the drop point shrink as reliability is established with results and analysis from each launch. For the initial launch of a new launch vehicle, the SHAs around the drop point are bigger to account for the increased likelihood of a vehicle failure, relative to a mature rocket. Subsequent launches of that launch vehicle will likely include smaller SHAs compared to the initial launch.

In sum, launches would be of short duration and scheduled in advance to minimize interruption to seaspace. For the purposes of the environmental review, Figure 2.1-7 provides the anticipated SHAs for initial operations.

2.1.3.2 Launch and Mission Profile

VO's proposed carrier aircraft flight corridors from Andersen AFB to and from the drop point are shown in Figure 2.1-8. The flight corridors would occur within the U.S. Exclusive Economic Zone (EEZ) around Guam. The holding patterns (or 'Racetrack') at the drop point are approximately 200 miles around. The exact drop point would be established based on mission-specific needs, communication line of sight (trajectory of the vehicle relative to the location of the ground-based telemetry station), and to avoid sonic boom impacts to land.

The carrier aircraft with the mated LauncherOne rocket would take off from Runway 24R at Andersen AFB and fly south to the designated drop point approximately 75 nautical miles (nm) south-southwest of Guam. The proposed mission profile is depicted in Figure 2.1-9. Figure 2.1-7 depicts the flight trajectory of the LauncherOne rocket from the drop point to the release of satellites and fairing re-entry.

LauncherOne would be carried to an altitude of approximately 35,000–40,000 ft MSL where it would be released. The drop point includes an AHA and SHA where no other aircraft or marine vessels can be present prior to the drop of the LauncherOne rocket (Figure 2.1-8). The carrier aircraft would then immediately pull away and return to Runway 6L at Andersen AFB. With a drop flight path angle of approximately 28 degrees and an angle of attack of approximately 5 degrees, the rocket would maintain the flight angle required for vehicle safety through the 5-second drop, prior to ignition of the rocket's first stage (Figure 2.1-8). The 5 seconds of separation is enough for the aircraft to move far enough away that if rocket ignition caused an explosion, debris and/or a pressure wave would not impact or cause damage to the carrier aircraft.



Release of LauncherOne from the Carrier Aircraft

Following ignition of the rocket's first stage, the rocket would be at supersonic speed (in excess of 768 miles per hour [mph]), and the engine would burn until all of the propellant is consumed. At approximately 650 nm downrange from the drop point, the rocket's first stage would detach and fall through a defined AHA and into the Pacific Ocean within the Stage 1 SHA (Figures 2.1-7 and 2.1-9). Mission-specific AHAs and SHAs would be defined for the rocket trajectory and associated hardware jettisons (Figure 2.1-9). Details of the mission specific AHAs and SHAs would be defined in the NOTAMs and NOTMARs, respectively.



First and Second Stage Separation

At approximately 700 nm downrange of the drop point, the shroud or fairings covering the satellites would be released and would fall through a defined AHA and into the Pacific Ocean within a defined and SHA (Figures 2.1-7 and 2.1-8). After release of the first stage, the rocket's second stage would ignite until reaching its desired LEO (Figure 2.1-7). Upon reaching the desired LEO, the second stage rocket would coast while releasing the small satellites at predetermined LEO heights and then re-ignite its engine (or blow-down⁽⁶⁾) until all of the propellants are consumed, per FAA regulations (14 CFR §417.129). The second stage would remain in orbit for months or years, eventually burning up upon reentry.



Payload Fairing Separation

⁽⁶⁾To deplete onboard energy sources after completion of mission.

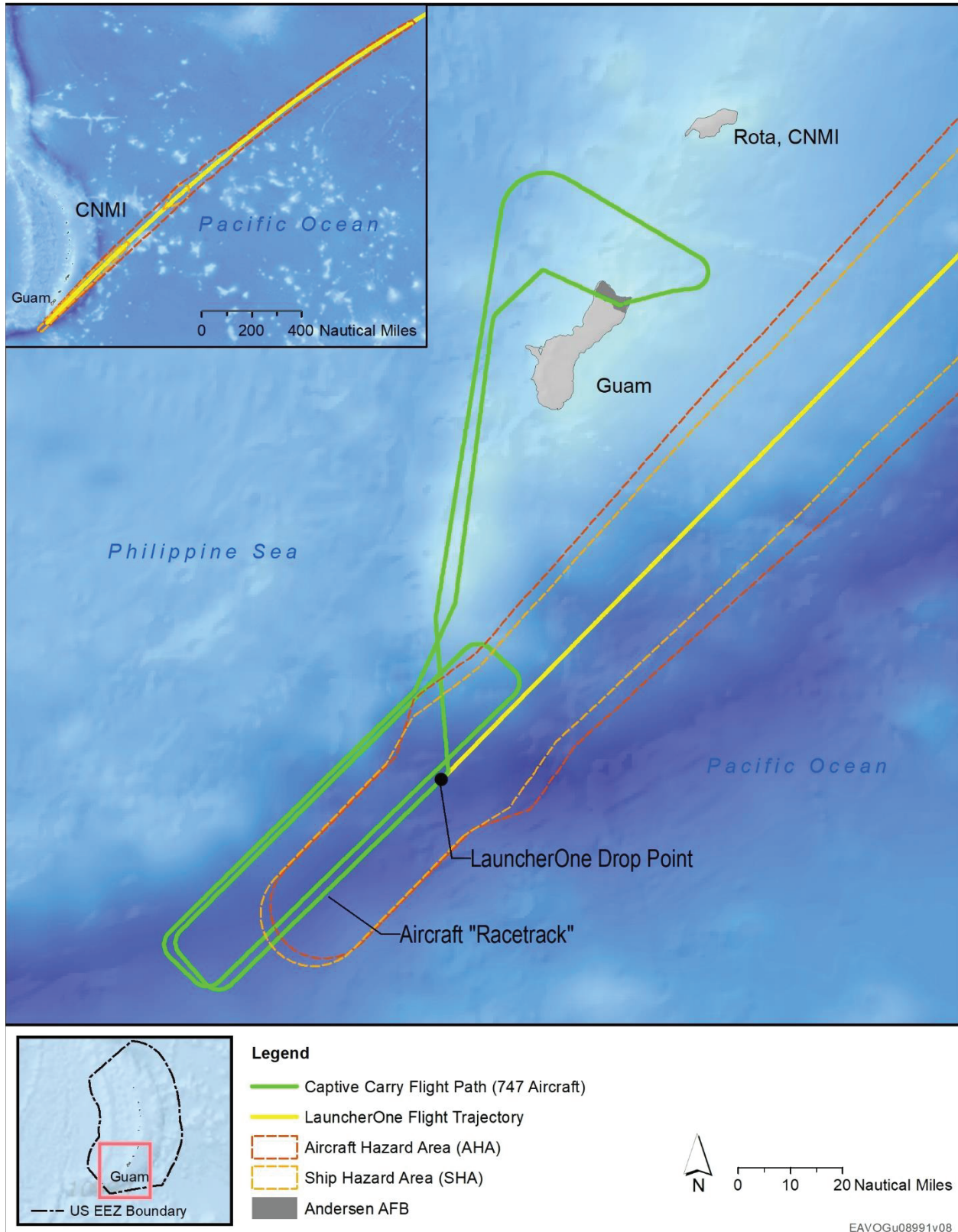


Figure 2.1-8. 747 Carrier Aircraft Flight Corridors, LauncherOne Drop Point, LauncherOne Trajectory, and Associated AHA and SHA

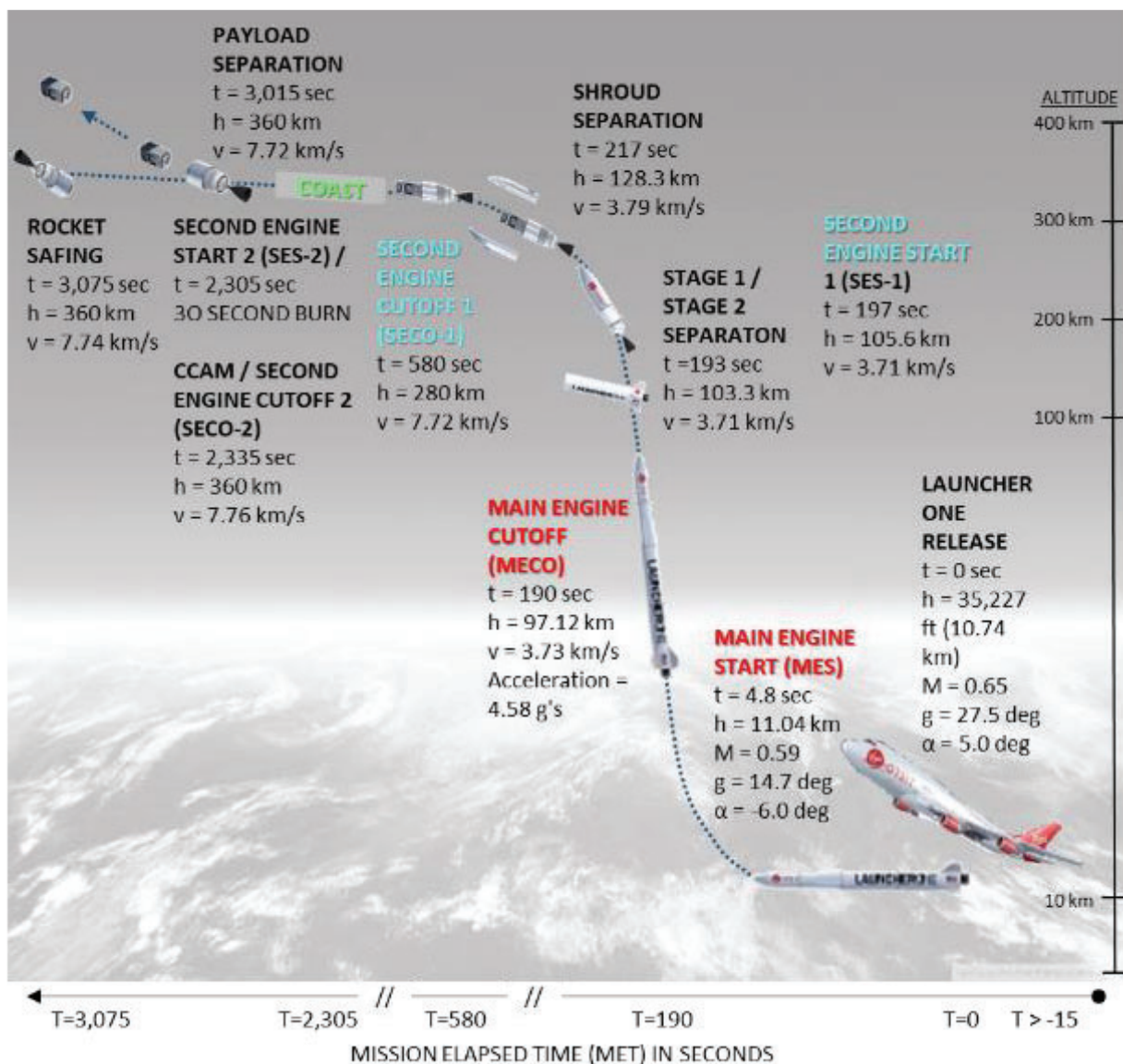


Figure 2.1-9. Proposed LauncherOne Rocket Mission Profile from Release from Carrier Aircraft to Release of Satellite Payload

Legend: α = angle of attack

CCAM = Collision and Contamination Avoidance Maneuver

ft = feet

g = flight path angle

h = height above sea level

km = kilometers

km/s = kilometers per second

M = Mach number

sec = seconds

t = time since release of LauncherOne

v = velocity

In the unlikely event of a launch mishap occurring whereby the LauncherOne rocket has been released from the carrier aircraft and there is a malfunction or other issue that results in the abort of the flight,

the rocket is expected to maintain structural integrity until impact with the ocean within the AHA and SHA if there is no secondary explosive failure (Figure 2.1-7). There is no destruct component on the vehicle. The vehicle safety system will shut down all thrust as soon as a failure is detected, preventing it from moving to a different area. As the drop of LauncherOne from the carrier aircraft occurs at approximately 35,000 ft MSL, if propellant tanks are ruptured, the RP-1 will vaporize when exposed to the ambient environment. The oxidizer in the rocket is LOX that will boil off into the atmosphere with no adverse effects. Once the rocket impacts the ocean surface, it will break up into small pieces and most will sink.

In the event the mission is aborted and the rocket is not released, or in case of an emergency, the carrier aircraft and LauncherOne rocket would return to Andersen AFB.

VO may identify additional flight corridors, trajectories, and drop points to support future mission needs. However, this EA analyzes the launch and mission parameters as described above. If VO requests to modify the launch license to include additional launch and mission parameters, the FAA will review any new information to determine whether it falls outside the scope of the analysis in this EA and whether it would require additional environmental review.

2.1.3.3 Post-flight Operations

For nominal launches, all of the oxidizer would be consumed during the rocket's powered flight. For a nominal launch, no hazardous post-flight ground operations would be required to return the carrier aircraft to safe conditions, so the carrier aircraft would be returned to Andersen AFB. For aborted flights, LOX and RP-1 would remain on-board the rocket for the return to Andersen AFB. After the carrier aircraft returns to Andersen AFB, for safety purposes, the LOX would be off-loaded (it takes approximately 2 hours to unload), and the aircraft would be moved so it does not interfere with runway operations. The RP-1 may stay on board if there is an intent to re-attempt the launch, and the carrier aircraft would be moved to an area at Andersen AFB that would not interfere with runway or other aircraft operations. In accordance with Andersen AFB requirements, any hazardous post-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

2.2 No Action Alternative

Paragraph 6-2.1 of FAA Order 1050.1F states in part: *"There is no requirement for a specific number of alternatives or a specific range of alternatives to be included in an EA. An EA may limit the range of alternatives to the proposed action and no action when there are no unresolved conflicts concerning alternative uses of available resources. Alternatives are to be considered to the degree commensurate with the nature of the proposed action and agency experience with the environmental issues involved."* Under the No Action Alternative, the FAA would not issue a launch license to VO for LauncherOne operations from Andersen AFB. The No Action Alternative provides the basis for comparing the environmental consequences of the Proposed Action.

2.3 Alternatives Considered but Eliminated from Further Consideration

Sites near the equator and open ocean can be advantageous for launch operations. These areas can allow increased orbital inclinations from one launch site. VO evaluated the use of U.S. Army Garrison (USAG) – Kwajalein Atoll as a potential launch site. However, the infrastructure and logistical constraints eliminated this site from further consideration:

- Existing runway length: The modified 747 carrier aircraft needs a longer than usual runway length due to the flaps not being able to fully extend with the LauncherOne rocket attached. This limits the 747 braking distance and requires a longer runway than that for a typical 747 aircraft.
- Existing runway weight limits: The runway is not compatible with the weight of the modified 747 carrier aircraft with the LauncherOne rocket.
- Access to and from Kwajalein Atoll is challenging and, at times, restricted.
- Ground support facilities: currently USAG – Kwajalein Atoll does not have sufficient ground facilities to support the logistical and operational components of VO's LauncherOne activities.

To support the proposed VO operations at USAG – Kwajalein Atoll, extensive infrastructure construction would be needed (e.g., runway modifications) that would result in potentially significant environmental impacts. Andersen AFB, Guam was the only potential U.S. site that allowed access to the required low-Earth orbits from an equatorial, or near-equatorial, location and required no infrastructure modifications or construction.

Chapter 3.

Affected Environment and Environmental Consequences

3.1 Introduction

This chapter provides a description of the affected environment and potential environmental consequences for the environmental impact categories that have the potential to be affected by the Proposed Action and No Action Alternative. The environmental impact categories assessed in this EA include air quality; climate; cultural resources, including historical, architectural, and archeological; noise and noise-compatible land use; Section 4(f) resources; water resources; biological resources; and hazardous materials, solid waste, and pollution prevention.

This EA examines two general areas that encompass the areas potentially affected by the Proposed Action. The first area, associated with takeoff and landing of the carrier aircraft, is Andersen AFB and the immediate airspace. The second area includes the LauncherOne drop point and associated flight trajectory, potential sonic boom area, and the location of the splashdown of the first stage and fairings. Specific environmental impact category study areas vary and are defined in this chapter. The level of detail provided in this chapter is commensurate with the importance of the potential impact on the environmental impact categories.

The following environmental impact categories are not analyzed in detail for the reasons stated.

- **Visual Effects:** Visual effects are related to the extent to which the Proposed Action would produce light emissions that create annoyance or interfere with activities; or the extent to which the Proposed Action would detract from, or contrast with, visual resources or the visual character of the existing environment. Andersen AFB currently supports existing aircraft operations, including B747 aircraft, which is the same as the carrier aircraft, as well as numerous large military aircraft such as B-52 and B-1 bombers. Based on the most current data summarizing flight operations by aircraft type, Andersen AFB supported approximately 23,691 flights annually, or approximately 65 operations per day in 2013 (PACAF and AFCEE 2013). The addition of a proposed maximum of 10 flight operations per year by the carrier aircraft would be imperceptible with respect to visual effects, as it would represent approximately 0.04% of all flights annually. The pre-flight and post-flight activities involved with the Proposed Action would not differ visually from those activities already occurring at Andersen AFB. Operation of the carrier aircraft with a mated rocket would not affect visual resources in either study area, as the contrails left by the carrier aircraft and rocket would be similar in visual impact to the contrails from existing aircraft operations in the vicinity of Andersen AFB and in airspace east of Guam. The Proposed Action would not degrade the existing visual character or quality of Andersen AFB and its surroundings and would have no adverse effect on a scenic vista or scenic resources. Under the Proposed Action, no new source of substantial light or glare would be created that would adversely affect day or nighttime views in the area. Therefore, implementation of the Proposed Action would not have significant visual effects.
- **Coastal Resources:** Per FAA Order 1050.1F, coastal resources include all natural resources occurring within coastal waters and their adjacent shorelands. The entire island of Guam is classified as a coastal zone under the Coastal Zone Management Act (CZMA), excluding lands solely under federal jurisdiction such as Andersen AFB, where part of the Proposed Action takes

place. The Guam Coastal Management Program was established in 1979 through a Cooperative Agreement between the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Planning Office of the Governor. The program's authorities are provided for in the CZMA, as well as by the regulatory and enforcement authorities of a network of local agencies, including the Department of Land Management, Public Works, Parks and Recreation, Agriculture, and Guam Environmental Protection Agency (JRM 2019). Under the Proposed Action, carrier aircraft takeoffs and landings would occur on an existing runway at Andersen AFB and LauncherOne operations would occur over the open ocean at an altitude >35,000 ft MSL. These operations would take place well away from coastal resources on Guam. Therefore, implementation of the Proposed Action would not result in any impacts to the coastal zone or coastal resources. Prior to the FAA issuing VO a license, in compliance with the CZMA and its implementing regulations as well as FAA policy, VO must submit a consistency certification to the Guam's Coastal Management Program (CMP) to ensure the project is consistent with Guam's CMP. In October 2020, VO submitted a Coastal Zone Management Act Consistency Determination to the Guam Coastal Management Program, Bureau of Statistics and Plans for aircraft activities that may have reasonably foreseeable effects on any coastal use or resource of Guam. On December 10, 2020, the Guam Bureau of Statistics and Plans issued a letter of concurrence stating that the project is consistent with Guam's CMP (refer to Appendix D.3).

- **Land Use:** The Proposed Action would not result in any new types of ground operations and would not change the existing or planned land use of Andersen AFB. Carrier aircraft operations would take off from an existing runway at Andersen AFB and would conform to the designated land uses. As mentioned previously, Andersen AFB currently supports existing aircraft operations, including B-747 aircraft, which is the same as the carrier aircraft.
- **Farmlands:** The Proposed Action does not involve construction activities and therefore will not impact farmlands, as defined by the Farmland Protection Policy Act.
- **Natural Resources and Energy Supply:** The Proposed Action would not result in any measurable effect on local supplies of energy or natural resources. The Proposed Action would not result in the development of new facilities or result in notable changes in local energy demands or consumption of other natural resources. The Proposed Action would not require additional sources of power or other public utilities. Aircraft and marine vessels in the vicinity of the AHA and SHA could re-route if abiding by the NOTAM and NOTMAR. However, aircraft and marine vessel density is low in these areas. Potential impacts on aircraft and marine vessel re-routing, would be temporary, infrequent, and anticipated to result in a negligible increase in fuel expenditure.
- **Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks:** The Proposed Action would not require construction or development. Only existing VO personnel would be used to conduct launch activities and therefore would not induce population growth or affect the number of jobs at Andersen AFB or in the nearby communities. Proposed carrier aircraft takeoffs and landings would constitute approximately 0.04% of the daily operations at Andersen AFB over a 12-month period and would be similar to existing operations.

Potential socioeconomic impacts from re-routing aircraft and marine vessels due to commercial space operations are expected to be negligible relative to other causes leading to the re-routing of aircraft and marine vessels. Other issues or activities such as weather and military exercises also require airspace and seaspace closures and may have longer and larger closure areas than

proposed VO operations. All launch operations would continue to comply with the necessary notification requirements, including issuance of NOTAMs and NOTMARs, consistent with current procedures.

Potential socioeconomic impacts include additional airline operating costs for increased flight distances and times resulting from re-routing aircraft and increased passenger costs as a result of impacted passenger travel, including time lost from delayed flights, flight cancellations, and missed connections. Alternatively, restricting or preventing a launch event would have socioeconomic impacts on VO, commercial payload providers, and consumers of payload services. Operations would not result in the closure of any public airport during the operation nor so severely restrict the use of the surrounding airspace as to prevent access to an airport for an extended period of time. Given existing airspace closures for VO operations are temporary as discussed above and the FAA's previous analyses related to the NAS over oceanic areas have concluded minor or minimal impacts on the NAS from commercial space launches, the FAA does not expect the airspace closures from VO's proposed launch operations would result in significant socioeconomic impacts. Further, local air traffic controls would coordinate with airports and aircraft operators to minimize the effect of these infrequent launch operations on airport traffic flows as well as traffic flows in en-route airspace.

Marine vessels in the vicinity of the SHA would be notified of VO operations by the NOTMAR and possibly incur additional transit time and delays. However, marine vessel density is low in these areas (MarineTraffic 2019). Given the very low level of shipping traffic underlying the proposed LauncherOne trajectory and that could occur within the SHAs, the advance notice in the NOTMAR, short duration of the temporary SHA, and infrequent occurrence of proposed launch activities (i.e., up to a maximum of 10 times per year), surface vessels may be able to make minor course corrections that would not result in significant changes to travel times for regional shipping traffic. There would also be no closures or restricted access to regional ports. Potential impacts on marine vessel re-routing would be temporary, infrequent, and anticipated to result in a negligible increase in operating costs. The FAA does not expect significant socioeconomic impacts associated with the notification of SHAs from VO's proposed launch activities.

There would be no impacts that disproportionately affect environmental justice populations. Additionally, no component of the Proposed Action would result in a disproportionate health and safety risk to children. Therefore, implementation of the Proposed Action would not result in significant impacts related to socioeconomics, environmental justice, or children's environmental health and safety risks.

3.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license to VO for carrier aircraft operations from Andersen AFB. Therefore, VO would not conduct 747 carrier aircraft operations from Andersen AFB and LauncherOne rocket operations over the Pacific Ocean east of Guam. Under the No Action Alternative, there would be no new impacts to the environmental impact categories analyzed in this EA.

3.3 Air Quality

3.3.1 Definition of Resource and Regulatory Setting

Air quality is the measure of the condition of the air expressed in terms of ambient pollutant concentrations and their temporal and spatial distribution. Air quality regulations in the United States

are based on concerns that high concentrations of air pollutants can harm human health, especially for children, the elderly, and people with compromised health conditions; as well as adversely affect public welfare by damage to crops, vegetation, buildings, and other property.

3.3.1.1 National Ambient Air Quality Standards (NAAQS)

Under the Clean Air Act (CAA), the U.S. Environmental Protection Agency (USEPA) developed the NAAQS for seven common air pollutants: carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), particulate matter ≤ 10 micrometers in diameter and > 2.5 micrometers in diameter (PM₁₀), particulate matter ≤ 2.5 micrometers in diameter (PM_{2.5}), sulfur dioxide (SO₂), and lead (Pb) (USEPA 2016a). The USEPA determined that these criteria air pollutants may harm human health and the environment, and cause property damage. The USEPA regulates these pollutants to permissible levels through human health-based (primary standards) and environmental-based (secondary standards) criteria. Toxic air pollutants, also called hazardous air pollutants, are a class of pollutants that do not have ambient air quality standards but are examined on an individual basis when there is a source of these pollutants. Additional information on the CAA and the NAAQS can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.3.1.2 Conformity Analyses in Nonattainment and Maintenance Areas

Areas that exceed a NAAQS standard are designated as “nonattainment” for that pollutant, while areas in compliance with a standard are in “attainment” for that pollutant. An area may be nonattainment for some pollutants and attainment for others simultaneously. The USEPA delegates the regulation of air quality to states and U.S. territories, through their air quality management agencies, and are required to prepare and implement a State Implementation Plan (SIP) for nonattainment areas, which demonstrate how the area will meet the NAAQS. Areas that have achieved attainment may be designated as “maintenance areas,” subject to maintenance plans showing how the area will continue to meet the NAAQS.

Federal actions are required to conform with the approved SIP for those areas of the U.S. designated as nonattainment or maintenance air quality areas for any criteria pollutant under the CAA (40 CFR §§ 51 and 93). This is also known as the General Conformity Rule. The purpose of the General Conformity Rule is to demonstrate that the Proposed Action would not cause or contribute to new violations of an air quality standard and that the Proposed Action would not adversely affect the attainment and maintenance of the NAAQS. A federal action would not conform if it increased the severity of any existing violations of an air quality standard or delayed the attainment of a standard, required interim emissions reductions, or delayed any other air quality milestone. To ensure that federal activities do not impede local efforts to control air pollution, Section 176(c) of the CAA (42 USC § 7506(c)) prohibits federal agencies from engaging in or approving actions that do not conform to an approved SIP. The emissions thresholds that trigger the conformity requirements are called *de minimis* thresholds.

Federal agency compliance with the General Conformity Rule can be demonstrated in several ways. The requirement can be satisfied by a determination that the Proposed Action is not subject to the General Conformity Rule, by a Record of Non-Applicability, or by a Conformity Determination. Compliance is presumed if the net increase in emissions from a federal action would be less than the relevant *de minimis* threshold. If net emissions increases exceed the *de minimis* thresholds, then a formal conformity determination must be prepared.

3.3.2 Study Area

The study area for air quality includes Andersen AFB and the surrounding area that would receive air emissions from carrier aircraft take offs and landings, and extends up to 3,000 ft above ground level (AGL). Of primary importance in this evaluation is the mixing height. In general, the mixing height is defined as the vertical region of the atmosphere where pollutant mixing occurs. Above this height, pollutants that are released generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. Per FAA-AEE-00-01, DTS-34 (*Consideration of Air Quality Impacts By Airplane Operations at or Above 3000 feet AGL*; September 2000), emissions above 3,000 ft AGL are not considered for local or regional air quality impacts because 3,000 ft AGL is a reasonable approximation of the nominal mixing height. Therefore, impacts associated with activities above the mixing level, including the drop and operation of the LauncherOne rocket above 35,000 ft MSL, are not analyzed as they do not have an effect on ground level air pollutant concentrations. In addition, emissions from aircraft being re-routed would occur above 3,000 ft AGL and thus would not affect ambient air quality.

3.3.3 Existing Conditions

Guam meets all national and local ambient air quality standards except for the area of the Cabras Power Plant, 20 miles southwest of Andersen AFB, which is in nonattainment for SO₂ primary NAAQS (USEPA 2020a). The nonattainment area extends in a circle with a radius of 3.8 miles from the power-generating facilities. The study area is not within any nonattainment areas. In addition to anthropogenic sources, volcanic activity within the Study Area naturally contributes to SO₂ concentrations in the region.

3.3.4 Environmental Consequences

Air quality impacts would be significant if the action would cause pollutant concentrations to exceed one or more of the NAAQS, as established by the USEPA under the CAA, for any of the time periods analyzed, or to increase the frequency or severity of any such existing violations.

3.3.4.1 Proposed Action

Pre-Flight and Post-Flight Activities

Emissions can occur from support equipment used during ground fueling operations, including trucks and equipment, and RP-1 tank venting. Trucks would be driven to the carrier aircraft and the rocket would be fueled. Approximate travel time to the loading location is anticipated to be less than 10 minutes roundtrip. For each flight event, it is assumed that up to five trucks would be utilized. Given the small number of trucks used, and the short run-time of each truck, the total emissions from pre-flight and post-flight activities would be too small to lead to violations of the NAAQS. Five trucks operating for 1 hour each during 10 fueling operations would create approximately 0.00134 tons of carbon dioxide (CO₂) per year, and proportionately less emissions of other pollutants. The air quality impacts would be insignificant and would not be distinguishable from the impacts of the other flight and ground operations at Andersen AFB.

In accordance with the Commercial Space Operations Service Agreement (CSOSA) between VO and the USAF (USAF and VO 2019), VO will provide, in advance and in a timely manner, any information that relates to activities that might have an impact upon the installation's air conformity status. VO will provide advance notice of any changes in operations or conditions that might result in increased air emissions in sufficient time to allow any necessary permits to be obtained or permits modified.

Carrier Aircraft Emissions

As described in Section 2.1, the Proposed Action would include a maximum of 10 flights per year in one year of the proposed 5-year operating period; the other 4 years would see ≤ 9 flights/year. The pollutants emitted by an aircraft during takeoff and landing operations are dependent on the emission rates and the duration of these operations. The emission rates are dependent upon the type of engine and its size or power rating. An aircraft operational cycle includes landing and takeoff operations and is termed the Landing and Take Off (LTO) cycle. An LTO cycle includes all normal operational modes performed by an aircraft between its descent from an altitude of about 3,000 ft on landing and subsequent takeoff to reach the 3,000 ft altitude. The term “operation” in this context is used by the FAA to describe either a landing or a takeoff cycle. Therefore, two operations make one LTO cycle. The aircraft LTO cycle is divided into five segments or operational “modes” and categorized by:

- landing approach (descent from about 3,000 ft to runway touch down),
- taxi/idle-in,
- taxi/idle-out,
- takeoff, and
- climb out (ascent from runway to about 3,000 ft)

The USEPA’s basic methodology for calculating aircraft emissions at any given airport in any given year can be summarized in six steps: (1) determine airport activity in terms of the number of LTOs; (2) determine the mixing height to be used to define an LTO cycle; (3) define the fleet make-up at the airport; (4) estimate time-in-mode (TIM); (5) select emission factors; and (6) calculate emissions based on the airport activity, TIM, and aircraft emission factors.

The emissions for the Proposed Action are based on the time of operation in each mode and the emission rates of the carrier aircraft engines. The time in the landing approach and climb-out modes are assumed to be 4.7 minutes and 3.0 minutes, respectively. The anticipated takeoff time is 0.5 minute and represents the time for initial climb from ground level to about 500 ft. The time in taxi/idle mode has been estimated as 15 minutes for both taxi/idle in and taxi/idle-out (FAA 2017).

Aircraft emissions for criteria pollutants were calculated by multiplying the TIM against respective emission factors and number of estimated flights. Table 3.3-1 lists the estimated annual criteria and precursor air pollutant emissions for the Proposed Action and compares them to the General Conformity *de minimis* emission levels for each pollutant as an indicator of potential impacts. The increase in carrier aircraft activities would result in a corresponding increase in criteria and precursor pollutant emissions. Although all would increase under the Proposed Action, air pollutant emissions under the Proposed Action would not result in violations of NAAQS because they would not have a measurable impact on air quality. As shown in Table 3.3-1, estimated emissions from the Proposed Action would account for less than 1% of the allowable emissions. Refer to Appendix A for detailed calculations and assumptions.

Table 3.3-1. Criteria and Precursor Air Pollutant Emissions for LTO Cycle under the Proposed Action

| Emission Source | Criteria and Precursor Air Pollutant Emissions (tons/year) | | | | |
|--------------------------------------|--|-----------------|-------------|-----------------|-----------------|
| | CO | NO _x | VOCs | SO _x | PM |
| Carrier Aircraft LTOs (tons per LTO) | 0.009 | 0.043 | 0.001 | 0.001 | <0.001 |
| Annual Carrier Aircraft LTOs | 0.089 | 0.43 | 0.01 | 0.01 | <0.01 |
| <i>de Minimis</i> Levels | 100 | 100 | 100 | 100 | 100 |

Notes: NO_x = nitrogen oxides, VOC = volatile organic compounds, SO_x = sulfide oxides.

Sources: USEPA 1999; USAF 2002; International Civil Aviation Organization 2019.

The USEPA has listed 188 hazardous air pollutants regulated under Title III (Hazardous Air Pollutants), Section 112(g) of the CAA. Hazardous air pollutants are emitted by processes associated with the Proposed Action, including fuel combustion. The amounts of hazardous air pollutants emitted are small compared to the emissions of criteria pollutants; emission factors for most hazardous air pollutants from combustion sources are roughly three or more orders of magnitude lower than emission factors for criteria pollutants. Hazardous air pollutant emissions estimates were not calculated because of the small amounts that would be emitted.

Under the Proposed Action, hazardous pollutant emissions would increase, and the increases would be roughly proportional to the increases observed for the criteria air pollutants emitted. Hazardous air pollutants emissions would be intermittent and distributed over the Andersen AFB study area. Their concentrations would be further reduced by atmospheric mixing and other dispersion processes. After initial mixing, it is possible that hazardous pollutants would be measurable, but they would be in very low concentrations and would not affect the air quality in the region. Therefore, no significant impacts to air quality would occur under the Proposed Action.

LauncherOne Rocket Emissions

Rocket activities would occur at altitudes above 35,000 ft AGL, in the atmospheric layer of the stratosphere. Pollutants that are released in the stratosphere do not mix with ground level emissions and do not have an effect on ground level concentrations in any local area. Additionally, per FAA-AEE-00-01 DTS-34, these activities are exempt from analysis for local and regional air quality. Accordingly, rocket activities would have no impact on regional air quality.

Airspace Closures and Marine Vessel Re-Routing

Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. Minimal, if any, additional emissions would be generated from aircraft departure delays because the FAA rarely receives reportable departure delays associated with commercial space launches. Airspace closures as a result of the Proposed Action could occur up to a maximum of 10 times per year. Thus, any delays in aircraft departures from affected airports would be short-term and any increases in air emissions from grounded aircraft are expected to be minimal and would occur in attainment areas. Therefore, these emissions increases are not expected to result in an exceedance of the NAAQS for any criteria pollutant and are not expected to result in significant air quality impacts.

Marine vessels in the vicinity of the SHA would be notified of VO operations by the NOTMAR and possibly incur additional transit time and delays. However, marine vessel density is low in these areas (MarineTraffic 2019). Given the very low level of shipping traffic underlying the proposed LauncherOne trajectory and that could occur within the SHAs, emissions from surface vessels potentially rerouting to avoid the SHA would not be significantly different from those emissions generated along the original course. The advance notice in the NOTMAR, short duration of the temporary SHA, and infrequent occurrence of proposed launch activities (i.e., up to a maximum of 10 times per year), surface vessels may be able to make minor course corrections that would not result in additional emissions that would impact ambient air quality. Potential impacts on marine vessel re-routing would be temporary, infrequent, and anticipated to result in a negligible increase in air emissions.

3.4 Climate

3.4.1 Definition of Resource and Regulatory Setting

Climate change is a global phenomenon that can have local impacts. Scientific measurements show that Earth's climate is warming, with concurrent impacts including warmer air temperatures, increased sea level rise, increased storm activity, and an increased intensity in precipitation events. Research has shown there is a direct correlation between fuel combustion and greenhouse gas (GHG) emissions. GHGs are defined as including carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). CO₂ is the most important anthropogenic GHG because it is a long-lived gas that remains in the atmosphere for up to 100 years.

GHGs have varying global warming potential (GWP). The GWP is the potential of a gas or aerosol to trap heat in the atmosphere; it is a measure of the total energy the emissions of 1 ton of gas will absorb over a given period of time (usually 100 years), compared to the emissions of 1 ton of CO₂ (USEPA 2018). The reference gas for GWP is CO₂; therefore, CO₂ has a GWP of 1. The other main GHGs that have been attributed to human activity include CH₄, which has a GWP of 28, and N₂O, which has a GWP of 265 (Myhre et al. 2013). CO₂, followed by CH₄ and N₂O, are the most common GHGs that result from human activity. CO₂, and to a lesser extent, CH₄ and N₂O, are products of combustion and are generated from stationary combustion sources as well as vehicles. The following formula is used to calculate the Carbon Dioxide Equivalent (CO₂e).

$$\text{CO}_2\text{e} = (\text{CO}_2 \times 1) + (\text{CH}_4 \times 28) + (\text{N}_2\text{O} \times 265)$$

The FAA has developed guidance for considering GHGs and climate under NEPA, as published in the Desk Reference to Order 1050.1F (FAA 2020). An FAA NEPA review should follow the basic procedure of considering the potential incremental change in CO₂ emissions that would result from the proposed action and alternative(s) compared to the no action alternative for the same timeframe and discussing the context for interpreting and understanding the potential changes. For such reviews, this consideration could be qualitative (e.g., explanatory text), but may also include quantitative data (e.g., calculations of estimated project emissions).⁷

3.4.2 Study Area

GHG emissions for this project are considered globally since climate change is a global issue. This means GHG emissions are considered at all altitudes for a carrier aircraft flight and LauncherOne launch.

3.4.3 Existing Conditions

In 2018, U.S. GHG emissions totaled an estimated 6,677 million MT of CO₂e. This 2018 total represents a 10.2% decrease since 2005 (USEPA 2020b). Transportation activities accounted for 36.3% of U.S. CO₂ emissions from fossil fuel combustion in 2018. The largest sources of transportation CO₂ emissions in 2018 were light-duty vehicles (including passenger cars and light-duty trucks) (58.6%), medium- and heavy-duty trucks (23.2%), commercial aircraft (6.9%), other aircraft (2.4%), and other sources (9.5%). Across all categories of aviation, CO₂ emissions decreased by 7.2% between 1990 and 2018 (USEPA 2020b).

⁷This analysis is consistent with Executive Order (EO) 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, 86 Federal Register 7037 (Jan. 25, 2021).

Based on the most current GHG data for Guam, GHG emissions for 2012 totaled 1.2 million MT of CO₂e (USEPA 2019). This value is based only on emissions from large facilities (e.g., power plants) and does not include other sources such as transportation.

While aviation in general represents a small percentage of fossil fuel use, it is important to note the unique impacts aviation emissions contribute because of their release at altitude. The majority of aircraft emissions occur high in the atmosphere, and the impact of burning fossil fuels at altitude is greater than burning the same fuels at ground level (particularly with regard to NO_x) (Intergovernmental Panel on Climate Change 1999). In addition, the mixture of exhaust gases discharged from aircraft perturbs radiative forcing directly through the heating effect and indirectly through affecting the microphysical processes of cirrus clouds formations (Lee et al. 2009).

3.4.4 Environmental Consequences

The FAA has not established a significance threshold for climate, nor has the FAA identified specific factors to consider in making a significance determination for GHG emissions. There are currently no accepted methods of determining significance applicable to commercial space launch projects given the small percentage of global GHG emissions they contribute. There is a considerable amount of ongoing scientific research to improve understanding of global climate change, and FAA guidance will evolve as the science matures or if new federal requirements are established.

3.4.4.1 Proposed Action

The projected increase in GHG emissions from the Proposed Action is discussed in the context of national and global emissions from all sources. GHG emissions for ground activities were not calculated for the Proposed Action because their minor usage contributes only incrementally (0.00134 tons of CO₂/year) when compared to the GHG emissions from carrier aircraft and rocket operations. Additionally, possible increases in GHG emissions caused by short-term airspace closures (e.g., from re-routed or grounded aircraft) during commercial space operations are not expected to result in significant climate-related impacts and are therefore were not calculated for the Proposed Action. Marine vessels in the vicinity of the SHA would be notified of VO operations by the NOTMAR and possibly have to re-route to avoid the SHA. However, marine vessel density is low in these areas (MarineTraffic 2019). Potential impacts on marine vessel re-routing would be temporary, infrequent, and anticipated to result in a negligible increase in GHG emissions.

A maximum of 10 missions are anticipated in any 1 year during the 5-year operating period. Each mission would produce 33.0 MT of CO₂e (Table 3.4-1). Refer to Appendix A for detailed calculations and assumptions. Therefore, the total GHG emissions for the single year with a maximum of 10 missions would be 330 MT. The number of proposed annual missions during all other years during the 5-year operating period would be ≤9.

Table 3.4-1. Projected Annual Greenhouse Gas (CO₂e) Emissions under the Proposed Action

| Emission Source | CO ₂ e Emissions (MT) |
|--|----------------------------------|
| GHG Emissions of Carrier Aircraft per LTO Cycle (<3,000 ft) | 3.1 |
| GHG Emissions of Carrier Aircraft per Flight to Drop Point (≥3,000 ft) | 19.3 |
| GHG Emissions per Rocket Launch | 10.6 |
| Total GHG Emissions for One Operation | 33.0 |

Sources: U.S. Energy Information Administration 2016; The Climate Registry 2019.

As the 2018 GHG emissions on Guam were estimated at 1.2 million MT, the addition of a maximum of 330 MT/year would only represent an increase of 0.0275% in the annual GHG emissions on Guam. This

is an inconsequential amount and would not result in a significant increase in GHG emissions on Guam. In addition, the level of GHG emissions under the Proposed Action would be lower in the other 4 years of the proposed 5-year operating period for proposed carrier aircraft and rocket operations.

3.5 Noise and Noise-Compatible Land Use

3.5.1 Definition of Resource and Regulatory Setting

Sound is a physical phenomenon consisting of pressure fluctuations that travel through a medium, such as air, and are sensed by the human ear. Noise is considered any unwanted sound that interferes with normal activities (e.g., sleep, conversation, student learning) and can cause annoyance. Noise sources can be constant or of short duration and contain a wide range of frequency (pitch) content.

Determining the character and level of sound aids in predicting the way it is perceived. Noise associated with aircraft takeoffs and landings, launch noise, and sonic booms are classified as short-duration events.

The compatibility of existing and planned land uses with proposed FAA actions is usually determined in relation to the level of aircraft (or launch vehicle) noise. Federal compatible land use guidelines for a variety of land uses are provided in Table 1 in Appendix A of 14 CFR Part 150, *Land Use Compatibility with Yearly Day-Night Average Sound Levels*.

The FAA has determined that the cumulative noise energy exposure of individuals to noise resulting from FAA actions must be established in terms of yearly Day-Night Average Sound Level (DNL), the FAA's primary noise metric. DNL accounts for the noise levels of all individual aircraft/launch vehicle events, the number of times those events occur, and the period of day/night in which they occur. Both noise metrics logarithmically average aircraft sound levels at a location over a complete 24-hour period, with a 10-decibel (dB) adjustment added to those noise events occurring from 10:00 p.m. to 7:00 a.m. The 10-dB adjustment is added because of the increased sensitivity to noise during normal nighttime hours and because ambient (without aircraft/launch vehicles) sound levels during nighttime are typically about 10-dB lower than during daytime hours. More information on noise and noise-compatible land use can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.5.2 Study Area

Andersen AFB is located on the north end of the island of Guam. Northwest Field, an unlit auxiliary airfield, is approximately 5 miles northwest of the center of the primary airfield at Andersen AFB. The only other major aviation use on the island is A.B. Won Pat International Airport (also known as Guam International Airport). The Andersen AFB runways terminate approximately 1 mile inside the border of Andersen AFB. Numerous residences are located on the border of Andersen AFB to the south and west and there is one school (Lupi Elementary) approximately 1 mile south of the Andersen AFB runways. This school is outside the 2013 Air Installations Compatibility Use Zones (AICUZ) 65-dB DNL contour (PACAF and AFCEE 2013). The 65-dB DNL contour is typically used to help determine compatibility of aircraft operations with local land use and the 65-dB DNL contour is the Federal significance threshold for aircraft noise exposure (FAA 2020). Therefore, the study area for Andersen AFB extends to the 65-dB DNL contour based on the 2013 AICUZ report for Andersen AFB (PACAF and AFCEE 2013) (Figure 3.5-1).

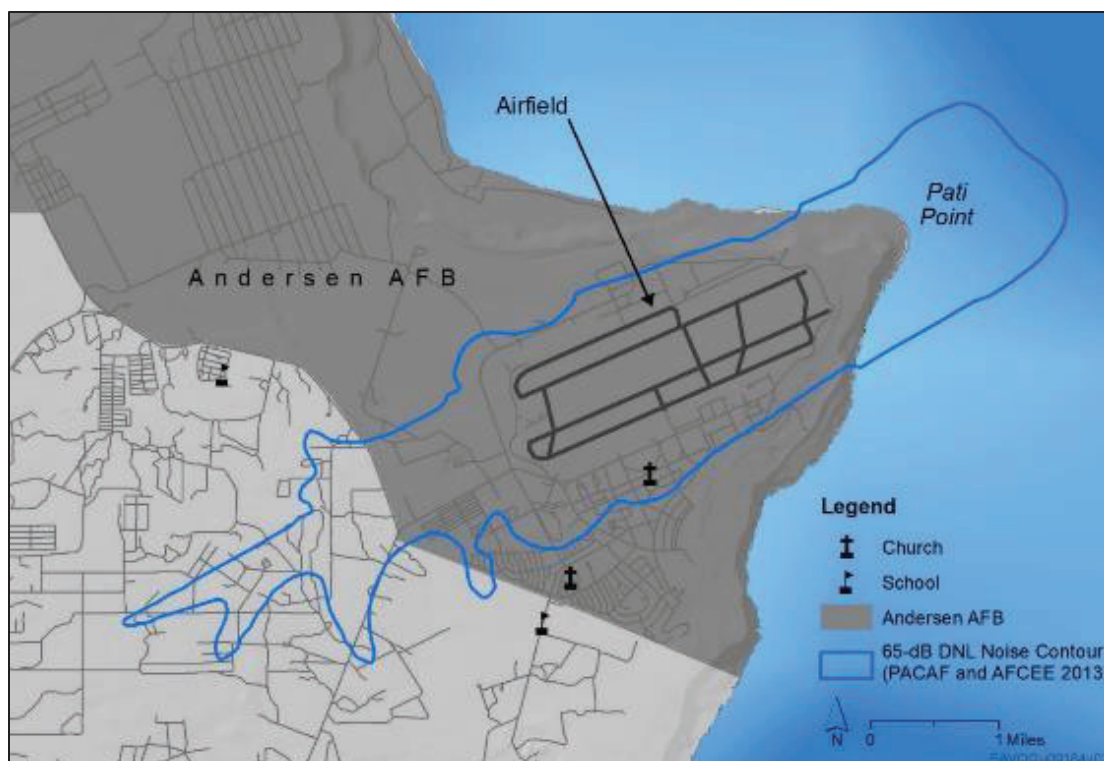


Figure 3.5-1. Current 65-dB DNL Noise Contour at Andersen AFB

The carrier aircraft and LauncherOne rocket would take off from Andersen AFB and fly south to the designated drop point approximately 75 nm south-southwest of Guam. LauncherOne would be carried to an altitude of approximately 35,000–40,000 ft MSL where it would be released. Following ignition of the rocket's first stage, the rocket would be at supersonic speed (in excess of 768 mph), and the engine would burn until all of the propellant is consumed. Therefore, the study area for noise also includes the area under the LauncherOne trajectory when travelling supersonically and can create a sonic boom that would propagate to the ocean surface.

3.5.3 Existing Conditions

Based on the most current data summarizing flight operations by aircraft type, Andersen AFB supported approximately 23,691 flights annually, or approximately 65 operations per day in 2013 (PACAF and AFCEE 2013). Aircraft from both Andersen AFB and the Guam International Airport contribute to aircraft noise on Guam. The International Airport is operated by the Guam International Airport Authority and handles nearly all of the commercial flights into and out of Guam and is the only civilian air transportation facility on Guam. Andersen AFB is home to the 36th Wing (host unit) as well as to the 624th Regional Support Group, Navy Helicopter Squadron 25, and several other tenant organizations and also handles Air Mobility Command Flights for military personnel and their dependents.

The area south and west of Andersen AFB is mostly rural. The most commonly occurring noise sources in the area include local vehicle traffic and noise associated with activities at Andersen AFB. Community noise levels in the area are presented in the Andersen AFB AICUZ (PACAF and AFCEE 2013), show noise contours above 65 dBA extending to the northeast and southwest past the boundaries of AAFB. The configuration of the contours generally follows that of aircraft takeoff and landing routes. While these

contours represent the 24-hour average sound level a sensitive receptor might encounter, single event noise levels from aircraft activity are readily audible throughout the surrounding community.

3.5.4 Environmental Consequences

Noise impacts would be significant if the action would increase noise by DNL 1.5 dB or more for a noise-sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB.

To determine the potential change in DNL, the FAA's Area Equivalent Method (AEM) is used. AEM is a screening procedure used to simplify the assessment step in determining the need for further analysis. AEM is a mathematical procedure that provides an estimated noise contour area of a specific airport given the types of aircraft and the number of operations for each aircraft. The noise contour area is a measure of the size of the landmass enclosed within a level of noise as produced by a given set of aircraft operations. The AEM produces noise contour areas (in square miles) for the DNL 65 dBA noise level and the purpose of AEM is to screen for significant impact within the 65-dBA contour area. Whether AEM results are significant depends both on the threshold of 17% area increase (an increase of approximately DNL 1.5 dBA distributed proportionately with no change in contour shape) and the level of public controversy surrounding the study project.

3.5.4.1 Proposed Action

Carrier Aircraft Operations at Andersen AFB

Based on the most current data summarizing flight operations by aircraft type, Andersen AFB supported approximately 23,691 flights annually, or approximately 65 operations per day in 2013 (PACAF and AFCEE 2013). The adjacent community experiences high noise levels from takeoffs and landings of military jets and helicopters. Portions of the community underlie 24-hour noise contours in excess of 65 dBA DNL.

To determine the potential noise impacts from a maximum of 10 annual carrier aircraft takeoffs and landings per year, the AEM was used. As shown in Table 3.5-1, adding 10 take off and landings per year has the potential to change the 65 dBA DNL by 0.2%. This is below the 17% increase threshold which would represent a 1.5 dB increase in the DNL. Note that the AEM does not incorporate helicopters in its model. At Andersen AFB, helicopters account for approximately one-third of the daily operations. Inclusion of these helicopter operations would further decrease the contribution of the carrier aircraft noise to the airfield DNL contours and further reduce the percent change in area.

Table 3.5-1. AEM Model Results

| DNL (dBA) | Baseline Area (acres) | Alternative Area (acres) | Change in Area |
|-----------|-----------------------|--------------------------|----------------|
| 65 | 25,568 | 25,632 | 0.2% |

Carrier aircraft takeoffs and landings are not expected to change the average DNL contours as reported in the 2013 AICUZ study (PACAF and AFCEE 2013) or elevate the DNL noise level more than 1.5 dB above the acceptable level of 65 dBA. The Proposed Action would represent a very small increase over the existing air traffic and it is unlikely that the proposed activities would contribute to the overall sound environment. Therefore, noise associated with proposed take off and landings of the carrier aircraft under the Proposed Action would not significantly impact the acoustic environment of Andersen AFB and vicinity.

LauncherOne Rocket Operations

The carrier aircraft would take off from Andersen AFB and fly south to the drop point. Once at the drop point, the rocket would be released at an altitude of 35,000–40,000 ft MSL. Within 20 seconds of its release, the rocket would be flying at supersonic speeds.

To determine the potential for a sonic boom, the modeling program PCBOOM was used. Based on the modeling results, no sonic boom would intersect with land or human-sensitive receptors (Figure 3.5-2). The closest boom to the coast with a magnitude of 1.0 pound per square foot (psf) or greater is located approximately 75 nm south-southwest of Guam. Received sonic boom levels at the water's surface would be <1 psf. As none of the sonic boom events that were modeled overlap or otherwise affect the coastal zone, terrestrial areas, sensitive marine habitats (such as the Marianas Trench Marine National Monument), or sensitive receptors, impacts to the marine environment related to sonic booms would be less than significant.

Airspace Closures

Airspace closures associated with commercial space operations could result in temporarily grounded aircraft at affected airports and re-routing of en-route flights on established alternate flight paths. As noted above, the FAA rarely receives reportable departure delays associated with launches. If aircraft were grounded because of temporary airspace closures from proposed launch activities, noise levels at the airport could temporarily increase as the planes sit idle. However, increased noise from grounded aircraft occurs for many reasons beyond launch operations, including weather, equipment outages, military operations, and traffic volume. Since launches would occur no more than 10 times per year, which typically is far less frequent than all other sources of delays, the effect would be negligible. Also, depending on the altitude at which aircraft approach an airport, there could be temporary increases in noise levels in communities around an airport. However, all aircraft re-routing in response to commercial space operations would occur along established alternative routes according to existing flight procedures that have already undergone environmental review and are the same flight paths that are used for other re-route reasons, such as weather issues, runway closures, military exercises, among others. Re-routing associated with launch-related closures represents a small fraction of the total amount of re-routing that occurs from all other reasons in any given year. Any incremental increases in noise levels at an individual airport would only last the duration of the airspace closure on a periodic basis and are not expected to meaningfully change existing day-night average sound levels at the affected airports and surrounding areas. Therefore, airspace closures due to commercial space operations are not expected to result in significant noise impacts. Advancements in airspace management as mentioned above are expected to further reduce the number of aircraft that would contribute to noise at the affected airports and surrounding areas.

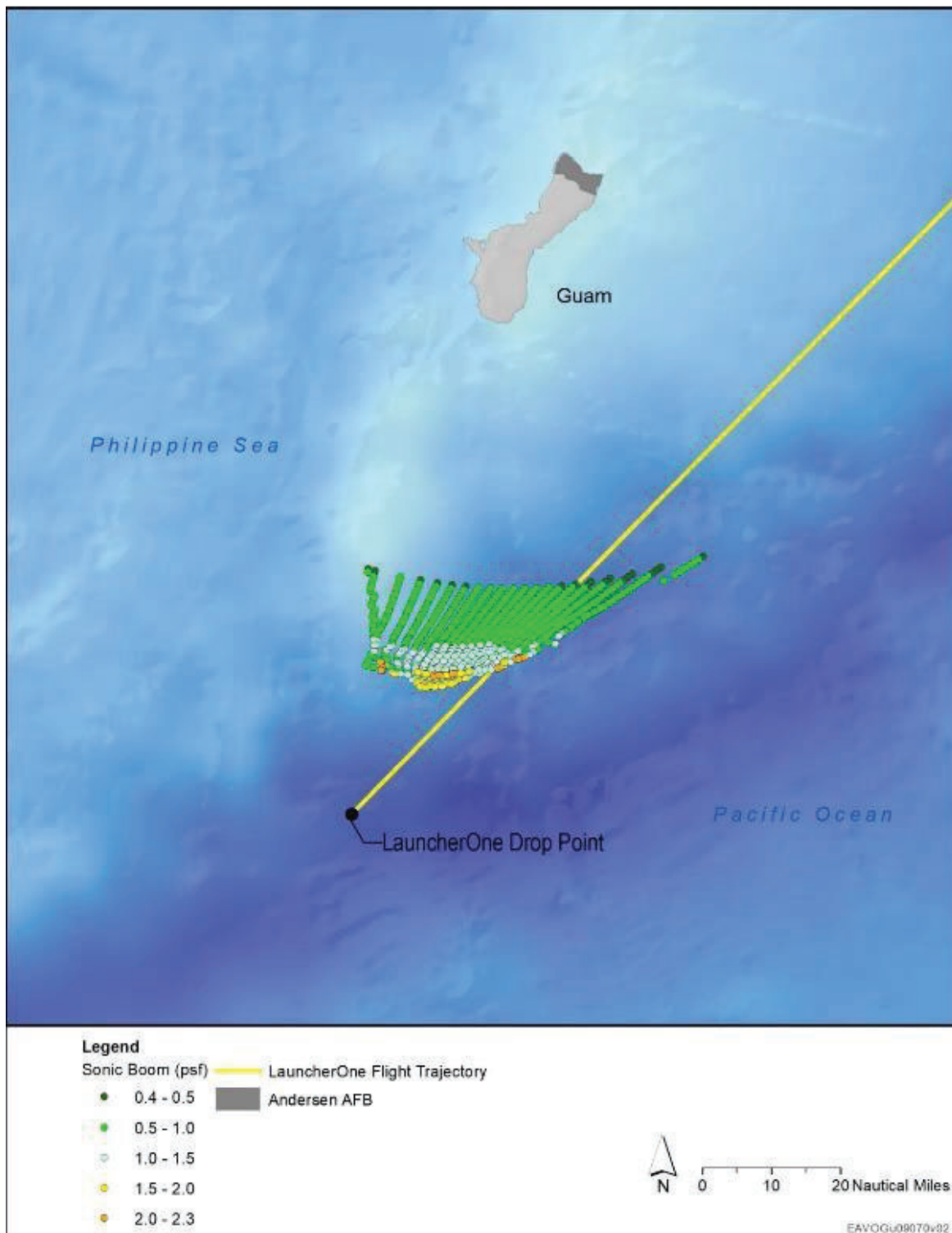


Figure 3.5-2. Modeled Potential Sonic Boom from LauncherOne Vehicle

3.6 Cultural Resources

3.6.1 Definition of Resource and Regulatory Setting

Cultural resources encompass a range of sites, properties, and physical resources relating to human activities, society, and cultural institutions. Such resources include past and present expressions of human culture and history in the physical environment, such as prehistoric and historic archaeological sites, structures, objects, and districts that are considered important to a culture or community. Cultural resources also include aspects of the physical environment, namely natural features and biota that are a part of traditional ways of life and practices and are associated with community values and institutions.

The major law that protects cultural resources is the National Historic Preservation Act (NHPA). Section 106 of the NHPA requires a federal agency to consider the effects of its action (referred to as the *undertaking*) on historic properties. Compliance with Section 106 requires consultation with the State Historic Preservation Officer (SHPO) and other parties, including Indian tribes. The Section 106 process is outlined in 36 CFR Part 800. Major steps in the process include identifying the Area of Potential Effects (APE) in consultation with the SHPO, identifying and evaluating any historic properties within the APE, and assessing the effect of the undertaking on any historic properties. If a historic property would be adversely affected, the consultation process includes resolution of adverse effects. More information on cultural resources can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.6.2 Study Area

In accordance with 36 CFR § 800.4(a)(1), the FAA determined an APE in consideration of the undertaking's potential direct and indirect effects. The APE (or study area) is defined as the airfield runways and immediately adjacent areas on Andersen AFB. In particular, the APE for architectural properties includes the entire potential Munitions Storage Area 2 (MSA-2) Historic District (Figure 3.6-1). Because the rocket is air-launched over the open ocean at >35,000 ft MSL, rocket operations south and east of Guam would not have the potential to affect cultural resources.

3.6.3 Existing Conditions

During World War II (WWII), two B-29 bomber airfields were built on Guam in the area that is now Andersen AFB: Northwest Field and North Field. After WWII, Northwest Field was decommissioned but North Field continued to be used and additional facilities were added in response to military needs arising from the Cold War, Korean War, and Vietnam War. When the USAF became a separate service in 1947, North Field became North Guam AFB. The installation was renamed Andersen AFB in 1949 (Andersen AFB 2007a).

The Andersen AFB study area includes potential historic properties that are part of the built environment, which include the airfield proper (e.g., taxiways, runways, aprons) (eligible for its WWII inception) and MSA-2 (eligible for its Cold War association). There are no other NRHP-listed or -eligible properties within or in the vicinity of proposed carrier aircraft operations at Andersen AFB (Naval Facilities Engineering Command Marianas 2015).



Figure 3.6-1. Location of MSA-2 within Andersen AFB

This potential MSA-2 Historic District was first identified by Mason Architects, Inc. (2004) and recommended eligible for listing in the NRHP under Criteria A and C⁽⁸⁾. The 2004 study defined the district as including “the various types of storage igloos” on MSA-2. A 2017 architectural history study of MSA-2 assessed the conditions and significance of architectural resources located within MSA-2 (Dixon et al. 2017). The same study found the Type 4 igloos and Facility 51150 (Munitions Support Equipment Maintenance) in MSA-2 to be eligible for the NRHP under Criterion A for their associations with Strategic Air Command’s Cold War era nuclear program. Type 4 igloos and Facility 51150 are also eligible under NRHP Criterion C for their specialized designs that were specific to their direct roles in supporting Strategic Air Command’s program. Furthermore, a historic district comprising the individually eligible structures and secondary supporting structures is eligible under NRHP Criterion A. The boundary of the district encompasses the fenced area of MSA-2.

⁽⁸⁾NRHP criteria for significance: A = eligible because they are associated with events that have made a significant contribution to the broad pattern of history; C = eligible because they embody the distinctive characteristics of a type, period, or method of construction (36 CFR 60.4).

3.6.4 Environmental Consequences

The FAA has not established a significance threshold for cultural resources. Factors to consider when assessing the significance of potential impacts on cultural resources include whether the action would result in a finding of *Adverse Effect* through the Section 106 process. However, an adverse effect finding does not automatically trigger preparation of an EIS.

3.6.4.1 Proposed Action

Carrier Aircraft Operations at Andersen AFB

Routine aircraft operations at Andersen AFB have not been an issue for any previous Section 106 consultations. Future impacts to historic properties that are part of the built environment, which include the airfield proper (eligible for its WWII inception) and MSA-2 (eligible for its Cold War association), have been addressed with Historic American Engineering Records. While both the airfield and the MSA-2 structures are built to withstand the vibrations inherent in use of the airfield (e.g., B-52s have routinely used the runways and have done their power checks on the parking aprons, exercises are routinely conducted that result in ramped-up flight activities with a variety of aircraft, and the MSA-2 structures are built to contain the effects of explosions), any damage that might result from enhanced vibrations associated with the proposed B-747 carrier aircraft operations on the airfield would not affect eligibility of the airfield-related properties (36 CES/CEV 2020).

The Proposed Action, known as an undertaking per NHPA Section 106, would not result in any ground-disturbing activities and would not require any construction or modification of facilities at Andersen AFB. Proposed carrier aircraft operations would occur on existing apron, taxiway, and runway surfaces and there would be no changes to these areas under the Proposed Action. Carrier aircraft operations would be similar to military activities currently conducted on the same aprons, taxiways, and runways. There are no known cultural resources underlying the proposed LauncherOne trajectory that would be potentially impacted by proposed rocket operations. FAA concludes that the proposed undertaking will not affect any properties listed or eligible for listing on the NRHP and has made a finding of No Historic Properties Affected in accordance with 36 CFR Part 800. The FAA conducted Section 106 consultation with the Guam Historic Preservation Division and on October 23, 2020, the SHPO concurred with the FAA's finding (refer to Appendix D.2). Therefore, the Proposed Action would not result in significant impacts on historical, architectural, archeological, or cultural resources.

3.7 Department of Transportation Act, Section 4(f)

3.7.1 Definition of Resource and Regulatory Setting

Section 4(f) of the U.S. Department of Transportation (DOT) Act of 1966 (now codified at 49 USC § 303) protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites. Section 4(f) provides that the Secretary of Transportation may approve a transportation program or project requiring the use of publicly owned land of a public park, recreation area, or wildlife or waterfowl refuge of national, state, or local significance, or land of an historic site of national, state, or local significance, only if there is no feasible and prudent alternative to the using that land and the program or project includes all possible planning to minimize harm resulting from the use.

Procedural requirements for complying with Section 4(f) are set forth in DOT Order 5610.1D, *Procedures for Considering Environmental Impacts*. The FAA also uses Federal Highway Administration (FHWA) regulations (23 CFR Part 774) and FHWA guidance (e.g., Section 4(f) Policy Paper) when assessing potential impacts on Section 4(f) properties. These requirements are not binding on the FAA; however,

the FAA may use them as guidance to the extent relevant to FAA projects. More information on the DOT Act, Section 4(f) can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.7.2 Study Area

For the purposes of assessing potential impact to Section 4(f) properties, there are two study areas: (1) the existing airfield apron, taxiway, and runway areas of Andersen AFB and associated airspace and noise from carrier aircraft operations; and (2) the Pacific Ocean south and east of Guam under the LauncherOne trajectory, particularly those areas subject to sonic booms and the area beneath the Drop Point, Stage 1, and Fairings Re-entry AHAs and SHAs (Figure 2.1-7).

3.7.3 Existing Conditions

3.7.3.1 Andersen AFB

The Andersen AFB study area includes potential historic properties that are part of the built environment, which include the airfield proper (e.g., taxiways, runways, aprons) (eligible for its WWII inception) and MSA-2 (eligible for its Cold War association). There are no other NRHP-listed or -eligible properties within or in the vicinity of proposed carrier aircraft operations at Andersen AFB (Naval Facilities Engineering Command Marianas 2015). Refer to Section 3.6, *Cultural Resources*, for further details.

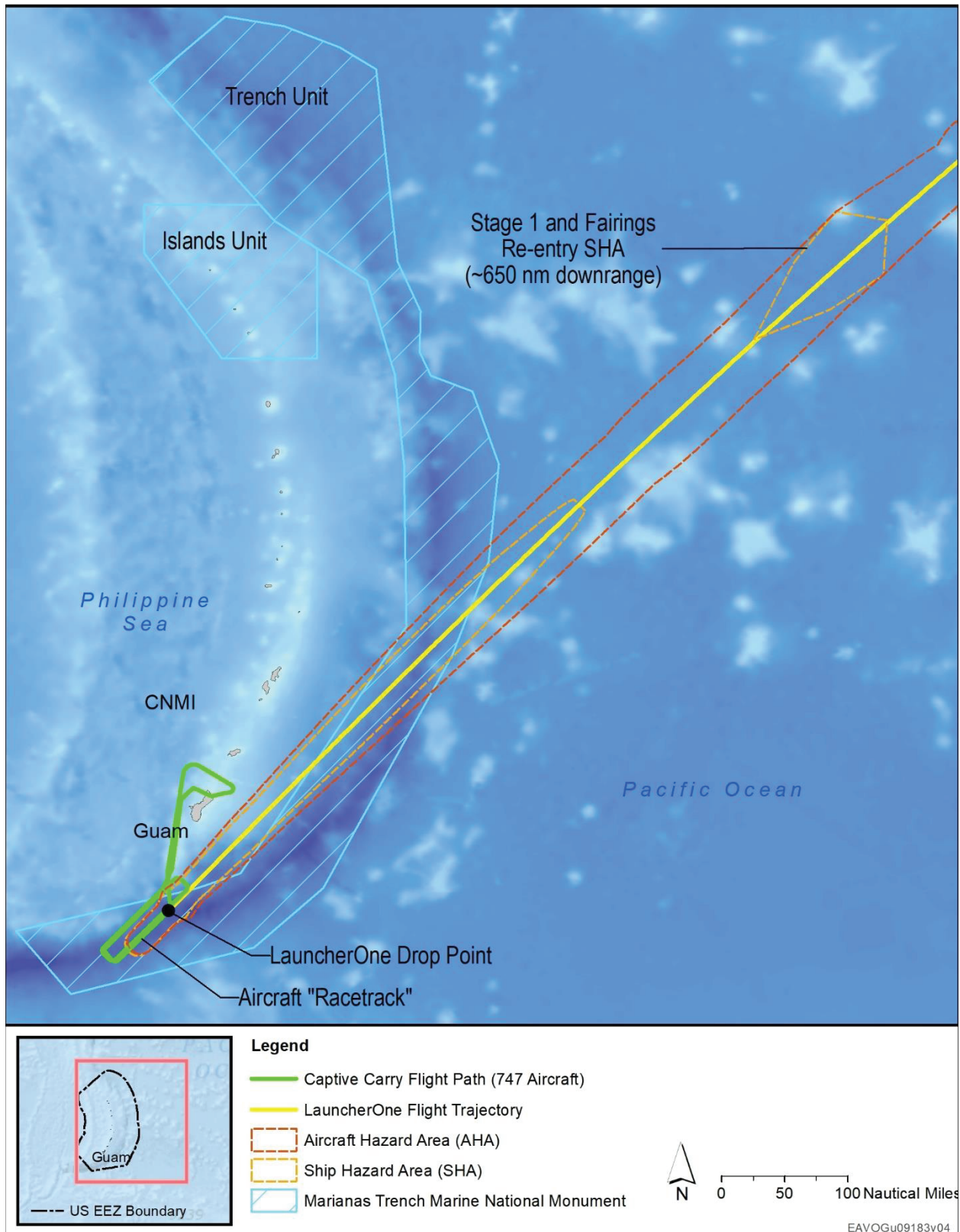
3.7.3.2 Pacific Ocean underlying the LauncherOne Trajectory

The only Section 4(f) property that lies within the Pacific Ocean study area is the Marianas Trench Marine National Monument (MTMNM). Designated in 2009, the MTMNM includes three units:

- Islands Unit: the waters and submerged lands of the three northernmost Mariana Islands (Farallon de Pajaros [also known as Uracus], Maug, and Asuncion).
- Volcanic Unit: the submerged lands within 1 nm of 21 designated volcanic sites located west of the Mariana Islands.
- Trench Unit: the submerged lands extending from the northern limit of the US EEZ in the CNMI to the southern limit of the EEZ in the Territory of Guam.

No waters are included in the Volcanic and Trench Units (USFWS 2012). Only the Trench Unit occurs within the study area and the southern portion underlies the proposed LauncherOne Drop Point and trajectory (Figure 3.7-1).

Presidential Proclamation 8335 established the monument under the authority of the Antiquities Act of 1906, which protects places of historic or scientific significance. Management responsibility was assigned to the Secretary of the Interior, in consultation with the Secretary of Commerce. The Interior Secretary placed the Trench Unit within the National Wildlife Refuge System and delegated his management responsibility to the USFWS (President of the United States 2009; USFWS 2012).



3.7.4 Environmental Consequences

Impacts on Section 4(f) properties would be significant if the Proposed Action involves more than a minimal physical use of a Section 4(f) resource or constitutes a “constructive use” based on an FAA determination that the project would substantially impair the Section 4(f) resource. The concept of constructive use is that a project that does not physically use land in a park, for example, may still, by means of noise, air pollution, water pollution, or other impacts, dissipate its aesthetic value, harm its wildlife, restrict its access, and take it in every practical sense. Constructive use occurs when the impacts of a project on a Section 4(f) property are so severe that the activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired. Substantial impairment occurs only when the protected activities, features, or attributes of the Section 4(f) property that contribute to its significance or enjoyment are substantially diminished. This means that the value of the Section 4(f) property, in terms of its prior significance and enjoyment, is substantially reduced or lost. For example, noise would need to be at levels high enough to have negative consequences of a substantial nature that amount to a taking of a park or portion of a park for transportation purposes.

3.7.4.1 Proposed Action

Carrier Aircraft Operations at Andersen AFB

The Proposed Action does not involve any construction activities and therefore would not require a physical use of a Section 4(f) property. The Proposed Action would not require a temporary occupancy of a 4(f) resource, such as a temporary easement or right of entry. While the airfield at Andersen AFB is eligible for an NRHP listing and is the site of the Proposed Action, no impacts to the airfield, including visual or noise, would be so severe that the activities, features, or attributes of the airfield would be substantially impaired. Therefore, the Proposed Action would not result in a constructive use of a Section 4(f) property. Thus, the Proposed Action would not result in significant impacts to Section 4(f) properties.

LauncherOne Rocket Operations

The LauncherOne drop point would be located 75 nm south-southwest of Guam and would occur over the Trench Unit of the MTMNM at an altitude >35,000 ft MSL. During the expected LauncherOne firing and flight trajectory, the AHA/SHA for the re-entry of Stage 1 and the payload fairings is 325 nm northeast of the MTMNM. Therefore, there would be no impacts to the MTMNM.

In the unlikely event of a launch mishap occurring whereby the LauncherOne rocket has been released from the carrier aircraft and there is a malfunction or other issue that results in the abort of the flight, the rocket is expected to maintain structural integrity until impact the ocean within the Drop Point AHA and SHA if there is no secondary explosive failure. There is no destruct component on the vehicle. The vehicle safety system will shut down all thrust as soon as a failure is detected, preventing it from moving to a different area. Based on the altitude and speed of the LauncherOne rocket upon release from the carrier aircraft, if ignition does not occur, it is expected to impact the ocean between 1 and 7 nm from the Drop Point. As the drop of LauncherOne from the carrier aircraft occurs at approximately 35,000 ft MSL, if propellant tanks are ruptured, the RP-1 will vaporize when exposed to the ambient environment. The oxidizer in the rocket is LOX that will boil off into the atmosphere with no adverse effects. Once the rocket impacts the ocean surface, it will break up into small pieces and most will sink. These small pieces impacting the ocean floor within the MTMNM would not result in a physical or constructive use of the MTMNM, and thus would not result in significant impacts.

3.8 Water Resources

3.8.1 Definition of Resource and Regulatory Setting

Water resources are surface waters and groundwater that are vital to society; they are important in providing drinking water and in supporting recreation, transportation and commerce, industry, agriculture, and aquatic ecosystems. This impact category includes surface waters, groundwater, floodplains, and wetlands. These resources do not function as separate and isolated components of the watershed but rather as a single, integrated natural system. Disruption of any one part of this system can have consequences to the functioning of the entire system. The analysis includes not only disruption of the resources but also potential impacts on the quality of the water resources. Because of the close and integrated relationship of these resources, their analysis is conducted under the all-encompassing impact category of water resources. Wild and Scenic Rivers are included because impacts on these rivers can result from obstructing or altering the free-flowing characteristics of a designated river, an impact more closely resembling an impact on a water resource. However, there are no designated wild and scenic rivers on Guam.

The major laws and EOs pertaining to water resources include the Clean Water Act (CWA); Executive Order (EO) 11990, *Protection of Wetlands*; EO 11988, *Floodplain Management*; and Safe Drinking Water Act. The CWA establishes the basic structure for regulating the discharge of pollutants into waters of the United States, including wetlands. Of note, the National Pollutant Discharge Elimination System (NPDES) is a federal permit created by the CWA that regulates specific stormwater and other point source pollution discharges.

EO 11990 requires federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Similarly, EO 11988 requires federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of 100-year floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

More information on water resources, including the laws that protect them, can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.8.2 Study Area

The water resources study areas include the existing airfield apron, taxiway, and runway areas of Andersen AFB and the ocean area under the AHA and within the SHA where Stage 1 and the fairings would fall into the ocean.

3.8.3 Existing Conditions

Proposed carrier aircraft operations on Andersen AFB would be limited to existing airfield apron, taxiway, and runway areas consisting of concrete. These areas do not contain any surface water features and are not near a floodplain or wetlands. Andersen AFB overlies the Northern Guam Lens Aquifer (NGLA), which is a U.S. Environmental Protection Agency (USEPA)-designated sole source aquifer. The NGLA is the limestone bedrock that underlies the entire northern half of Guam and contains a large and permanent body of fresh groundwater (Water and Environmental Research Institute of the Western Pacific and Island Research & Education Initiative 2020).

The Guam Environmental Protection Agency assists in the administration of NPDES permits and reviews and certifies the permit for compliance with all local regulations and policies and in accordance with the

Guam Water Quality Standards. Andersen AFB routes its wastewater discharge to Guam's Northern District Wastewater Treatment plant, which currently has an NPDES permit issued by the USEPA pursuant to the CWA.

Guam is in a tropical environment that receives an estimated 100 inches of rainfall annually. As a result, the island has unique stormwater discharge requirements. Andersen AFB is relatively flat, and heavy precipitation generally flows by sheets into swales, then into sink holes or other depressions, where it percolates into the ground or is channeled into stormwater wells. Dry injection wells that use the porous limestone bedrock to assist in stormwater migration into the NGLA below are located throughout the base. These injection wells are permitted and regulated by Guam Environmental Protection Agency through Underground Injection Control permits. A number of the wells are sampled twice a year to ensure that water entering the wells meets drinking water standards (Navy 2010; Joint Guam Program Office 2015).

The Stage 1 AHA and SHA occur in an area of the Pacific Ocean approximately 550 nm northeast of Guam where ocean depths are approximately -20,000 ft.

3.8.4 Environmental Consequences

Impacts on surface waters would be significant if the action would 1) exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or 2) contaminate public drinking water supply such that public health may be adversely affected.

Impacts on wetlands would be significant if the action would:

- Adversely affect a wetland's function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers;
- Substantially alter the hydrology needed to sustain the affected wetland system's values and functions or those of a wetland to which it is connected;
- Substantially reduce the affected wetland's ability to retain floodwaters or storm runoff, thereby threatening public health, safety or welfare (the term welfare includes cultural, recreational, and scientific resources or property important to the public);
- Adversely affect the maintenance of natural systems supporting wildlife and fish habitat or economically important timber, food, or fiber resources of the affected or surrounding wetlands;
- Promote development of secondary activities or services that would cause the circumstances listed above to occur; or
- Be inconsistent with applicable State wetland strategies.

Impacts on groundwater would be significant if the action would 1) exceed groundwater quality standards established by federal, state, local, and tribal regulatory agencies; or 2) contaminate an aquifer used for public water supply such that public health may be adversely affected.

Impacts on floodplains would be significant if the action would cause notable adverse impacts on natural and beneficial floodplain values. Natural and beneficial floodplain values are defined in Paragraph 4.k of Department of Transportation Order 5650.2, *Floodplain Management and Protection*.

3.8.4.1 Proposed Action

Carrier Aircraft Operations at Andersen AFB

The Proposed Action does not involve construction activities that would potentially introduce non-point source pollution at Andersen AFB. The potential impact of operations is negligible as the LauncherOne propellants and pressurants are similar to those already in use at Andersen AFB with appropriate safety and pollution control measures in place. Any accidental spills associated with pre- and post-flight activities would be addressed by Andersen AFB emergency response procedures (refer to Section 3.9). Therefore, implementation of the Proposed Action would not have significant impacts on water resources on Andersen AFB.

LauncherOne Rocket Operations

The carrier aircraft and LauncherOne rocket would take off from Andersen AFB and fly south to the designated drop point approximately 75 nm over open ocean south-southwest of Guam. LauncherOne would be carried to an altitude of approximately 35,000–40,000 ft MSL where it would be released. Following ignition of the rocket's first stage, the engine would burn until all of the propellant is consumed, and Stage 1 would fall through the AHA and into the ocean within the Stage 1 and Fairings Re-entry SHA approximately 550 nm northeast of Guam (Figure 2.1-7)⁹.

Both stages of the rocket are expendable. Stage 1 debris would fall into the Pacific Ocean within the SHA, and second stage debris would expend into Earth's orbit. First stage and fairings debris, which is comprised of inert materials which are neither chemically nor biologically reactive, are anticipated to sink relatively quickly. Accordingly, it would not affect water quality in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

The propellant type used by LauncherOne Stage 1 is a mixture of a kerosene-based fuel (known as RP-1) and LOX. In the event of a launch failure and the LauncherOne rocket impacts the Pacific Ocean, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1 and the creation of a thin film of petroleum on the water surface near the impact area. RP-1 is a Type 1 "very light oil," which is characterized as being highly volatile and having low viscosity and low specific gravity. Due to its high volatility, RP-1 evaporates quickly when exposed to the air and would completely dissipate into ocean waters within hours due to a combination of wave movement, oxygen exposure, and sunlight (NOAA 2019). The amount of water in comparison to the amount of propellant would allow the propellant to quickly dilute so that impacts would be temporary and extremely localized. Cleanup following a spill of very light oil is usually not necessary or possible, particularly with such a small quantity of oil that would enter the ocean in the event of an unsuccessful launch. Therefore, no attempt would be made to boom nor recover RP-1 fuel from the ocean. Although it would require hours or perhaps days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatilized rapidly because of increased agitation and dissipation. LOX is a non-toxic cryogenic liquid which will evaporate into the air when released. Therefore, implementation of the Proposed Action would not have significant impacts on water resources underlying the AHA and Stage 1 and Fairings Re-entry SHA.

⁹ If there is a malfunction or other issue that results in the abort of the flight, the LauncherOne may land within the Drop Point AHA/SHA but will not have a significant impact on water resources. See Section 3.7.4 for further discussion.

3.9 Biological Resources

3.9.1 Definition of Resource and Regulatory Setting

Biological resources are valued for their intrinsic, aesthetic, economic, and recreational qualities, and include fish, wildlife, plants, and their respective habitats. Typical categories of biological resources include terrestrial and aquatic plant and animal species, game and non-game species, special-status species (state or federally listed threatened or endangered species, marine mammals, or species of concern, such as species proposed for listing or migratory birds), and environmentally sensitive or critical habitats.

Section 7(a)(2) of the Endangered Species Act (ESA) (16 USC §1531 et seq.) requires that each federal agency, in consultation with the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS), ensures that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. The FAA is required to consult with the USFWS or NMFS if an action may affect a federally listed species or critical habitat.

The Marine Mammal Protection Act (MMPA) prohibits, with certain exceptions, the “take” of marine mammals in U.S. waters and by U.S. citizens on the high seas. If an action has the potential to impact marine mammals, the FAA is required to consult the USFWS (for sea and marine otters, walruses, polar bears, three species of manatee, and the dugongs) and/or NMFS (for all marine mammals). Often the marine mammals present in a project area are also listed under the ESA.

Under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), the FAA must consult with NMFS if the action may adversely affect essential fish habitat (EFH). As defined by the Act, EFH refers to those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.

More information on biological resources, including the laws that protect them, can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.9.2 Study Area

There are two biological resources study areas: (1) the existing airfield apron, taxiway, and runway areas of Andersen AFB and associated airspace and noise from carrier aircraft operations; and (2) the Pacific Ocean south and east of Guam under the LauncherOne trajectory, particularly those areas subject to sonic booms, and the area beneath the AHA, Drop Point SHA, and Stage 1 and Fairings Re-entry SHA (Figure 2.1-7).

3.9.3 Existing Conditions

3.9.3.1 Andersen AFB

There would be no ground-disturbing activities associated with the Proposed Action, and therefore, no impact on vegetation communities, ESA-listed plant species, or vegetated terrestrial wildlife habitat; these resources are dismissed from further discussion. In addition, the USFWS has not designated critical habitat for federally listed threatened or endangered species on Andersen AFB. The Guam National Wildlife Refuge at Ritidian Point, approximately 7 miles northwest of the Andersen AFB airfield (Figure 2.1-2), does contain critical habitat for the threatened Mariana fruit bat, endangered Mariana crow, and endangered Guam Micronesian kingfisher (JRM 2019). Proposed carrier aircraft operations

would not occur over or in the vicinity of Ritidian Point and the Guam NWR (Figures 2.1-2 and 2.1-5); therefore, critical habitat is dismissed from further discussion.

The following wildlife information is based on Andersen AFB's recent Integrated Natural Resources Management Plan (JRM 2019).

Wildlife species on Andersen AFB include nine species of non-native mammals (Norway rat [*Rattus norvegicus*], black rat [*Rattus rattus*], Polynesian rat [*Rattus exulans*], house mouse [*Mus musculus*], musk shrew [*Suncus murinus*], feral dog [*Canis lupus familiaris*], feral cat [*Felis catus*], feral pig [*Sus scrofa*], and Philippine deer [*Rusa marianna*]), and only one native mammal species, the ESA-listed endangered Mariana fruit bat (*Pteropus mariannus mariannus*). The installation also supports three other ESA-listed animal species: green turtle (*Chelonia mydas*), including nesting on the beaches north of the airfield and occurring in the marine waters north of Andersen AFB; Guam tree snail (*Partula radiolata*); and Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*).

Most avian species on the installation are native to the region; however, many are seasonal visitors that use coastal, grassy, or other open habitats to forage during their annual migration. Migratory birds either spend the winter on Guam or migrate through during the spring and fall to breeding areas to the north and south. Seabirds that have the potential to occur on Andersen AFB either during migration or as year-round residents include black noddy (*Anous minutus*), brown noddy (*Anous stolidus*), brown booby (*Sula leucogaster*), red-footed booby (*Sula sula*), white tern (*Gygis alba*), great frigatebird (*Fregata minor*), sooty tern (*Onychoprion fuscatus*), and white-tailed tropicbird (*Phaethon lepturus*). Several shorebird species also occur on base including Pacific golden plover (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), wood sandpiper (*Tringa glareola*), wandering tattler (*Tringa incana*), grey-tailed tattler (*Tringa brevipes*), sharp-tailed sandpiper (*Calidris acuminata*), whimbrel (*Numenius phaeopus*) and several species of sandpipers and plovers. Wading birds that have the potential to migrate through or reside on Andersen AFB include Eastern cattle egret (*Bubulcus coromandus*), intermediate egret (*Ardea intermedia*), Pacific reef heron (*Egretta sacra*), and yellow bittern (*Ixobrychus sinensis*). Four non-native bird species also occur on base and include black drongo (*Dicrurus macrocercus*), Eurasian tree sparrow (*Passer montanus*), black francolin (*Francolinus francolinus*), and island collared dove (*Streptopelia bitorquata*).

In addition, a number of native and non-native reptile and amphibian species are found in appropriate habitats on Andersen AFB. Native species include Pacific blue-tailed skink (*Emoia caeruleocauda*), moth skink (*Lipinia noctua*), monitor lizard (*Varanus indicus*), and mutilating gecko (*Gehyra mutilata*); and non-native species are curious skink (*Carlia ailanpalai*), house gecko (*Hemidactylus frenatus*), brown treesnake (*Boiga irregularis*), Brahminy blind snake (*Ramphotyphlops braminus*), marine toad (*Rhinella marina*), and greenhouse frog (*Eleutherodactylus planirostris*).

3.9.3.2 Pacific Ocean underlying the LauncherOne Trajectory

Birds

Pelagic seabird species potentially occurring in the open ocean environment south and northeast of Guam beneath the proposed LauncherOne trajectory include Bulmer's petrel (*Bulweria bulwerii*); streaked (*Calonectris leucomelas*), wedge-tailed (*Ardenna pacifica*), and Audubon's shearwaters (*Puffinus lherminieri*); masked (*Sula dactylatra*), brown (*Sula leucogaster*), and red-footed boobies (*Sula sula*); great frigatebird (*Fregata minor*), common tern (*Sterna hirundo*), and sooty tern (*Onychoprion fuscatus*) (Baker 1951; Harrison 1983; Pratt et al. 1989). Three seabirds that may occur in the study area are listed under the ESA as threatened or endangered species: short-tailed albatross (*Phoebastria*

albatrus), Hawaiian petrel (*Pterodroma sandwichensis*), and Newell's shearwater (*Puffinus auricularis newelli*) (Table 3.9-1). These three species nest outside the study area and are thought to occur only very rarely within the study area (Navy 2015; USFWS 2010, 2015). Therefore, the proposed action would have no effect on these ESA-listed bird species and are not discussed further.

Marine Mammals

A total of 26 marine mammal species may occur within the marine waters underlying the LauncherOne trajectory, including 5 ESA-listed endangered species (Table 3.9-1). The species presented in Table 3.9-1 are based on observed marine mammals during surveys in the Mariana Islands Training and Testing (MITT) Study Area and associated transit corridor in support of the MITT Draft Supplemental EIS/Overseas EIS (Navy 2019b). The MITT Study Area extends 450 nm north of Guam, 250 nm east of Guam, and 300 nm south of Guam and includes the LauncherOne drop point. The transit corridor is located on the eastern edge of the MITT Study Area and is 300 nm south of the Stage 1 and Fairings Re-entry SHA. Information from the MITT Supplemental EIS/Overseas EIS provide the best available data regarding the occurrence of marine mammals in the vicinity of the proposed LauncherOne operations. Density estimates for each species are provided in Appendix B.

Table 3.9-1. Special-status Marine Species Potentially underlying the Proposed LauncherOne Trajectory

| Common Name | Scientific Name | ESA Status |
|--|---------------------------------------|------------|
| SEABIRDS | | |
| Hawaiian petrel | <i>Pterodroma sandwichensis</i> | E |
| Newell's shearwater | <i>Puffinus auricularis newelli</i>) | T |
| Short-tailed albatross | <i>Phoebastria albatrus</i> | E |
| MARINE MAMMALS* | | |
| Blainville's beaked whale | <i>Mesoplodon densirostris</i> | nl |
| Blue whale | <i>Balaenoptera musculus</i> | E |
| Bryde's whale | <i>Balaenoptera edeni</i> | nl |
| Common bottlenose dolphin | <i>Tursiops truncatus</i> | nl |
| Cuvier's beaked whale | <i>Ziphius cavirostris</i> | nl |
| Dwarf sperm whale | <i>Kogia sima</i> | nl |
| False killer whale | <i>Pseudorca crassidens</i> | nl |
| Fin whale | <i>Balaenoptera physalus</i> | E |
| Fraser's dolphin | <i>Lagenodelphis hosei</i> | nl |
| Ginkgo-toothed beaked whale | <i>Mesoplodon ginkgodens</i> | nl |
| Humpback whale (Western North Pacific DPS) | <i>Megaptera novaeangliae</i> | E |
| Killer whale | <i>Orcinus orca</i> | nl |
| Longman's beaked whale | <i>Indopacetus pacificus</i> | nl |
| Melon-headed whale | <i>Peponocephala electra</i> | nl |
| Minke whale | <i>Balaenoptera acutorostrata</i> | nl |
| Omura's whale | <i>Balaenoptera omurai</i> | nl |
| Pantropical spotted dolphin | <i>Stenella attenuata</i> | nl |
| Pygmy killer whale | <i>Feresa attenuata</i> | nl |
| Pygmy sperm whale | <i>Kogia breviceps</i> | nl |
| Risso's dolphin | <i>Grampus griseus</i> | nl |
| Rough-toothed dolphin | <i>Steno bredanensis</i> | nl |
| Sei whale | <i>Balaenoptera borealis</i> | E |
| Short-finned pilot whale | <i>Globicephala macrorhynchus</i> | nl |
| Sperm whale | <i>Physeter macrocephalus</i> | E |

Table 3.9-1. Special-status Marine Species Potentially underlying the Proposed LauncherOne Trajectory

| Common Name | Scientific Name | ESA Status |
|--|--------------------------------|------------|
| Spinner dolphin | <i>Stenella longirostris</i> | nl |
| Striped dolphin | <i>Stenella coeruleoalba</i> | nl |
| SEA TURTLES | | |
| Green sea turtle (Central West Pacific DPS) | <i>Chelonia mydas</i> | E |
| Hawksbill sea turtle | <i>Eretmochelys imbricata</i> | E |
| Leatherback sea turtle | <i>Dermochelys coriacea</i> | E |
| Loggerhead sea turtle (North Pacific DPS) | <i>Caretta caretta</i> | E |
| FISH | | |
| Giant manta ray | <i>Manta birostris</i> | T |
| Oceanic whitetip shark | <i>Carcharhinus longimanus</i> | T |
| Scalloped hammerhead shark (Indo-West Pacific DPS) | <i>Sphyrna lewini</i> | T |

Notes: *All marine mammals are also listed under the MMPA. E = endangered; nl = not listed; T = threatened.

Sources: Navy 2015, 2018; National Oceanic and Atmospheric Administration (NOAA) Fisheries 2020; USFWS 2020.

Sea Turtles

Four ESA-listed endangered sea turtle species may also occur within the marine waters underlying the proposed LauncherOne activities: green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*) (Table 3.9-1). As there are no terrestrial areas underlying proposed LauncherOne activities, there are no sea turtle nesting areas in the study area.

Fish

In addition to hundreds of species of marine fish, three ESA-listed threatened fish species potentially occur within the marine waters underlying the proposed LauncherOne activities: giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus longimanus*), and scalloped hammerhead shark (*Sphyrna lewini*) (Table 3.9-1).

Although all of the water column and benthic nearshore resources and submerged lands under the management responsibility of Andersen AFB are designated as EFH under the Magnuson-Stevens Act (JRM 2019), these resources occur in the coastal zone of Guam and there would be no impacts to EFH from takeoff and landings of the carrier aircraft at Andersen AFB. No EFH occurs under the proposed LauncherOne drop point or trajectory, including the AHA/SHAs. Therefore, EFH is not discussed further.

3.9.4 Environmental Consequences

A significant impact on biological resources would occur if the USFWS or NMFS determines that the action would be likely to jeopardize the continued existence of a federally listed threatened or endangered species, or would result in the destruction or adverse modification of federally designated critical habitat. The FAA has not established a significance threshold for unlisted species. Factors to consider when assessing the significance of potential impacts on unlisted species include whether the action would have the potential for:

- A long-term or permanent loss of unlisted plant or wildlife species (i.e., extirpation of the species from a large project area, such as from a new commercial service airport);
- Adverse impacts on special status species or their habitats;
- Substantial loss, reduction, degradation, disturbance, or fragmentation of native species' habitats or their populations; and/or

- Adverse impacts on a species' reproductive success rates, natural mortality rates, non-natural mortality (e.g., road kills and hunting), or ability to sustain the minimum population levels required for population maintenance.

3.9.4.1 Proposed Action

Implementation of the Proposed Action would not result in significant impacts to wildlife and ESA-listed mammals, sea turtles, and fish species in the vicinity of the proposed carrier aircraft and LauncherOne activities. These impacts include noise associated with overflights of the carrier aircraft taking off and landing at Andersen AFB, in-air and underwater acoustic impacts from sonic booms under the LauncherOne trajectory, unspent RP-1 fuel from Stage 1 when it impacts the Pacific Ocean, and potential strike of marine species from Stage 1 and the fairings debris underlying the AHA and Stage 1 and Fairings SHA.

Carrier Aircraft Operations at Andersen AFB

Under the Proposed Action, a maximum of 10 takeoffs and landings would occur at Andersen AFB in any one year during the 5-year operating period. The other 4 years would see ≤ 9 takeoffs and landings at Andersen AFB not exceeding 25 operations across 5 years. The additional 10 flight operations per year would represent a very small increase over the baseline air traffic (23,691 operations) and it is unlikely that these activities would contribute to the overall sound environment or be noticeably different than the current sound environment at Andersen AFB. Therefore, noise associated with proposed take off and landings of the carrier aircraft under the Proposed Action would not result in significant impacts to wildlife species on and in the vicinity of Andersen AFB. In addition, in accordance with ESA section 7, the FAA has determined that the Proposed Action would have no effect on ESA-listed terrestrial species on Andersen AFB (i.e., green turtle, Mariana fruit bat, Guam tree snail, and Mariana eight-spot butterfly).

LauncherOne Rocket Operations

Sonic Booms

Impulse sounds may include a sonic boom from the LauncherOne rocket. NMFS uses conservative thresholds of received sound pressure levels from broad band sounds that may cause behavioral disturbance and injury (NMFS 2018). These conservative thresholds are applied in both MMPA permits and ESA section 7 consultations for marine mammals to evaluate the potential for sound effects. The criterion levels discussed here are specific to the levels of harassment as defined under the MMPA. Level A criteria for in-water permanent threshold shift (PTS) (injury) to marine mammals, excluding tactical sonar and explosives, range from 173 dB cumulative sound exposure level (SEL_{cum}) to 219 dB SEL_{cum} , depending on the marine mammal hearing group. Level B criterion for in-water for behavioral disruption for impulsive noise is 160 dB root mean square reference 1 micropascal (160 dB_{rms} re 1 μ Pa) (NMFS 2018). The proposed project activities were evaluated using the above acoustic thresholds. In the ESA context, these thresholds are informative as the thresholds at which we might expect either behavioral changes or physical injury to an animal to occur, but the actual anticipated effects would be the result of the specific circumstances of the action (as further explained below).

It is likely that any noise associated with the sonic boom would transmit from the air to water and propagate some distance in the water column. All of the sonic boom pressure signals measured in Sohn et al. (2000) decayed to ambient levels in all frequency bands by 131-164 ft. A sonic boom at the surface of 2 psf (2-4 times greater than the anticipated sonic boom from the proposed LauncherOne activities; Figure 3.5-2) decayed to approximately 152 dB_{rms} re 1 μ Pa at a depth of 23 ft. By 72 ft, the received level was approximately 140 dB_{rms} re 1 μ Pa and at 121 ft, it was equal to ambient noise levels.

All of these sound pressure levels are below the current NMFS threshold for potential permanent injury for cetaceans (180 dB_{rms} re 1 µPa sound pressure level) and potential behavioral change or temporary injury (160 dB_{rms} re 1 µPa sound pressure level). Although it was not possible to estimate the point at which underwater sound pressure levels would equal or exceed 160 dB_{rms} re 1 µPa, but it is estimated this would likely occur at less than 23 ft which could be at or near the surface level of the water based on the decay rate provided above at a depth of 23 ft.

The onset of physical injury to fish would be expected if the peak levels exceed 206 dB re 1 µPa (Stadler and Woodbury 2009). The sonic boom associated with the LauncherOne operations would be significantly less than 206 dB re 1 µPa in the water column.

Based on the estimated sound levels, the frequency with which the sonic booms may occur over the course of a year, and the relative infrequency with which marine mammals (including ESA-listed marine mammals), sea turtles, and ESA-listed fish may be in the immediate vicinity during those times, sonic booms associated with LauncherOne operations would not result in significant impacts to any marine mammal, sea turtle, or ESA-listed fish species. In addition, the FAA has determined that sonic booms associated with the Proposed Action *may affect, but are not likely to adversely affect* ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory.

Potential for Debris Strike from Stage 1 or Fairings Re-entry

The impact of debris striking a marine mammal or sea turtle may result in injury or mortality to individuals. Using a statistical probability analysis for estimating direct strike impact developed by the U.S. Navy (Navy 2019), the probability of impact of debris with a single marine mammal (P) is then multiplied by the number of animals to obtain the number of exposures (T). Refer to Appendix B for details on the methodology and assumptions. Using this procedure, P and T were calculated for the five species of ESA-listed marine mammals. P and T were also calculated for the non-ESA listed marine mammal species and the sea turtle species with the highest average month density underlying the AHA, which includes the Drop Point SHA and Stage 1 and Fairings Re-entry SHA (panropical spotted dolphin and green sea turtle, respectively).

VO proposes to conduct up to a maximum of 10 LauncherOne operations per any 1 year during the 5-year operating period; the other 4 years would see ≤9 operations, not exceeding 25 operations across 5 years. The potential number of individuals impacted/year are reported in Table 3.9-2.

Table 3.9-2. Estimated Representative Marine Mammal and Sea Turtle Exposures from a Potential Direct Strike of the LauncherOne Stage 1 in a Single Year

| Species (ESA Status) | Est. Density (km ²)* | Probability of Impact (T) | Est. No. Impacts/Year† |
|-------------------------------|----------------------------------|---------------------------|------------------------|
| Humpback whale (Endangered) | 0.00089 | 0.0000001 | 0.000001 |
| Sei whale (Endangered) | 0.00013 | 0.00000002 | 0.0000002 |
| Fin whale (Endangered) | 0.00006 | 0.00000001 | 0.0000001 |
| Blue whale (Endangered) | 0.00005 | 0.00000001 | 0.0000001 |
| Sperm whale (Endangered) | 0.00222 | 0.0000003 | 0.000003 |
| Pantropical spotted dolphin | 0.01132 | 0.0000002 | 0.000002 |
| Green sea turtle (Endangered) | 0.00039 | 0.000000005 | 0.00000005 |

Notes: *Number of animals per square kilometer (km²). See Appendix B for further details on the calculation of estimated impacts.

†Based on the maximum of 10 proposed launches in any one year of the 5-year operating period; all other years would be ≤9 launches/year.

Source: *Navy 2018.

For ESA-listed marine mammals, modeling based on the estimated density of individuals for each species results in estimates of the probability of a direct strike of debris with an individual during each event of 0.0000002 or less (Table 3.9-2). The estimated number of takes for each species annually, assuming the maximum of 10 LauncherOne operations and the re-entry of Stage 1, was approximately 0.000002 or less. With the intentionally conservative overestimation of parameters and assumptions in the model, the results indicate that it is extremely unlikely the re-entry of Stage 1 would result in debris impacting the ESA-listed species. These probabilities are sufficiently low to reasonably conclude that it would be unlikely that any of the five ESA-listed marine mammals would be struck by debris as a result of conducting up to 10 LauncherOne operations/year and the impact of Stage 1 and the fairings in the ocean. For marine mammals protected under the MMPA, the probability of debris strike for individuals of all species was also negligible given the species with the highest density in the study area (pantropical spotted dolphin) was modeled and found to have a negligible potential for impact from Stage 1 impact. Therefore, those marine mammal and sea turtle species with lower densities in the study area would have an even lower probability of being struck by the Stage 1.

Sufficient density data are not available to conduct a debris strike analysis for ESA-listed fish species in the manner conducted above for marine mammals and sea turtles. However, it is assumed that ESA-listed fish species likely to be in the area would be rare because of their known distribution in the area and likely swimming below the surface at all times. Should debris hit the water, it is expected that the initial impact at the water's surface or even slightly below the surface, would absorb much of the energy from that impact. If they were present, ESA-listed fish would be expected to be below this initial area of impact, and therefore unaffected by the debris.

Therefore, implementation of the Proposed Action and the impact of Stage 1 and fairings in the Pacific Ocean would not significantly impact marine biological resources, particularly marine mammals and ESA-listed sea turtles and fish species. In addition, the FAA has determined that the Proposed Action *may affect, but is not likely to adversely affect* ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory.

Unspent RP-1 Fuel and Debris Materials from Stage 1 or Fairings Re-entry¹⁰

As stated above in Section 3.8.4.1 (Water Resources), the propellant type used by LauncherOne is a mixture of a kerosene-based fuel (known as RP-1) and LOX. In the event of a launch failure, and the LauncherOne rocket impacting the Pacific Ocean, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 "Very Light Oil," which is characterized as being highly volatile and having low viscosity and low specific gravity. Due to its high volatility, RP-1 evaporates quickly when exposed to the air and would completely dissipate within hours or days after a spill in the water (NOAA 2019). Cleanup following a spill of very light oil is usually not necessary or possible, particularly with such a small quantity of oil that would enter the ocean in the event of an unsuccessful launch. Therefore, no attempt would be made to boom nor recover RP-1 fuel from the ocean. Although it would require 1–2 days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatilized rapidly because of increased agitation and dissipation. This conclusion is also applicable for any unspent RP-1 fuel that remains in the Stage 1 after a successful launch, separation from Stage 2, and

¹⁰If there is a malfunction or other issue that results in the abort of the flight, the LauncherOne may fall through the AHA and land within the Drop Point SHA but will not have a significant impact on biological resources. See Section 3.7.4 for further discussion.

when Stage 1 impacts the ocean. LOX is a non-toxic cryogenic liquid which will evaporate into the air when released. Therefore, the Proposed Action would have insignificant impacts on marine species.

First stage and fairings debris, which is comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials, are anticipated to sink relatively quickly. Accordingly, it would not affect the marine environment and associated marine species in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

Therefore, implementation of the Proposed Action and the impact of unspent RP-1 fuel and Stage 1 and fairings debris in the Pacific Ocean would not significantly impact marine biological resources, particularly marine mammals and ESA-listed sea turtles and fish species. In addition, the FAA has determined that the Proposed Action *may affect, but is not likely to adversely affect* ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory.

As required by ESA section 7(a)(2), the FAA prepared a Biological Evaluation and conducted informal consultation with NMFS to assess the potential impacts of the Proposed Action on ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory. On December 29, 2020, NMFS issued a letter of concurrence stating that implementation of the Proposed Action may affect, but is not likely to adversely affect, ESA-listed marine species within the action area under their jurisdiction (refer to Appendix D.1).

3.10 Hazardous Materials, Solid Waste, and Pollution Prevention

3.10.1 Definition of Resource and Regulatory Setting

Hazardous materials, solid waste, and pollution prevention as an impact category includes an evaluation of the following:

- Waste streams that would be generated by a project, potential for the wastes to impact environmental resources, and the impacts on waste handling and disposal facilities that would likely receive the wastes;
- Potential hazardous materials that could be used during operation of a project, and applicable pollution prevention procedures;
- Potential to encounter existing hazardous materials at contaminated sites during construction, operation, and decommissioning of a project; and
- Potential to interfere with any ongoing remediation of existing contaminated sites at the proposed project site or in the immediate vicinity of a project site.

The terms hazardous material, hazardous waste, and hazardous substance are often used interchangeably when used informally to refer to contaminants, industrial wastes, dangerous goods, and petroleum products. Each of these terms, however, has a specific technical meaning based on the relevant regulations.

Solid waste is defined by the implementing regulations of the Resource Conservation and Recovery Act (RCRA) generally as any discarded material that meets specific regulatory requirements and can include such items as refuse and scrap metal, spent materials, chemical by-products, and sludge from industrial and municipal wastewater and water treatment plants.

Hazardous waste is a type of solid waste defined under the implementing regulations of RCRA. A hazardous waste is a solid waste that possesses at least one of the following four characteristics:

ignitibility, corrosivity, reactivity, or toxicity as defined in 40 CFR part 261 subpart C, or is listed in one of four lists in 40 CFR part 261 subpart D, which contains a list of specific types of solid waste that the USEPA has deemed hazardous. RCRA imposes stringent requirements on the handling, management, and disposal of hazardous waste, especially in comparison to requirements for non-hazardous wastes.

Hazardous substance is a term broadly defined under Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Hazardous substances include:

- any element, compound, mixture, solution, or substance designated as hazardous under Section 102 of CERCLA;
- any hazardous substance designated under Section 311(b)(2)(A) or any toxic pollutant listed under Section 307(a) of the CWA;
- any hazardous waste under Section 3001 of RCRA;
- any hazardous air pollutant listed under Section 112 of the CAA; and
- any imminently hazardous chemical substance or mixture for which the USEPA has “taken action under” Section 7 of the Toxic Substances Control Act.

Hazardous material is any substance or material that has been determined to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce. The term hazardous materials includes both hazardous wastes and hazardous substances, as well as petroleum and natural gas substances and materials (see 49 CFR § 172.101). *Pollution prevention* describes methods used to avoid, prevent, or reduce pollutant discharges or emissions through strategies such as using fewer toxic inputs, redesigning products, altering manufacturing and maintenance processes, and conserving energy.

EO 13834, *Efficient Federal Operations*, states that agencies “must comply with Federal as well as State, interstate, and local requirements for management and disposal of nonhazardous solid waste and hazardous waste. Agencies should pursue cost-effective waste prevention by first reducing overall waste generated, while also pursuing strategies that reduce disposal fees and minimize environmental impacts by diverting waste from treatment and disposal facilities, including landfill and incineration without energy recovery.”

More information on hazardous materials, solid waste, and pollution prevention can be found in the FAA Order 1050.1F Desk Reference (FAA 2020).

3.10.2 Study Area

The study areas include the existing airfield apron, taxiway, and runway areas of Andersen AFB and associated airspace, and the ocean area under the AHA, Drop Point, SHA, and Stage 1 and Fairings Re-entry SHA where Stage 1 and the fairings would fall into the ocean.

3.10.3 Existing Conditions

Routine operations at Department of Defense (DoD) installations require the storage, use, and handling of a variety of hazardous materials. When discussed in this document, hazardous materials include petroleum, oils, and lubricants (POL), cleaning agents, adhesives, and other products necessary to perform essential functions. Bulk quantities of fuels and other POLs are stored and distributed in aboveground storage tanks and underground storage tanks, pumps, and pipelines. Fueling operations to support aircraft, vehicle operations, and emergency power generation require the storage of these bulk quantities of this POL. These POL storage areas represent potential sources of leaks, releases, or spills. POLs include various fuels such as gasoline, jet fuels, and diesel fuels; kerosene; and a variety of oils and other lubricant products.

The 36 CES/CEV is responsible for overseeing the management of hazardous materials (and hazardous waste) at Andersen AFB. Air Force Instruction (AFI) 32-7086, *Hazardous Materials Management*, establishes procedures for the management of hazardous materials at all USAF installations. AFI 32-7086 incorporates the requirements of federal regulations, other AFIs, and DoD directives for reducing the use of hazardous materials. Andersen AFB has a Hazardous Materials Management Plan pursuant to the AFI designed to guide and instruct all USAF personnel involved in authorizing, procuring, using, managing, or disposing of hazardous materials. This plan specifically addresses hazardous materials management, transportation, spill/release control and containment, and clean up (Andersen AFB 2007b).

Hazardous materials are managed by the base's hazardous materials pharmacy. This facility was established with the mission of overseeing, procuring, and minimizing the use of hazardous materials. The Andersen AFB pharmacy reduces the need to store large quantities of hazardous materials elsewhere on base and allows these materials to be efficiently reordered on an as-needed basis. The resulting outcome is more effective control over the use of these materials.

Numerous fueling operations to support aircraft, vehicle operation, and emergency power generation are performed at Andersen AFB. The majority of fuel handled at Andersen AFB is aviation fuel. Fuel storage facilities on the base have the primary and secondary containment and leak detection features required to contain unintended leaks, spills, and releases. Bulk jet fuel is sent to Andersen AFB from fuel facilities at Apra Harbor via pipelines. Diesel and gasoline are delivered to the base by tanker truck.

Andersen AFB is a Large Quantity Generator (40 CFR 262.34 [d], [e], and [f]) of hazardous wastes with USEPA identification handler number GU6571999519 (Guam Environmental Protection Agency 2015). The Defense Reutilization and Marketing Office arranges for all hazardous waste collection, transportation, and disposal via licensed contractors who ultimately dispose of the hazardous waste at permitted off-island disposal facilities (Andersen AFB 2007b).

3.10.4 Environmental Consequences

The FAA has not established a significance threshold for hazardous materials, solid waste, or pollution prevention. Factors to consider when assessing the significance of potential impacts include whether the action would have the potential to:

- violate applicable federal, state, tribal, or local laws or regulations regarding hazardous materials and/or solid waste management;
- involve contaminated sites;
- produce an appreciably different quantity or type of hazardous waste;
- generate an appreciably different quantity or type of solid waste or using a different method of collection or disposal and/or exceeding local capacity; or
- adversely affect human health and the environment.

3.10.4.1 Proposed Action

Carrier Aircraft Operations at Andersen AFB

All hazardous pre- and post-flight activities, including propellant loading and unloading (if necessary), would take place in a specified location which has established appropriate safety clear zones in accordance with 36 Wing Safety requirements. LauncherOne propellant loading operations and ground safety plans will comply with 14 CFR Parts 415 and 417. LauncherOne propellant loading operations shall be treated as explosive operations and be coordinated with 36 Wing Weapons Safety accordingly. All fuels and other hazardous materials would be stored and used in compliance with the regulations applicable to their storage and use and already in place at Andersen AFB. In accordance with the CSOSA between VO and Andersen AFB, VO will:

- Handle, store, and otherwise manage solid wastes, including hazardous wastes, in a manner consistent with Andersen AFB procedures. Coordinate hazardous waste management activities with the Andersen AFB Hazardous Waste Program Manager.
- Comply with, and participate in, all applicable elements of Andersen AFB's hazardous materials management program. Provide all information necessary to assist in determining storage and disposal requirements of any hazardous/non-hazardous materials under VO's control.
- Dispose of hazardous waste independently while operating on Andersen AFB.
- Immediately report all hazardous waste, hazardous material, or substance releases to the installation emergency response activity, and fully cooperate with any emergency response in accordance with 36th Wing plans and directives.

In the event of a launch vehicle accident or spill, Andersen AFB would respond in accordance with its Hazardous Materials Management Plan. Andersen AFB has a highly experienced rescue and firefighting staff onsite and has established response procedures for safety purposes.

Hazardous materials that would be used to support pre-flight and post-flight activities associated with the Proposed Action are similar to materials already handled at Andersen AFB. Procedures are currently in place to accommodate additional fuel and other launch-related and maintenance-related hazardous materials, including POLs, and solvents, and the Proposed Action would be conducted according to those procedures. The environmental impact of proposed VO operations is negligible as the LauncherOne propellants and pressurants are similar to those already in use at the airfield. The rocket propellant, RP-1 is a highly refined form of kerosene outwardly similar to jet fuel. The oxidizer, LOX, is already in use at Andersen AFB. LOX and liquid nitrogen, used for liquid oxygen conditioning, are non-toxic cryogenic liquids which, if spilled, will evaporate into the air. Pressurants are inert helium and nitrogen gases. LauncherOne also uses a small amount of triethylaluminum-triethylborane (TEA-TEB), a pyrophoric liquid, to start the first and second stage engines in flight. To mitigate environmental concerns regarding hydrocarbon fuel spills and leaks, Andersen AFB hazmat procedures will be in place and the 36 Wing Hazmat team will be ready on standby.

Because activities associated with the Proposed Action would comply with all relevant Federal and Andersen AFB regulations related to hazardous materials and hazardous waste, no significant impacts are anticipated.

LauncherOne Rocket Operations

The carrier aircraft and LauncherOne rocket would take off from Andersen AFB and fly south to the designated drop point approximately 75 nm over open ocean south-southwest of Guam. LauncherOne would be carried to an altitude of approximately 35,000–40,000 ft MSL where it would be released. Following ignition of the rocket's first stage, the engine would burn until all of the propellant is consumed, and Stage 1 would fall through the AHA and into the ocean within the Stage 1 and Fairings Re-entry SHA approximately 650-700 nm northeast of Guam (Figure 2.1-7).¹¹

Both stages of the rocket are expendable. Stage 1 debris would fall through the AHA and into the Pacific Ocean within the Stage 1 and Fairings Re-entry SHA, and second stage debris would expend into Earth's orbit. First stage and fairings debris, which is comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials, is anticipated to sink relatively quickly. Accordingly, it would not affect the marine environment in the short term (while the debris is floating or

¹¹ If there is a malfunction or other issue that results in the abort of the flight, the LauncherOne may fall through the AHA and land within the Drop Point SHA but will not have a significant impact on marine resources. See Section 3.7.4 for further discussion.

descending through the water column) or in the long term (when the debris has settled into benthic habitats).

The propellant type used by LauncherOne Stage 1 is a mixture of a kerosene-based fuel (RP-1) and LOX. In the event of a launch failure, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 “very light oil,” which is characterized as being highly volatile and having low viscosity and low specific gravity. Due to its high volatility, RP-1 evaporates quickly when exposed to the air and would completely dissipate within 1–2 days after a spill in the water (NOAA 2019). Although it would require hours or days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatilized rapidly because of increased agitation and dissipation. Cleanup following a spill of very light oil is usually not necessary or possible, particularly with such a small quantity that would enter the ocean. Therefore, no attempt would be made to recover RP-1 fuel from the ocean.

Therefore, implementation of the Proposed Action would not have significant impacts on the marine environment due to hazardous materials associated with the Stage 1 and fairings.

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Chapter 4. Cumulative Impacts

Cumulative impacts are defined by CEQ as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions” (40 CFR §1508.7) (1978). The FAA analyzed the potential cumulative impacts in accordance with CEQ regulations and FAA Order 1050.1F.

For this EA, spatial and temporal boundaries were delineated to determine the area and projects the cumulative analysis would address. For this cumulative analysis, the spatial boundary is the airfield environment of Andersen AFB. The temporal boundary includes past actions that have occurred within the last 3 years, and reasonably foreseeable future actions include those that are planned to occur within the next 5 years. Because the flight operations of the carrier aircraft with LauncherOne rocket would be above 35,000 ft MSL over open ocean south and east of Guam, past, present, or reasonably foreseeable future projects underlying the areas of the drop point and LauncherOne flight trajectory were not included in the cumulative impacts analysis. Past, present, and reasonably foreseeable actions at Andersen AFB and the surrounding area include current and future aircraft operations at Andersen AFB.

The projects identified in the following sections include those that had or have the potential to affect the environmental impact categories that are analyzed in this EA.

4.1 Past Actions

Past projects and actions at Andersen AFB are primarily tied to aircraft operations and other activities on the airfield, taxiways, aprons and associated infrastructure such as hangars. No projects within the last 3 years have been identified that would result in potential cumulative effects when combined with the Proposed Action.

4.2 Present Actions

Present projects and actions at Andersen AFB are primarily tied to aircraft operations and other activities on the airfield, taxiways, aprons and associated infrastructure such as hangars. Present actions at Andersen AFB that may result in potential cumulative effects when combined with the Proposed Action include on-going military activities, particularly aircraft operations.

4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future projects and actions at Andersen AFB are primarily tied to aircraft operations and other activities on the airfield, taxiways, aprons and associated infrastructure such as hangars. No future actions or projects were identified that would result in potential cumulative effects when combined with the Proposed Action.

4.4 Environmental Consequences

This EA uses information presented in Sections 4.1, 4.2, and 4.3 to determine potential cumulative impacts. The Proposed Action’s impacts were analyzed for their potential to result in cumulative impacts when added to past, present, and reasonably foreseeable future actions.

As discussed in Section 3.1, implementation of the Proposed Action would result in no impact to the following impact categories: visual effects; coastal resources; land use; farmlands; natural resources and

energy supply; and socioeconomics, environmental justice, and children's environmental health and safety risks. Therefore, when combined with past, present, and reasonably foreseeable projects, the Proposed Action would not result in cumulative impacts to these impact categories.

Implementation of the Proposed Action would result in no impacts to cultural resources; water resources; and hazardous materials, solid waste, and pollution prevention; and less than significant impacts related to air quality; climate; noise and noise-compatible land use; and biological resources. The Proposed Action would result in the addition of up to 10 takeoffs and landings of a 747 aircraft at Andersen AFB resulting in a negligible incremental increase in aircraft operations over current levels (~23,700 aircraft operations/year). This negligible increase in aircraft operations would result in associated negligible cumulative impacts to air quality, including climate and GHGs, noise in the airfield environment, and biological resources when combined with current military operations at Andersen AFB. As no past or reasonably foreseeable projects and actions have been identified within the Andersen AFB spatial boundary, implementation of the Proposed Action would not result in significant cumulative impacts to any resource area assessed in this EA.

Chapter 5.

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APPENDIX A:

Air Quality and Greenhouse Gas Emissions Calculations

This appendix provides the calculations and assumptions for calculating the air quality pollutant and greenhouse gas (GHG) emissions from the proposed carrier aircraft and rocket operations.

A.1 Carrier Aircraft Emissions

Table A-1 provides the estimated emissions associated with the proposed carrier aircraft operations.

Table A-1. Carrier Aircraft Pollutant and GHG Emissions during LTOs and Cruise to/from Drop Point

| Mode | Power Setting (%) | Time (mins) | Fuel Flow (lbs/hr) | Emissions Indices (lb/1,000 lbs fuel) | | | | | |
|---------------------------------|-------------------|-------------|--------------------|---------------------------------------|--------------------|--|------------------------|------------------------|------------------------|
| | | | | VOCs | CO | NO _x | SO ₂ | PM | CO ₂ e |
| LANDING AND TAKE OFFS (LTOs) | | | | | | | | | |
| Take Off | 100 | 0.5 | 19,222 | 0.06 | 0.04 | 24.94 | 1.06 | 0.07 | 3,233.9 |
| Climb Out | 85 | 3 | 15,738 | 0.06 | 0.05 | 19.72 | 1.06 | 0.06 | 3,233.9 |
| Approach | 30 | 4.7 | 5,159 | 0.13 | 2.61 | 12.47 | 1.06 | 0.04 | 3,233.9 |
| Idle | 7 | 30 | 1,579 | 1.77 | 22.41 | 4.73 | 1.06 | 0.05 | 3,233.9 |
| Emissions per LTO (lbs) | | | | 1.41 | 17.74 | 85.43 | 1.36 | 0.05 | 6,914.4 |
| | | | | VOCs (tons) | CO (tons) | NO _x (tons) | SO ₂ (tons) | PM (tons) | CO ₂ e (MT) |
| Emissions per LTO (tons and MT) | | | | 0.001 | 0.009 | 0.043 | 0.001 | <0.001 | 3.1 |
| CRUISE* | | | | | | | | | |
| Mode | Power Setting (%) | Speed (mph) | Distance (miles) | Time (mins) | Fuel Flow (lbs/hr) | Emissions Indices (lbs/1,000 lbs fuel) | | CO ₂ e (MT) | |
| Cruise | 94 | 678 | 372.6 | 32.9 | 24,000 | 3,233.9 | | 19.3 | |

Notes: CO = carbon monoxide; CO₂e – carbon dioxide equivalent; lbs/hr = pounds per hour; mins = minutes; mph = miles per hour; MT = metric tons; NO_x = nitrous oxides; PM = particulate matter; SO_x = sulphur oxides; VOC = volatile organic compounds.

***Assumptions:**

Aircraft: Boeing 747-400; Engine: GE CF6-80C2B1F. Number of engines: 4 (but database emissions indexes are for 1 engine, so total amounts are multiplied by 4.

Cruise Distance Estimation:

75 nm (86.3 miles from Anderson AFB to Racetrack)

200-mile Racetrack (assume single circuit)

75 nm (86.3 miles from Racetrack to Anderson AFB)

Source: U.S. Air Force 2013. Air Emissions Guide for Air Force Mobile Sources: Methods for Estimating Emissions of Air Pollutants for Mobile Sources at U.S. Air Force Installations. Air Force Civil Engineer Center, Compliance Technical Support Branch, Lackland AFB, TX. January.

A.2 LauncherOne Rocket Emissions

As described in Federal Aviation Administration (FAA) (2009: Section D.1.1.5), rocket emissions were calculated by multiplying the propellant-specific emissions weight fractions for each pollutant by the amount of propellant used. The rocket is a liquid oxygen (LOX)/rocket propellant 1 (RP-1) (kerosene) system comprised of a first stage with 29,215 pound mass (lbm) of LOX and 13,279 lbm of RP-1, and second stage with 3,642 lbm of LOX and 1,683 lbm of RP 1. As described in Section 2.1.3.3 (Post-Flight Operations) of this EA, it is expected that all propellant would be consumed during each launch. Therefore, the total weight of propellant was used in the multiplication against the emissions weight fractions. Only CO₂ is expected to be generated from the use of RP-1/LOX, with no other CO₂e contributors (methane [CH₄] or nitrous oxide [N₂O]) expected to be generated by the use of RP-1/LOX propellant (Table A-2).

Table A-2. LauncherOne Rocket GHG Emissions

| Pollutant | Lbs Emitted/ Lb of Propellant | Lbs of Propellant Used | Lbs/ Launch | Tons/ Launch | MT/ Launch |
|-----------------------|----------------------------------|---------------------------|-----------------|-----------------|---------------|
| CO | 0.2 | 47,819 | 9,563.8 | 4.8 | 4.3 |
| CO₂ | 0.49 | 47,819 | 23,431.3 | 11.7 | 10.6 |
| H ₂ | 0.004 | 47,819 | 200.8 | 0.1 | 0.09 |
| H ₂ O | 0.3 | 47,819 | 14345.7 | 7.2 | 6.5 |

Assumptions: Exhibit D-7 from FAA (2009) was used for pounds emitted per pound of propellant (RP-1[Kerosene]/LOX). While Exhibit D-6 (FAA 2009) lists propellant consumption by atmospheric layer, total propellant amounts were taken from the project description (see Chapter 2 of this EA).

A.3 Total GHG Emissions from the Proposed Action

Table A-3 provides the total GHGs from proposed carrier aircraft and LauncherOne rocket operations under the Proposed Action.

Table A-3. Total GHG Emissions under the Proposed Action

| Event Stage | GHG Emissions/Event |
|-------------------------------|---------------------|
| Carrier Aircraft LTO | 3.1 |
| Carrier Aircraft Cruise | 19.3 |
| LauncherOne Rocket | 10.6 |
| Total per Launch Event | 33.0 |

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APPENDIX B:

Statistical Probability Analysis for Estimating Direct Strike Impacts to Marine Mammals and Sea Turtles from Stage 1 of the LauncherOne Rocket⁽¹⁾

This appendix discusses the methods and results for calculating the probability of the direct strike of an ESA-listed marine mammal or sea turtle by the LauncherOne rocket, Stage 1, or fairings within the Drop Point, Stage 1, and Fairings Re-entry AHAs. Only marine mammals and sea turtles are analyzed using these methods because animal densities are necessary to complete the calculations, and density estimates are currently only available for marine mammals and sea turtles within the Study Area (Table B-1).

Table B-1. Summary of Density Values for Marine Mammals and Sea Turtles within the Stage 1 and Fairings Re-entry AHA

| | Season* | | | |
|-----------------------------|----------|----------|----------|----------|
| | Spring | Summer | Fall | Winter |
| MARINE MAMMALS | | | | |
| | | 0.0007 | 0.00070 | 0.00070 |
| Blue whale | 0.00005 | 0 | 0.00005 | 0.00005 |
| Bryde's whale | 0.00030 | 0.00030 | 0.00030 | 0.00030 |
| Common bottlenose dolphin | 0.00077 | 0.00077 | 0.00077 | 0.00077 |
| Cuvier's beaked whale | 0.00374 | 0.00374 | 0.00374 | 0.00374 |
| Dwarf sperm whale | 0.00430 | 0.00430 | 0.00430 | 0.00430 |
| False killer whale | 0.00057 | 0.00057 | 0.00057 | 0.00057 |
| Fin whale | 0.00006 | 0 | 0.00006 | 0.00006 |
| Fraser's dolphin | 0.00252 | 0.00252 | 0.00252 | 0.00252 |
| Ginkgo-toothed beaked whale | 0.00189 | 0.00189 | 0.00189 | 0.00189 |
| Humpback whale | 0.00089 | 0 | 0.00089 | 0.00089 |
| Killer whale | 0.00009 | 0.00009 | 0.00009 | 0.00009 |
| Longman's beaked whale | 0.00025 | 0.00025 | 0.00025 | 0.00025 |
| Melon-headed whale | 0.00267 | 0.00267 | 0.00267 | 0.00267 |
| Minke whale | 0.00015 | 0 | 0.00015 | 0.00015 |
| Omura's whale | 0.00004 | 0.00004 | 0.00004 | 0.00004 |
| Pantropical spotted dolphin | 0.01132 | 0.01132 | 0.01132 | 0.01132 |
| Pygmy killer whale | 0.00006 | 0.00006 | 0.00006 | 0.00006 |
| Pygmy sperm whale | 0.00176 | 0.00176 | 0.00176 | 0.00176 |
| Risso's dolphin | 0.00046 | 0.00046 | 0.00046 | 0.00046 |
| Rough-toothed dolphin | 0.00185 | 0.00185 | 0.00185 | 0.00185 |
| Sei whale | 0.00013 | 0 | 0.00013 | 0.00013 |
| Short-finned pilot whale | 0.00211 | 0.00211 | 0.00211 | 0.00211 |
| Sperm whale | 0.00222 | 0.00222 | 0.00222 | 0.00222 |
| Spinner dolphin | 0.00187 | 0.00187 | 0.00187 | 0.00187 |
| Striped dolphin | 0.00584 | 0.00584 | 0.00584 | 0.00584 |
| SEA TURTLES | | | | |
| Green sea turtle | 0.000390 | 0.000390 | 0.000390 | 0.000390 |
| Hawksbill sea turtle | 0.000024 | 0.000024 | 0.000024 | 0.000024 |
| Leatherback sea turtle | 0.000022 | 0.000022 | 0.000022 | 0.000022 |
| Loggerhead sea turtle | 0.000022 | 0.000022 | 0.000022 | 0.000022 |

Notes: *Numerical values are animals/km². 0 = species is not expected to be present.

Source: Navy 2018.

¹ Adapted from Navy (2019a).

The values presented in Table B-1 are based on estimated marine mammal and sea turtle densities for the Mariana Islands Training and Testing (MITT) Study Area and associated transit corridor (Navy 2018) in support of the Public Draft Supplemental EIS/Overseas EIS (Navy 2019b). The MITT Study Area extends 450 nm north of Guam, 250 nm east of Guam, and 300 nm south of Guam. The transit corridor is located on the eastern edge of the MITT Study Area and is 300 nm south of the Stage 1 and Fairings Re-entry AHA. These density estimates are the best available data regarding the occurrence of marine mammals and sea turtles in the vicinity of the LauncherOne operations.

These calculations estimate the impact probability (P) and number of exposures (T) associated with direct impact of the LauncherOne Stage 1 on marine animals on the sea surface within the Stage 1 and Fairings Re-entry AHA. The statistical probability analysis is based on probability theory and modified Venn diagrams with rectangular “footprint” areas for the individual animal (A) and total impact (I) inscribed inside the AHA (R). The analysis is over-predictive and conservative, in that it assumes: (1) that all animals would be at or near the surface 100% of the time, when in fact, marine mammals spend the majority of their time underwater, and (2) that the animals are stationary.

$A = \text{length} \times \text{width}$, where the individual animal’s width (breadth) is assumed to be 20% of its length for marine mammals and 112% of its length for sea turtles. A is multiplied by the estimated number of animals N_a in the AHA (i.e., product of the highest average seasonal animal density [D] and area of AHA [R]: $N_a = D \times R$) to obtain the total animal footprint area ($A \times N_a = A \times D \times R$) in the AHA. As a conservative scenario, the total animal footprint area is calculated for the species with the highest average seasonal density (pantropical spotted dolphins).

$I = \text{length} \times \text{diameter of Stage 1} = \text{impact footprint area}$.

The analysis is expected to provide an overestimation of the probability of a strike for the following reasons: (1) it calculates the probability of the Stage 1 hitting a single animal at its species’ highest seasonal density, and (2) it does not take into account the possibility that an animal may not be at the water surface.

The likelihood of an impact is calculated as the probability (P) that the animal footprint (A) and the impact footprint (I) will intersect within the AHA (R). This is calculated as the area ratio A/R or I/R , respectively. Note that A (referring to an individual animal footprint) and I (referring to the impact footprint resulting from the Stage 1) are the relevant quantities used in the following calculations of single-animal impact probability [P], which is then multiplied by the number of animals to obtain the number of exposures (T). The probability that the animal in the AHA is within both types of footprints (i.e., A and I) depends on the degree of overlap of A and I. The probability that I overlaps A is calculated by adding a buffer distance around A based on one-half of the impact area (i.e., $0.5 \times I$), such that an impact (center) occurring anywhere within the combined (overlapping) area would impact the animal. Thus, if L_i and W_i are the length and width of the impact footprint such that $L_i \times W_i = 0.5 \times I$ and $W_i/L_i = L_a/W_a$ (i.e., similar geometry between the animal footprint and impact footprint), and if L_a and W_a are the length and width (breadth) of the individual animal such that $L_a \times W_a = A$ (= individual animal footprint area), then, assuming a purely static, rectangular scenario, the total area $A_{\text{tot}} = (L_a + 2 \times L_i) \times (W_a + 2 \times W_i)$, and the buffer area $A_{\text{buffer}} = A_{\text{tot}} - L_a \times W_a$. The static, rectangular impact assumes no additional aerial coverage effects of the Stage 1 beyond the initial impact.

Impact probability P is the probability of impacting one animal by the Stage 1 occurring in the area per year, and is given by the ratio of total area (A_{tot}) to AHA (R): $P = A_{\text{tot}}/R$. Number of exposures is $T = N \times P = N \times A_{\text{tot}}/R$, where N = number of animals in the AHA per year (given as the product of the animal density [D] and AHA size [R]). Thus, $N = D \times R$ and hence $T = N \times P = N \times A_{\text{tot}}/R = D \times A_{\text{tot}}$.

Using this procedure, P and T were calculated for the five species of ESA-listed marine mammals and the non-ESA listed marine mammal species with the highest average month density (pantropical spotted dolphin), and the sea turtle species with the highest average month density in the AHA (green sea turtles). The potential number of individuals impacted/year are reported in Table B-2.

Table B-2. Estimated Representative Marine Mammal and Sea Turtle Exposures from a Potential Direct Strike of LauncherOne Stage 1 in a Single Year

| Species (ESA Status) | Est. Density (km ²)* | Probability of Impact (T) | Est. No. Impacts/Year† |
|-------------------------------|----------------------------------|---------------------------|------------------------|
| Humpback whale (Endangered) | 0.00089 | 0.0000001 | 0.000001 |
| Sei whale (Endangered) | 0.00013 | 0.00000002 | 0.0000002 |
| Fin whale (Endangered) | 0.00006 | 0.00000001 | 0.0000001 |
| Blue whale (Endangered) | 0.00005 | 0.00000001 | 0.0000001 |
| Sperm whale (Endangered) | 0.00222 | 0.0000003 | 0.000003 |
| Pantropical spotted dolphin | 0.01132 | 0.0000002 | 0.000002 |
| Green sea turtle (Endangered) | 0.00039 | 0.000000005 | 0.00000005 |

Note: †Based on the maximum of 10 proposed launches in any one year of the 5-year operating period; all other years would be <9 launches/year.

*Source: Navy 2018.

References

- Navy. 2018. U.S. Navy Marine Species Density Database Phase III for the Mariana Islands Training and Testing Study Area, Technical Report. Prepared for U.S. Pacific Fleet, Joint Base Pearl Harbor-Hickam, HI by ManTech International, Solana Beach, CA. July.
- Navy. 2019a. Appendix J: Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures from Military Expended Materials in Mariana Islands Training and Testing Activities Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement. Prepared for Naval Facilities Engineering Command Pacific, Pearl Harbor, HI by ManTech International, Solana Beach, CA. January.
- Navy. 2019b. Mariana Islands Training and Testing Activities Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement. Prepared for Naval Facilities Engineering Command Pacific, Pearl Harbor, HI by ManTech International, Solana Beach, CA. January.

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APPENDIX C:

Public Comments and FAA Responses

[*Note:* comments are presented in the order in which they were received.]

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COMMENT #1

From: [Jacob Katz](#)
To: [VOLauncherOne](#)
Subject: Virgin Orbit in Guam
Date: Thursday, October 22, 2020 9:47:39 AM

I am completely 100% supportive of Virgin Orbit utilizing B-747 aircraft out of either PGUM or PGUA.

This will be good for the community and the economy.

Very minimal impact to the island. There used to be dozens more flights a day in/out of Guam and even with this operation, most residents will never know the difference.

With trade winds the aircraft will depart PGUA northeast bound from Runway 6L or 6R out to sea and not over any populated areas.

Please support this operation.

Thank you,
Jay Katz
27 year Guam resident.

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process.

COMMENT #2

From: [Derek Cepeda](#)
To: [VOLauncherOne](#)
Subject: Public comments
Date: Thursday, October 22, 2020 10:45:47 PM

Hi,

I have a few comments or questions for your organization.

1. Will there be continuous environmental monitoring such as before, during, and after the licensing period? If so what is the monitoring methods?

I strongly believe this should be a requirement of the license. The reasoning is the following, sampling of the environment is needed to establish a base line; sampling during the process will monitor the affects as they occur and they can provide evidence versus speculation; and sampling after the licensing period should continue to ensure no long term problems exist. We will continue to live here far after the launch operation is completed.

2. Will this launch area occur outside the typhoon beltway that lays east of Guam?

My concern is precipitation may be contaminated and that will affect the populated islands. How can we ensure this will not happen?

3. What is the exact chemical exposure and any potential effects?

4. What studies or research can be referenced that shows we will be safe and any other opposing research show?

Sincerely,
Derek Cepeda

E-mail administered by Guam Community College

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process. Responses to each item are provided below.

1. The FAA does not plan to conduct environmental monitoring before, during, or after the licensing period. However, sections 3.3 (Air Quality), 3.4 (Climate), 3.5 (Noise), 3.8 (Water Resources, 3.9 (Biological Resources), and 3.10 (Hazardous Materials, Solid Waste, and Pollution Prevention) provide a discussion of the proposed impacts based on a thorough analysis under NEPA in accordance with standard impact analysis procedures and modeling, not on speculation. The components of the LauncherOne rocket (first stage, fairings, propellant) are neither chemically or biologically reactive and contain no hazardous materials and therefore would not result in significant impacts to the environment. In addition, after consulting with the National Marine Fisheries Service (see Appendix D.1), Guam Historic Resources Division (see Appendix D.2), and Guam Coastal Zone Management Office (see Appendix D.3), no monitoring would be required. FAA would reevaluate the analyses prior to the issuance of any new, renewed, or modified licenses regarding proposed LauncherOne rocket operations by Virgin Orbit within the vicinity of Guam.
2. The proposed LauncherOne operations would occur approximately 75 nautical miles south-southwest of Guam and continue to the northeast (refer to Figure 2.1-5). Although launch operations would be conducted in the eastern tropical Pacific in an area of potential typhoon

activity, weather conditions would be monitored closely prior to any proposed launch operations and would not occur if a typhoon or tropical storm is approaching the carrier aircraft or LauncherOne flight corridors. As stated above under Item 1, the propellant type used by LauncherOne Stage 1 is a mixture of a kerosene-based fuel and LOX. Neither would result in contamination of the environment. Operations should not result in any widespread chemical exposure. For further discussion, see Section 3.10 of the Final EA.

3. See Section 3.8.4.1 of the Final EA, including the cited NOAA (2019) reference.
NOAA. 2019. Kerosene and Jet Fuel Spills. Office of Response & Restoration, Emergency Response Division. August. Available at <https://response.restoration.noaa.gov/sites/default/files/Kerosene-Jet-Fuel.pdf>.

COMMENT #3

From: [Anne Santos](#)
To: [VOLauncherOne](#)
Subject: Virgin Orbit Proposed Launches from AAFB Guam
Date: Sunday, October 25, 2020 10:40:53 PM

Good day to you all,

I am not against it but, can it be conducted further away like in the middle of the ocean and away from civilians.

Besides the debris, the sonic boom is my worry too because I am concerned of our people and marine lives as well as our infants, toddlers and children's hearings.

With GOD JESUS' grace and blessings with prayers you will consider my request.

Sent from my iPhone

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process.

The proposed LauncherOne operations would be conducted more than 50 nautical miles east of Guam and would not occur within the vicinity of or over any terrestrial areas. As stated in Section 3.8.4.1 of the Draft EA, the first stage and fairings debris are comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials. They are anticipated to sink relatively quickly. Accordingly, it would not affect the marine environment in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

Based on the sonic boom modeling results, no sonic boom would intersect with land or human-sensitive receptors. The closest sonic boom to the coast of Guam would occur approximately 75 nautical miles south-southwest of Guam (see Section 3.5.4 and Figure 3.5-2 of the Draft EA). None of the sonic boom events that were modeled overlap or otherwise affect the coastal zone, terrestrial areas, sensitive marine habitats, or sensitive receptors.

COMMENT #4

From: [Michelle](#)
To: [VOLauncherOne](#)
Subject: Virgin Orbit will drop debris into ocean, "may affect" marine life
Date: Monday, October 26, 2020 1:48:42 AM

<https://amp.guampdn.com/amp/3723667001>

Appalling and unacceptable. Terrible risk to the environment and aquatic life. Do not allow this to happen!

Michelle Orengo-McFarlane
El Sobrante CA 94803

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process.

The analysis in the Draft EA shows that the proposed LauncherOne operations would not have significant impacts on the environment, including marine life. In particular, see Section 3.9, Biological Resources.

COMMENT #5

From: [Charlie Prouse](#)
To: [VOLauncherOne](#)
Subject: Public Comment
Date: Monday, October 26, 2020 7:41:19 AM

We are destroying the planet enough as is. Regardless of the potential that the debris might not hit an endangered species, we have no idea what the long term effects of this stuff being in the ocean ecosystem. They should not be allowed to dump their trash into the ocean out of convenience. Especially when companies like SpaceX had shown that recovery is an option.

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process.

As stated in Section 3.8.4.1 of the Draft EA, the first stage and fairings debris are comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials. They are anticipated to sink relatively quickly. Accordingly, it would not affect the marine environment in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

The propellant type used by LauncherOne Stage 1 is a mixture of a kerosene-based fuel (known as RP-1) and liquid oxygen (LOX). In the event of a launch failure, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 “very light oil,” which is characterized as being highly volatile and having low viscosity and low specific gravity. Due to its high volatility, RP-1 evaporates quickly when exposed to the air, and would completely dissipate into ocean waters within hours due to a combination of wave movement, oxygen exposure, and sunlight. The amount of water in comparison to the amount of propellant would allow the propellant to quickly dilute so that impacts would be temporary and extremely localized. Although it would require hours or days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatilized rapidly because of increased agitation and dissipation. LOX is a non-toxic cryogenic liquid which will evaporate into the air when released. Therefore, implementation of the Proposed Action would not have significant impacts on water or biological resources underlying the Stage 1 and Fairings Re-entry AHA.

COMMENT #6

From: [Naputi, Franklin R CTR USARMY ASC 406 AFSB LRC \(USA\)](#)
To: [VOLauncherOne](#)
Subject: my opinion (UNCLASSIFIED)
Date: Monday, October 26, 2020 11:44:17 AM

CLASSIFICATION: UNCLASSIFIED

Please leave our waters alone. We have enough issues as it is. Thanks for listening.

Franklin Naputi
Vectrus - True to your mission
Materiel Maintenance Division
HEM/EVT Tech. Inspector (Contractor)
AFSBn-Bragg
Fort Bragg, NC 28310
Office ☎ : 910-432-7880
Cell ☎ : 910-476-3037
franklin.r.naputi.ctr@mail.mil

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process.

The analysis in the Draft EA shows that the proposed LauncherOne operations would not have significant impacts on the environment, including marine life. In particular, see Section 3.9, Biological Resources.

COMMENT #7

From: [Claire Simeone](#)
To: [VOLauncherOne](#)
Subject: Virgin Orbit public comment
Date: Monday, October 26, 2020 6:45:28 PM

Good morning Leslie,

Thank you for the opportunity to comment on the draft environmental assessment for the launch operator license to Virgin Orbit out of Andersen Air Force Base. I agree with the assessment that the probabilities are sufficiently low to reasonably conclude that it would be unlikely that any ESA-listed marine mammals or turtles would be struck by debris, and do not have a specific concern for potential harm.

I do have a concern with Virgin Orbit dumping debris into the ocean. While the number of launches is small, and the debris is considered to be comprised of inert materials, this shows a lack of company accountability for the proper disposal of the waste they produce.

The recent LA Times article (<https://www.latimes.com/projects/la-coast-ddt-dumping-ground/>) detailing dumping of tons of DDT off the coast of California highlights the effect of this lack of accountability. DDT, aggressively defending at the time as playing a vital role in society and not a serious threat to human health, is now recognized as having catastrophic health and environmental effects.

We are reckoning with the effects of dumping, and lack of accountability for companies that produce marine debris worldwide. Although the environmental effects are assessed to be minimal in this EA, I would strongly support increased regulation for the dumping Virgin Orbit is proposing.

Thank you for your consideration,

Claire Simeone, DVM

FAA Response

Thank you for your comments and taking part in the National Environmental Policy Act review process.

The Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, prohibits dumping into the ocean material that would unreasonably degrade or endanger human health or the marine environment. As shown in the Final EA (Section 3.9, *Biological Resources* and Section 3.10, *Hazardous Materials, Solid Waste, and Pollution Prevention*), the proposed action would not result in significant impacts to human health or the marine environment.

COMMENT #8

From: Flo Hawkins
To: VCLauncherOne; voice@guampdn.com; governor@guam.gov.; mindy@postguam.com
Subject: No to Virgin!!
Date: Wednesday, October 28, 2020 6:47:39 PM
Attachments: image.png
 image.png
 image.png

To whoever will listen:

The Pacific Ocean surrounding the island chains of the Marianas, Micronesia, Melanesia, and all the surrounding islands and countries including island nations is my birth home. It has been a playground for too many years for experiments all in the name to benefit mankind. I'm almost sure that polluting and nearly destroying the oceans does not benefit anyone except the people with great ideas to line their pockets with money.

The Pacific area is still reeling from the atom bomb fiascos of the '50s, '60s, the arrogant French fiascos, and the ones we have not known about.

FYI from wikipedia:

1. The Pacific Proving Grounds was the name given by the United States government to several sites in the Marshall Islands and a few other sites in the Pacific Ocean at which it conducted nuclear testing between 1946 and 1962. The U.S. tested a nuclear weapon (codenamed Able) on Bikini Atoll on June 30, 1946. The United States detonated 67 nuclear bombs on, in, and above the Marshall Islands — vaporizing whole islands, carving craters into its shallow lagoons, and exiling hundreds of people from their homes.
2. The Soviet Union had two main sites but also conducted tests around the country of Kiribati.
3. France carried out 193 nuclear tests in French Polynesia in the South Pacific until 1996.

It is with notable interest that these counties except for the U.S. are located in the Atlantic region and I suppose it's safer to go halfway around the world so as not to destroy their own backyard. What conscientious countries they are, thinking about the safety of their people.

FYI... Over 70 percent of the world catch from the sea comes from the Pacific Ocean. Food for the planet!

If Mr. Branson really needs this project he can do it over on his side of the world, something closer to his home. The Atlantic Ocean is the 2nd largest of the oceans, 106,406,000 km² and it's in his back yard.

Dear Mr. Branson, please stay away from our ocean, it is polluted enough with mankind's disregard of others than itself. Space exploration will not house or feed people. Why don't you come up with a plan to help heal the planet instead of how to help destroy it more?

God created our oceans for this:



God did not create our oceans for this:

**FAA Response**

Thank you for your comments and taking part in the National Environmental Policy Act review process.

COMMENT #9

November 16, 2020

Via Email: VOLauncherOne@icf.com; leslie.grey@faa.gov

Leslie Grey
Environmental Protection Specialist
Federal Aviation Administration
800 Independence Avenue SW, Suite 325
Washington, DC 20591
907-227-2113

Re: Draft Environmental Assessment for Issuing a Launch Operator License to Virgin Orbit, LLC for LauncherOne Operations from Andersen Air Force Base, Guam (85 Fed. Reg. 66404, Oct. 19, 2020)

Ms. Grey:

United Airlines, Inc. (United) transports people and cargo throughout North America and to destinations in Asia, Europe, Africa, the Pacific, the Middle East and Latin America. United is proud to have the most comprehensive global route network and, historically, United and its regional carriers have operated as many as 4,900 flights per day to 362 airports across six continents, including its domestic hub at A.B. Won Pat International Airport (GUM) on the island of Guam. For example, in 2019 United and United Express operated more than 1.7 million flights carrying more than 162 million customers. Because United operates principally through its domestic hubs, a significant interruption or disruption in service at one of its hubs or other airports where it has a substantial presence could result in the cancellation or delay of a large portion of flights and, as a result, could have a material impact on United's business.

With regard to GUM, such disruptions would have serious implications beyond United. United's commitment to its shared purpose of "Connecting People. Uniting the World." is demonstrated every day on Guam and the surrounding islands in the region. In 2018 United celebrated 50 years of service to GUM, and United also serves KSA (Kosrae, Federated States of Micronesia); KWA (Kwajalein, Marshall Islands); MAJ (Majuro, Marshall Islands); PNI (Pohnpei, Federated States of Micronesia); ROR (Palau, Republic of Palau); TKK (Chuuk, Federated States of Micronesia); and YAP (Yap, Federated States of Micronesia). For many people living in the Micronesia region of the Western Pacific United's flights are the only reasonable way to get from island to island. United provides critical transport to individuals experiencing medical emergencies, in addition to carrying tourists and those visiting family or friends. United moves mail year-round in this region and, in response to the COVID-19 pandemic, has increased the frequency of cargo-only flights carrying fresh food, medical supplies and other essential freight for both the military and civilian families living on Guam.

As such, United appreciates the opportunity to provide these comments on the *Draft Environmental Assessment for Issuing a Launch Operator License to Virgin Orbit, LLC for LauncherOne Operations from Andersen Air Force Base, Guam* (Draft EA). United is concerned

233 S. Wacker Drive, Chicago, IL 60606

A STAR ALLIANCE MEMBER 

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that the proposed project activities could adversely impact United's operations and, as such, the people of Micronesia who depend on United.

The analysis in the Draft EA is incomplete. Although the Draft EA acknowledges that "temporary closures of existing airspace may be necessary ... during the proposed operations" (Draft EA, Section 2.1.3) it does not meaningfully evaluate the potential impacts of such closures, nor does the Draft EA provide enough information about the proposal for United to fully assess the implications. In the absence of additional details about the proposed operations, in particular the latitude and longitude coordinates specifically identifying the operational area of the project, it is not possible for the Draft EA to accurately determine and evaluate the impacts of the project.

The Draft EA does not adequately consider operational impacts. In addition to mainland flights to and from Honolulu (HNL) and United's "Island Hopper" flight, which goes between HNL and GUM with stops at five other islands along the way, United has identified several other city pairs, including but not limited to: Singapore, Ninoy Aquino, Hong Kong, Narita, Honolulu, Los Angeles and San Francisco, that would be potentially negatively impacted by closures of airspace in the region or re-routes necessary to accommodate launches.

United utilizes a Fatigue Risk Management System (FRMS) on the Island Hopper service to help ensure that its crews are sufficiently rested and alert when operating these flights. Even a small delay for flights within the Micronesia region can have compound, detrimental effects. If a crewmember reaches his or her duty limit while on one of the relatively smaller islands, for example, there is not likely to be a replacement crew available on site or able to reach the station within a reasonable time. As a result, the flight, and all its subsequent segments, would likely be canceled. The other flight operations are governed by Part 117 of the Federal Aviation Regulations, which provides strict duty and flight time restrictions. Both re-routes and airspace closures could result in crew members reaching flight duty time limits on every GUM flight. Re-routes may also lead to changes in aircraft weight restrictions which, when vital cargo is at issue, is not inconsequential. Delays and re-routes could also cause environmental impacts that are not sufficiently considered given the vague nature of the proposed operational parameters as described in the Draft EA.

United therefore requests that the Draft EA incorporate the following conditions into the proposed project to mitigate and better define these potential impacts:

- Provide at least a 96-hour advance notice of any airspace closures or required re-routes.
- Limit launch times to mid-day local time.
- If a launch is not feasible at the specified time (e.g., due to weather conditions), require the operator to re-schedule the launch (with a new notice period) rather than indefinitely extending the restrictions until the launch takes place.

The Draft EA acknowledges that "VO may identify additional flight corridors, trajectories, and drop points to support future mission needs" and that if "VO requests to modify the launch license to include additional launch and mission parameters, the FAA will review any new information to determine whether it falls outside the scope of the analysis in this EA and whether it would require

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additional environmental review.” (Draft EA, Section 2.1.3) United respectfully submits that the flight corridors, trajectories, and drop points currently described in the Draft EA are so ambiguous that they provide the operator an unreasonable amount of flexibility to change the operations without prompting further environmental review. Adding additional conditions to the project approval will increase transparency and help avoid unforeseen impacts in the event of future project changes.

Finally, the consideration of alternatives in the Draft EA is inadequate. The Draft EA limits its analysis to the proposed project and a no action alternative, without considering other locations for the project that may avoid or minimize potential operational and environmental impacts. The Draft EA should be revised to offer due consideration to other potential locations for the launch site.

Thank you for your attention to these comments.

FAA RESPONSE

Thank you for your comments and taking part in the National Environmental Policy Act review process.

Comment Letter Page 2, Paragraph 1

In addition to the response provided below, Section 2.1.3 of the Final EA has been revised to include further discussion of airspace closures. In addition, the analysis of potential impacts from proposed airspace closures on socioeconomics, air quality, climate, and noise, has been added to Sections 3.1, 3.3, 3.4, and 3.5, respectively.

Please refer to Figures 2.1-5 and 2.1-6 for a general depiction of the operational area of the proposed LauncherOne operations. Prior to each launch, the specific temporarily closed airspace would be defined and published through a Notice to Airmen (NOTAM). Specific latitude and longitude coordinates for specific operations are not known to the applicant or the Federal Aviation Administration (FAA) at this stage; each specific trajectory and associated Aircraft Hazard Areas (AHAs) would be provided in Virgin Orbit’s (VO’s) Flight Safety Data Package and submitted to the FAA in advance of the launch. This is how the FAA can specify the temporarily closed airspace in the NOTAM.

As discussed in Section 2.1.3.1 of the Final EA, the airspace closure duration depends on the mission type. For the proposed VO LauncherOne operations from Guam, the launch window is typically less than 4 hours. This closure time represents the maximum value for this type of mission. The FAA and launch operators take steps to reduce the closure durations as a successful mission unfolds. First, the operators plan to conduct their operations at the beginning of their launch window. So, while they may request a window that spans hours in order to have more opportunity to work around weather or technical issues, they make every effort to launch as soon as they are ready in the launch window. While percentages are not readily available, far more launches occur at or near the launch window opening than the closing. Further, as the launch unfolds successfully, the FAA incrementally releases airspace as it is no longer affected. For example, the airspace nearest the LauncherOne drop point can generally be released within 3 to 5 minutes of release as the LauncherOne successfully progresses along its trajectory. In practice, the FAA attempts to divide airspace closures into subsets that can be released incrementally in time, as well as geographically based on airspace boundaries. In doing so, the actual closure times are often significantly smaller than these maximum values defined in a given NOTAM.

The location and size of airspace closures for commercial space operations also vary with each mission type and are influenced by multiple factors, including hardware reliability, and the number and type of items that may be jettisoned. The size of airspace closures in the vicinity of the drop point shrink as

reliability is established with results and analysis from each launch. For the initial launch of a new launch vehicle, the AHA and associated airspace closures around the drop point are bigger to account for the increased likelihood of a vehicle failure, relative to a mature rocket. Subsequent launches of that launch vehicle include even smaller hazard areas compared to the initial launch.

Airspace closures due to commercial space operations can result in delayed aircraft departures and arrivals, aircraft being re-routed along established alternative routes in the airspace, and aircraft flying more miles due to the re-routing. Aircraft departures could be delayed if airspace was closed over or around the airport. Ground delays are also used under some circumstances to avoid airborne reroutes. After departure, the aircraft is re-routed as needed along established alternative routes to avoid the closed airspace. Based on the FAA's previous experience with commercial launches, most of the airspace-related impact is aircraft being re-routed in the airspace and thus aircraft flying more miles. Rarely, if ever, does the FAA receive notification that a launch-related airspace closure resulted in aircraft departures or arrivals being delayed at least 15 minutes (referred to as a "reportable" delay). Therefore, it is very unlikely that launch-related airspace closures would cause flight operators to violate its obligations under the Part 117 regulations. Re-routing associated with launch-related closures represents a small fraction of the total amount of re-routing that occurs from all other reasons in any given year. For example, weather results in the greatest amount of re-routing in any given year.

All aircraft re-routing in response to commercial space operations would occur along established alternative routes according to existing flight procedures that have already undergone environmental review. The alternative flight paths would be the same flight paths that are used for other re-route reasons (e.g., weather issues, runway closures, and military operations). The magnitude of aircraft re-routing depends on several conditions, including the time of day, the day of the week, and the month of the year, since air traffic volume fluctuates over time. The duration of the closure also affects the number of necessary re-routes to ensure safety in the affected airspace.

In addition to the trajectory-specific analysis provided in VO's Flight Safety Data Package and submitted to the FAA in advance of the launch (see discussion above), the FAA conducts an analysis of the effects on airspace efficiency and capacity for each licensed launch operation. These analyses are documented in Airspace Management Plans, which are completed approximately 3–5 days prior to a launch. They help the FAA determine whether the proposed launch would result in an unacceptable limitation on air traffic. If that were the case, the FAA may need to work with the operator to identify appropriate mitigation strategies, such as shortening the requested launch window or shifting the launch time, if possible. The FAA currently shares data with launch operators to avoid operations during days with high aviation traffic volume. These analyses have concluded that the majority of commercial space launch operations result in minor or minimal impacts on commercial and private users of airspace. This is largely due to the relatively low aircraft traffic density in the oceanic regions where VO operations would occur and the ability of the FAA to manage the airspace for all users.

As commercial space operations increase and new vehicles are developed, the FAA continues to explore ways to better manage airspace to increase the efficiency and capacity of the affected airspace for all users. For example, the FAA's Air Traffic Organization is currently examining dynamic launch windows and time-based launch procedures to enable air traffic to move dynamically through airspace even when it is closed via a NOTAM. These procedures involve ATC being in constant contact with the launch operator and knowing the status of a launch so the airspace can be used by aircraft as long as possible prior to the moment a commercial launch operation occurs.

Comment Letter Page 2, Paragraph 2

The Island Hopper route is well south of the proposed LauncherOne operations that are east and northeast of Guam and would not impact flight operations at Majuro Atoll, Kwajalein Atoll, Kosrae,

Pohnpei, and Chuuk. For potential impacts to the direct Honolulu-Guam route, refer to response to Comment Letter Page 2, Paragraph 1.

Comment Letter Page 2, Paragraph 3

Refer to response to Comment Letter Page 2, Paragraph 1.

Comment Letter Page 2, Paragraph 4

Request to incorporate the following conditions in the proposed action:

- *“Provide at least a 96-hour advance notice of any airspace closures or required re-routes.”* Per the LOA, Oakland ARTCC must: “(4) Ensure that Notices to Airmen (NOTAMs) are published at least 72 hours in advance, for affected airspace IAW FAAO 7930.2 Chapter 6.”
- *“Limit launch times to mid-day local time.”* This is not possible as the purpose of launch operations near Guam are to access specific low-Earth orbits that require a very specific launch time.
- *“If a launch is not feasible at the specified time (e.g., due to weather conditions), require the operator to re-schedule the launch (with a new notice period) rather than indefinitely extending the restrictions until the launch takes place.”* Refer to response to Comment Letter Page 2, Paragraph 1.

Comment Letter Page 3, Paragraph 1

Refer to response to Comment Letter Page 2, Paragraph 1.

Comment Letter Page 3, Paragraph 2

Sites near the equator and open ocean are advantageous for launch vehicles. These areas allow increased orbital inclinations from one launch site and less impact to population centers. Virgin Orbit evaluated the use of Kwajalein Atoll as a potential launch site. The Final EA has been revised to include a new section, Section 2.3 (Alternatives Considered but Eliminated from Further Consideration), that provides further detail on why this alternative site was not carried forward for analysis in the EA. Guam was the only potential U.S. site that allowed access to the required low-Earth orbits from an equatorial, or near-equatorial, location.

APPENDIX D: Agency Correspondence

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D.1 Endangered Species Act (ESA) Section 7 Consultation with the National Marine Fisheries Service (NMFS)

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Associate Administrator for
Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

October 16, 2020

Michael Tosatto
Pacific Islands Regional Office
National Marine Fisheries Service
Protected Resources Division
1845 Wasp Blvd., Building 176
Honolulu, HI 96818

SUBJECT: Proposed Virgin One LauncherOne Operations from Andersen AFB, Guam

Dear Mr. Tosatto:

The Federal Aviation Administration (FAA) Office of Commercial Space Transportation (FAA/AST) is in the process of preparing an Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA) to assess the potential environmental impacts of the proposed issuance of a launch license to Virgin Orbit, LLC (VO) to conduct launches using a 747 carrier aircraft from Andersen Air Force Base (AFB), Guam, including LauncherOne rocket operations over the Pacific Ocean east of Guam for purposes of transporting small satellites into a variety of low earth orbits (Figure 1). Pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) and in accordance with FAA environmental policies and procedures (FAA Order 1050.1F), the FAA is initiating consultation with the National Marine Fisheries Service (NMFS) regarding potential effects from the issuance of a launch license on ESA-listed marine species that may occur in the project area.

PROPOSED ACTION

The FAA's Proposed Action is to issue a launch license to allow VO to conduct launches using a 747 carrier aircraft from Andersen AFB, Guam, including LauncherOne rocket operations over the Pacific Ocean east of Guam. VO is proposing to conduct a maximum of 25 launches over the next 5 years (2021-2025), with a maximum of 10 launches in any 1 year during the 5-year period. For example, a potential launch scenario could be the following: 1 launch in 2021, 3 in 2022, 5 in 2023, 6 in 2024, and 10 in 2025. The following subsections provide a description of the project's location, launch system (carrier and launch vehicle), and proposed launch operations.

Location

Located in the Western Pacific Ocean, Guam is the southernmost and largest island of the Mariana Islands archipelago. The Mariana Islands include Guam and the Commonwealth of the Northern Mariana Islands (CNMI), both of which are sovereign (self-governing) territories of the U.S. Guam is situated approximately 3,700 miles west-southwest of Hawaii and 1,560 miles south-southeast of Japan.

Andersen AFB encompasses approximately 15,400 acres and is located in northern Guam (Figure 1). The main operations area of the base is in the eastern third of the installation and includes the main active airfield and an array of operations, maintenance, and community support facilities. The central third of the installation is a Munitions Storage Area. The western third is Northwest Field, which is used for helicopter training, various field exercises, bivouacs, and is the permanent location of the Pacific Air Forces (PACAF)

Regional Training Center and the U.S. Army Terminal High-Altitude Area Defense ballistic missile defense battery. The 36th Wing is the host unit to U.S. Air Force (Air Force), U.S. Army, U.S. Navy (Navy), and U.S. Marine Corps active forces along with Air Force Reserve and Air National Guard. The Wing's mission is to provide the highest quality peacetime and wartime support from its strategic Pacific location. Guam serves as a stopping point for numerous aircraft *en route* to Japan, Korea, and other Indo-Asian Pacific locations (U.S. Department of the Navy [Navy] 2010; Joint Region Marianas [JRM] 2019).

The Andersen AFB airfield has two parallel runways: one 11,200 feet (ft) long and one 10,527 ft long; both are 200 ft wide. Based on the most current data summarizing flight operations by aircraft type, Andersen AFB supported approximately 23,691 flights annually, or approximately 65 operations per day in 2013 (Pacific Air Forces and Air Force Center for Engineering and the Environment [PACAF and AFCEE] 2013). The airfield supports flight operations including takeoffs, landings, and traffic pattern training of all types of based and transient aircraft including B-1, B-2, B-52, C-5, C-17, E-2, EA-18G, F/A-18, F-15, F-16, KC-10, KC-135, and B747 fixed-wing aircraft; CH-53, H-60, and H-1 helicopters; and MV-22 tilt rotor aircraft (Wyle 2008; Navy 2010; PACAF and AFCEE 2013).

Launch System

Carrier Aircraft: Boeing 747-400

The carrier aircraft, a Boeing 747-400, is a four-engine, wide-body vehicle, similar to other Boeing 747 aircraft that have been extensively used in commercial passenger and cargo transport for the last few decades (Figure 2). The 747-400 has a non-stop range of over 8,055 miles at almost maximum payload weight. To facilitate LauncherOne operations, the port wing of the carrier aircraft has been modified to carry both the rocket and a removable adapter, which houses the structural release mechanism, and quick release electrical and pneumatic connections to the carrier aircraft. The carrier aircraft provides electrical power, purge gasses, and monitoring and control of the rocket by a launch engineer onboard the carrier aircraft.

Launch Vehicle: LauncherOne Rocket

The LauncherOne is an expendable, air-launched two-stage rocket (Figure 3) that is designed to carry small satellites (approximately 661–1,102 lb of payload) into a variety of LEOs. The rocket is a liquid oxygen (LOX)/rocket propellant 1 (RP-1) (kerosene) system comprised of a first stage with 29,215 pound mass (lbm) of LOX and 13,279 lbm of RP-1, and second stage with 3,642 lbm of LOX and 1,683 lbm of RP-1. The thrust of the first stage is 69,298 ft lb.

Rather than launching from ground level, the rocket is carried to an altitude of approximately 35,000–40,000 ft above mean sea level (MSL) by the carrier aircraft and released into a flight path angle of approximately 28 degrees. The rocket offers a large fairing with a payload adapter capable of accommodating a variety of standard sizes for one or multiple satellites and a simple design that increases reliability while keeping costs low.

Launch Operations

Pre-flight Operations

Pre-flight activities consist of preparing the carrier aircraft and rocket for takeoff and launch, mounting and loading propellants on LauncherOne, and support operations, such as gathering and distributing telemetry. In accordance with Andersen AFB requirements, all hazardous pre-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

All airspace launch operations would comply with the necessary notification requirements, including issuance of Notice to Airmen (NOTAM) and Notice to Mariners (NOTMAR), as defined in the launch license issued by the FAA Office of Commercial Space Transportation. The proposed operations would

occur within FAA Oakland Air Route Traffic Control Center (ARTCC) airspace and would be scheduled for use as needed using the NOTAM process. A NOTAM provides notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (FAA Order 7930.2S, Notices to Airmen [NOTAM]). The FAA issues a NOTAM at least 72 hours prior to a launch activity in the ARTCC airspace to notify pilots and other interested parties of temporary conditions. Similarly, the National Geospatial-Intelligence Agency (NGA), in conjunction with the U.S. Coast Guard (USCG), publishes NOTMARs weekly and as needed, informing the maritime community of temporary changes in conditions or hazards in navigable waterways.

VO has entered into an LOA with the USCG District 14 in order to safely operate the LauncherOne over open ocean. The LOA describes the required procedures for both VO and USCG during a launch operation. USCG will be responsible for issuing NOTMARs for the local hazard area south of Guam. USCG will also coordinate issuing NOTMARs with the National Geospatial-Intelligence Agency (NGA) for stage 1 and fairing splashdown hazard areas in international waters. VO will provide these hazard area locations prior to launch of the rocket.

Advance notice via NOTAMs and NOTMARs would assist general aviation pilots and mariners in scheduling around any temporary disruption of flight or shipping activities in the area of operation. Launches would be infrequent (up to 10 per year in any one year), of short duration, and scheduled in advance to minimize interruption to airspace.

Launch and Mission Profile

The carrier aircraft flight corridors from Andersen AFB to and from the drop point are shown in Figure 4. The flight corridors would occur within the U.S. Exclusive Economic Zone (EEZ) around Guam. The holding patterns (or ‘Racetrack’) at the drop point are approximately 200 miles around. The drop point was established based on mission-specific needs, communication line of sight (trajectory of the vehicle relative to the location of the ground-based telemetry station), and to avoid sonic boom impacts to land.

The carrier aircraft and LauncherOne rocket would take off from Runway 24R at Andersen AFB and fly south to the designated drop point approximately 75 nautical miles (nm) south-southwest of Guam. A typical mission profile is depicted in Figure 5. Figure 6 depicts the flight trajectory of the LauncherOne rocket from the drop point to the release of satellites and fairing re-entry.

LauncherOne would be carried to an altitude of approximately 35,000–40,000 ft MSL where it would be released. The carrier aircraft would then immediately pull away and return to Runway 6L at Andersen AFB. With a drop flight path angle of approximately 28 degrees and an angle of attack of approximately 5 degrees, the rocket would maintain the flight angle required for vehicle safety through the 5-second drop, prior to ignition of the rocket’s first stage (Figure 5).



Release of LauncherOne from the Carrier Aircraft

The drop point includes a 10-nm radius Aircraft Hazard Area (AHA) where no other aircraft can be present prior to the drop of the LauncherOne rocket (Figure 4). In addition, one or more AHAs are defined for the initial flight of the rocket trajectory and associated hardware jettisons (Figure 6). Mission-specific AHAs will be defined in the NOTAMs.

Following ignition of the rocket's first stage, the rocket would be at supersonic speed (in excess of 768 miles per hour [mph]), and the engine would burn until all of the propellant is consumed. At approximately 700 nm downrange from the drop point, the rocket's first stage would detach and fall into the Pacific Ocean within a defined AHA (Figures 5 and 6).

After release of the first stage, the rocket's second stage would ignite until reaching its desired LEO (Figure 5). At approximately 750 nm downrange of the drop point, the shroud or fairings covering the satellites would be released and would fall into the Pacific Ocean within a defined AHA (Figures 5 and 6). Upon reaching the desired LEO, the second stage rocket would coast while releasing the small satellites at predetermined LEO heights and then re-ignite its engine (or blow-down⁽¹⁾) until all of the propellants are consumed, per FAA regulations (14 CFR §417.129) (Figure 5). The second stage would remain in orbit for months or years, eventually burning up upon reentry.

If after the LauncherOne rocket has been released from the carrier aircraft and there is a malfunction or other issue that results in the abort of the flight, the rocket is expected to maintain structural integrity until impact with the ocean if there is no secondary explosive failure. There is no destruct component on the vehicle. The vehicle safety system will shut down all thrust as soon as a failure is detected, preventing it from moving to a different area. As the drop of LauncherOne from the carrier aircraft occurs at approximately 35,000 ft MSL, if propellant tanks are ruptured, the RP-1 will vaporize when exposed to the ambient environment. The oxidizer in the rocket is LOX that will simply boil off into the atmosphere with no adverse effects. Once the rocket impacts the ocean surface, it will break up into small pieces and most will sink.

In the event the mission is aborted and the rocket is not released, or in case of an emergency, the carrier aircraft and LauncherOne rocket would return to Andersen AFB.

VO may identify additional flight corridors, trajectories, and drop points to support future mission needs. However, the current analysis is based on the launch and mission parameters as described above. If VO requests to modify the launch license to include additional launch and mission parameters, the FAA will review any new information to determine whether it falls outside the scope of the current analysis and whether it would require additional environmental review, including consultation under ESA section 7.

Post-flight Operations

For nominal launches, all of the oxidizer would be consumed during the rocket's powered flight. For a nominal launch, no hazardous post-flight ground operations would be required to return the carrier aircraft to safe conditions, so the carrier aircraft would be returned to Andersen AFB. For aborted flights, LOX and RP-1 would remain on-board the rocket for the return to Andersen AFB. After the carrier aircraft returns to Andersen AFB, for safety purposes, the LOX would be off-loaded (takes approximately 2 hours to unload), and the aircraft would be moved so it does not interfere with runway operations. The RP-1 may stay on board if there is an intent to re-attempt launch, and the carrier aircraft would be moved to an area at Andersen AFB that would not interfere with runway or other aircraft operations. In accordance with Andersen AFB requirements, any hazardous post-flight ground operations would take place in a specified location that has established appropriate safety clear zones.



First and Second Stage Separation



Payload Fairing Separation

⁽¹⁾To deplete onboard energy sources after completion of mission.

ACTION AREA

The action area includes the Pacific Ocean south and east of Guam under the LauncherOne trajectory, particularly those areas subject to sonic booms and the area beneath the Stage 1 and Fairings Re-entry AHA (Figure 6).

ESA-LISTED SPECIES

The FAA has reviewed information regarding ESA-listed threatened and endangered species, species proposed for listing, and designated critical habitat that may be present in the action area. In accordance with 50 CFR 402.12 (c) and (d), we have prepared a list of ESA-listed species that we have included in our analysis (Table 1). The list was developed based on previous NEPA documentation of the action area and NMFS Pacific Islands Regional Office website (<https://www.fisheries.noaa.gov/region/pacific-islands/protected-marine-life> as of July 30, 2020).

Table 1. ESA-listed Marine Species under the Jurisdiction of NMFS Potentially underlying the Proposed LauncherOne Trajectory

| Common Name | Scientific Name | ESA Status* |
|--|--------------------------------|-------------|
| MARINE MAMMALS* | | |
| Blue whale | <i>Balaenoptera musculus</i> | E |
| Fin whale | <i>Balaenoptera physalus</i> | E |
| Humpback whale (Western North Pacific DPS) | <i>Megaptera novaeangliae</i> | E |
| Sei whale | <i>Balaenoptera borealis</i> | E |
| Sperm whale | <i>Physeter macrocephalus</i> | E |
| SEA TURTLES | | |
| Green sea turtle (Central West Pacific DPS) | <i>Chelonia mydas</i> | E |
| Hawksbill sea turtle | <i>Eretmochelys imbricata</i> | E |
| Leatherback sea turtle | <i>Dermochelys coriacea</i> | E |
| Loggerhead sea turtle (North Pacific DPS) | <i>Caretta caretta</i> | E |
| FISH | | |
| Giant manta ray | <i>Manta birostris</i> | T |
| Oceanic whitetip shark | <i>Carcharhinus longimanus</i> | T |
| Scalloped hammerhead shark (Indo-West Pacific DPS) | <i>Sphyrna lewini</i> | T |

Notes: *E = endangered; T = threatened.

Sources: Navy 2015, 2018; National Oceanic and Atmospheric Administration (NOAA) Fisheries 2020.

Marine Mammals

Five ESA-listed endangered marine mammal species may occur within the marine waters underlying the LauncherOne activities (Table 1). The species presented in Table 1 are based on observed marine mammals during surveys in the Mariana Islands Training and Testing (MITT) Study Area and associated transit corridor in support of the MITT Draft Supplemental EIS/Overseas EIS (Navy 2019). The MITT Study Area extends 450 nm north of Guam, 250 nm east of Guam, and 300 nm south of Guam and includes the LauncherOne drop point. The transit corridor is located on the eastern edge of the MITT Study Area and is 300 nm south of the Stage 1 and Fairings Re-entry AHA. Information from the MITT Supplemental EIS/Overseas EIS provides the best available data regarding the occurrence of marine mammals in the vicinity of the proposed LauncherOne operations. Density estimates for each species are provided in Appendix A.

Sea Turtles

Four ESA-listed endangered sea turtle species may also occur within the marine waters underlying the proposed LauncherOne activities: green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*) (Table 1).

Fish

In addition to hundreds of species of marine fish, three ESA-listed threatened fish species potentially occur within the marine waters underlying the proposed LauncherOne activities: giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus longimanus*), and scalloped hammerhead shark (*Sphyrna lewini*) (Table 1).

EFFECTS OF THE ACTION

Under the proposed action, the FAA has determined that potential impacts to ESA-listed species under NMFS jurisdiction could include:

- in-air and underwater acoustic impacts from sonic booms under the LauncherOne trajectory,
- potential strike of marine species from Stage 1 and the fairings debris underlying the Drop Point and Stage 1 and Fairings AHAs,
- unspent RP-1 fuel from Stage 1 when it impacts the Pacific Ocean, and
- launch failure and associated physical debris and debris fallout into open waters during LauncherOne rocket launches.

Sonic Booms

The carrier aircraft would take off from Andersen AFB and fly south to the drop point. Once at the drop point, the rocket would be released at an altitude of 35,000–40,000 ft MSL. Within 20 seconds of releasing the rocket, it would be flying at supersonic speeds.

Impulse sounds may include a sonic boom from the LauncherOne rocket. To determine the potential for a sonic boom, the modeling program PCBOOM was used. Based on the modeling results, no sonic boom would intersect with land or human-sensitive receptors (Figure 7). The closest boom to the coast with a magnitude of 1.0 psf or greater is located approximately 75 nm south-southwest of Guam. Received sonic boom levels at the water's surface would be <1 psf.

NMFS uses conservative thresholds of received sound pressure levels from broad band sounds that may cause behavioral disturbance and injury (NMFS 2018). These conservative thresholds are applied in both MMPA permits and ESA section 7 consultations for marine mammals to evaluate the potential for sound effects. The criterion levels specified here are specific to the levels of harassment as defined under the MMPA. Level A criterion for in-water permanent threshold shift (PTS) (injury), excluding tactical sonar and explosives, is 180 dB root mean square reference 1 micropascal (180 dBrms re 1 μ Pa). Level B criterion for in-water for behavioral disruption for impulsive noise is 160 dBrms re 1 μ Pa. The proposed project activities were evaluated using the above acoustic thresholds. In the ESA context, these thresholds are informative as the thresholds at which we might expect either behavioral changes or physical injury to an animal to occur, but the actual anticipated effects would be the result of the specific circumstances of the action (as further explained below).

It is likely that any noise associated with the sonic boom would transmit from the air to water and propagate some distance in the water column. All of the boom pressure signals measured in Sohn et al. (2000) experiment decayed to ambient levels in all frequency bands by 131-164 ft. A sonic boom at the surface of 2 psf (2-4 times greater than the anticipated sonic boom from the proposed LauncherOne activities; Figure 3.5-3) decayed to approximately 152 dBrms re 1 μ Pa at a depth of 23 ft. By 72 ft, the received level was approximately 140 dBrms re 1 μ Pa and at 121 ft, it was equal to ambient noise levels. All of these sound pressure levels are below the current NMFS threshold for potential permanent injury for cetaceans (180 dBrms re 1 μ Pa sound pressure level) and potential behavioral change or temporary injury (160 dBrms re 1 μ Pa sound pressure level). Although it was not possible to estimate the point at which underwater sound pressure levels would equal or exceed 160 dBrms re 1 μ Pa, but it is estimated this would likely occur at

less than 23 ft which could be at or near the surface level of the water based on the decay rate provided above at a depth of 23 ft.

The onset of physical injury to fish would be expected if the peak levels exceed 206 dB re 1 μ Pa (Stadler and Woodbury 2009). The sonic boom associated with the LauncherOne operations would be significantly less than 206 dB re 1 μ Pa in the water column.

Based on the estimated sound levels, the frequency with which the sonic booms may occur over the course of a year, and the relative infrequency with which ESA-listed marine mammals, sea turtles, and fish may be in the immediate vicinity during those times, sonic booms associated with LauncherOne operations **may affect, but are not likely to adversely affect** ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory.

Potential for Debris Strike from Stage 1 or Fairings Re-entry

Using a statistical probability analysis for estimating direct strike impact developed by the U.S. Navy (Navy 2019), the probability of impact of debris with a single marine mammal (P) is then multiplied by the number of animals to obtain the number of exposures (T). Refer to Appendix A for details on the methodology and assumptions. Using this procedure, P and T were calculated for the five species of ESA-listed marine mammals and the non-ESA listed marine mammal species with the highest average month density (pantropical spotted dolphin), and the sea turtle species with the highest average month density in the AHA (green sea turtle).

VO proposes to conduct up to a maximum of 10 LauncherOne launches per any one year during the 5-year operating period; the other 4 years will see <9 LauncherOne launches, not exceeding 25 operations across 5 years, and therefore fewer potential strikes. The potential number of individuals impacted/year are provided in Table 2.

Table 2. Estimated Representative Marine Mammal and Sea Turtle Exposures from a Potential Direct Strike of the LauncherOne Stage 1 and Fairings in a Single Year

| Species (ESA Status) | Est. Density (km ²)* | Probability of Impact (T) | Est. No. Impacts/Year† |
|-------------------------------|----------------------------------|---------------------------|------------------------|
| Humpback whale (Endangered) | 0.00089 | 0.0000001 | 0.000001 |
| Sei whale (Endangered) | 0.00013 | 0.00000002 | 0.0000002 |
| Fin whale (Endangered) | 0.00006 | 0.00000001 | 0.0000001 |
| Blue whale (Endangered) | 0.00005 | 0.00000001 | 0.0000001 |
| Sperm whale (Endangered) | 0.00222 | 0.0000003 | 0.000003 |
| Pantropical spotted dolphin | 0.01132 | 0.0000002 | 0.000002 |
| Green sea turtle (Endangered) | 0.00039 | 0.000000005 | 0.00000005 |

Notes: *number of animals per square kilometer (km²). See Appendix A for further details on the calculation of estimated impacts.

†Based on the maximum of 10 proposed launches in any one year of the 5-year operating period; all other years would be \leq 9 launches/year.

Source: *Navy 2018.

The impact of debris striking a marine mammal or sea turtle may result in injury or mortality to individuals. For ESA-listed marine mammals, modeling based on the estimated density of individuals for each species results in estimates of the probability of a direct strike of debris with an individual during each event of 0.0000002 or less (Table 2). The estimated number of takes for each species annually, assuming the maximum of 10 LauncherOne operations and the re-entry of Stage 1, was approximately 0.000002 or less (Table 2). With the intentionally conservative overestimation of parameters and assumptions in the model, the results indicate that it is extremely unlikely the re-entry of Stage 1 would result in debris impacting the ESA-listed species. These probabilities are sufficiently low to reasonably conclude that it would be unlikely that any of the five ESA-listed marine mammals would be struck by debris as a result of conducting up to

10 LauncherOne operations/year and the impact of Stage 1 and the fairings in the ocean. For marine mammals protected under the MMPA, the probability of debris strike for individuals of all species was also negligible given the species with the highest density in the study area (pantropical spotted dolphin) was modeled and found to have a negligible potential for impact from Stage 1 impact. Therefore, those marine mammal and sea turtle species with lower densities in the study area would have an even lower probability of being struck by the Stage 1.

Sufficient density data are not available to conduct a debris strike analysis for ESA-listed fish species in the manner conducted above for marine mammals and sea turtles. However, it is assumed that ESA-listed fish species likely to be in the area would be rare because of their known distribution in the area and likely swimming below the surface at all times. Should debris hit the water, it is expected that the initial impact at the water's surface or even slightly below the surface, would absorb much of the energy from that impact. If they were present, ESA-listed fish would be expected to be below this initial area of impact, and therefore unaffected by the debris.

Therefore, implementation of the Proposed Action and the impact of Stage 1 and fairings in the Pacific Ocean **may affect, but is not likely to adversely affect** ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory.

Unspent RP-1 Fuel and Debris Materials from Stage 1 or Fairings Re-entry or Launch Failure

The propellant type used by LauncherOne is a mixture of a kerosene-based fuel (known as RP-1) and LOX. In the event of a launch failure, and the LauncherOne rocket impacting the Pacific Ocean, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 "Very Light Oil," which is characterized as being highly volatile and having low viscosity and low specific gravity. Due to its high volatility, RP-1 evaporates quickly when exposed to the air, and would completely dissipate within hours or days after a spill in the water (NOAA 2019). Cleanup following a spill of very light oil is usually not necessary or possible, particularly with such a small quantity of oil that would enter the ocean in the event of an unsuccessful launch. Therefore, no attempt would be made to boom nor recover RP-1 fuel from the ocean. Although it would require 1–2 days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatilized rapidly because of increased agitation and dissipation. This conclusion is also applicable for any unspent RP-1 fuel that remains in the Stage 1 after a successful launch, separation from Stage 2, and when Stage 1 impacts the ocean.

First stage and fairings debris, which is comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials, is anticipated to sink relatively quickly. Accordingly, it would not affect the marine environment and associated marine species in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

Therefore, implementation of the Proposed Action and the impact of unspent RP-1 fuel and Stage 1 and fairings debris in the Pacific Ocean **may affect, but is not likely to adversely affect** ESA-listed marine mammal, sea turtle, and fish species beneath the LauncherOne flight trajectory.

CONCLUSION

Due to the limited number of launches (maximum of 10 per year) and the unlikely scenario of a launch failure, based on the evaluation presented above, FAA/AST has determined that the Proposed Action **may affect, but is not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish within the action area.

We request your concurrence on the above effects determination within 30 days of your receipt of this letter, and we request any comments that you may have regarding the Proposed Action's potential effects on ESA-listed species under your jurisdiction in the marine environment.

Thank you for your assistance. If you have any questions or need further information on the project, please contact Ms. Leslie Grey of my staff at (907) 227-2113 or at Leslie.Grey@faa.gov.

Sincerely,

DANIEL P MURRAY

Digitally signed by DANIEL P
MURRAY
Date: 2020.10.16 10:38:50 -04'00'

Daniel Murray

Manager, Safety Authorization Division

Enclosures:

Figure 1. Andersen AFB and Vicinity, Guam

Figure 2. Carrier Aircraft with LauncherOne Attached

Figure 3. LauncherOne Rocket

Figure 4. 747 Carrier Aircraft Flight Corridors, LauncherOne Drop Point, LauncherOne Trajectory, and Associated AHAs

Figure 5. Typical LauncherOne Rocket Mission Profile from Release from Carrier Aircraft to Release of Satellite Payload

Figure 6. LauncherOne Flight Trajectory Including Drop Point, Downrange AHA, and Stage 1 and Fairings Re-entry AHA

Figure 7. Modeled Potential Sonic Boom from LauncherOne Vehicle

Appendix A: Statistical Probability Analysis for Estimating Direct Strike Impacts to Marine Mammals and Sea Turtles from Stage 1 of the LauncherOne Rocket

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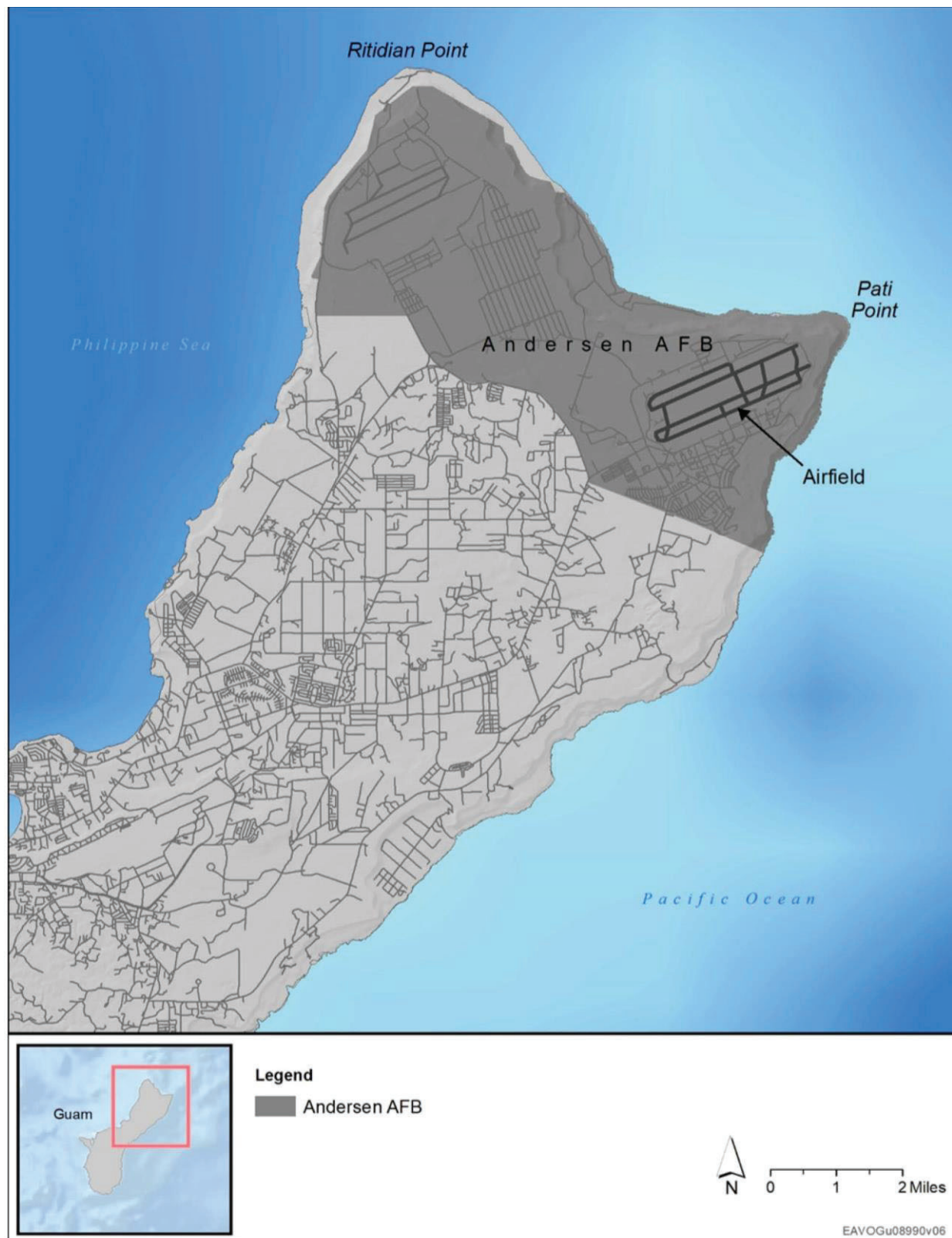


Figure 1. Andersen AFB and Vicinity, Guam



Figure 2. Carrier Aircraft with LauncherOne Attached

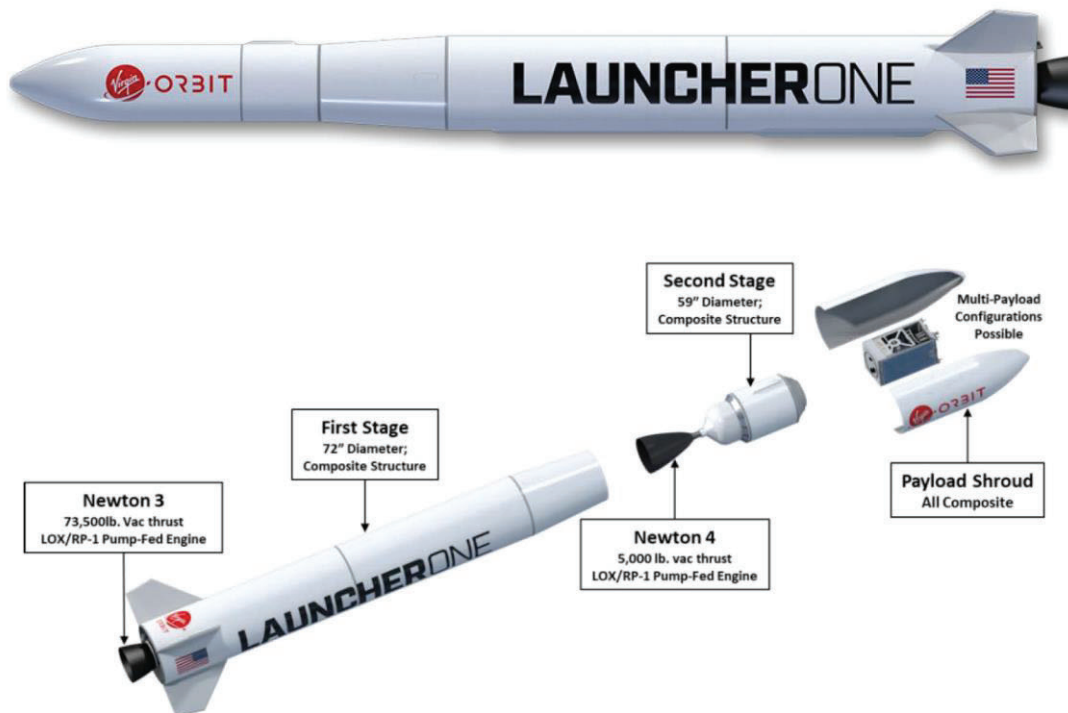


Figure 3. LauncherOne Rocket

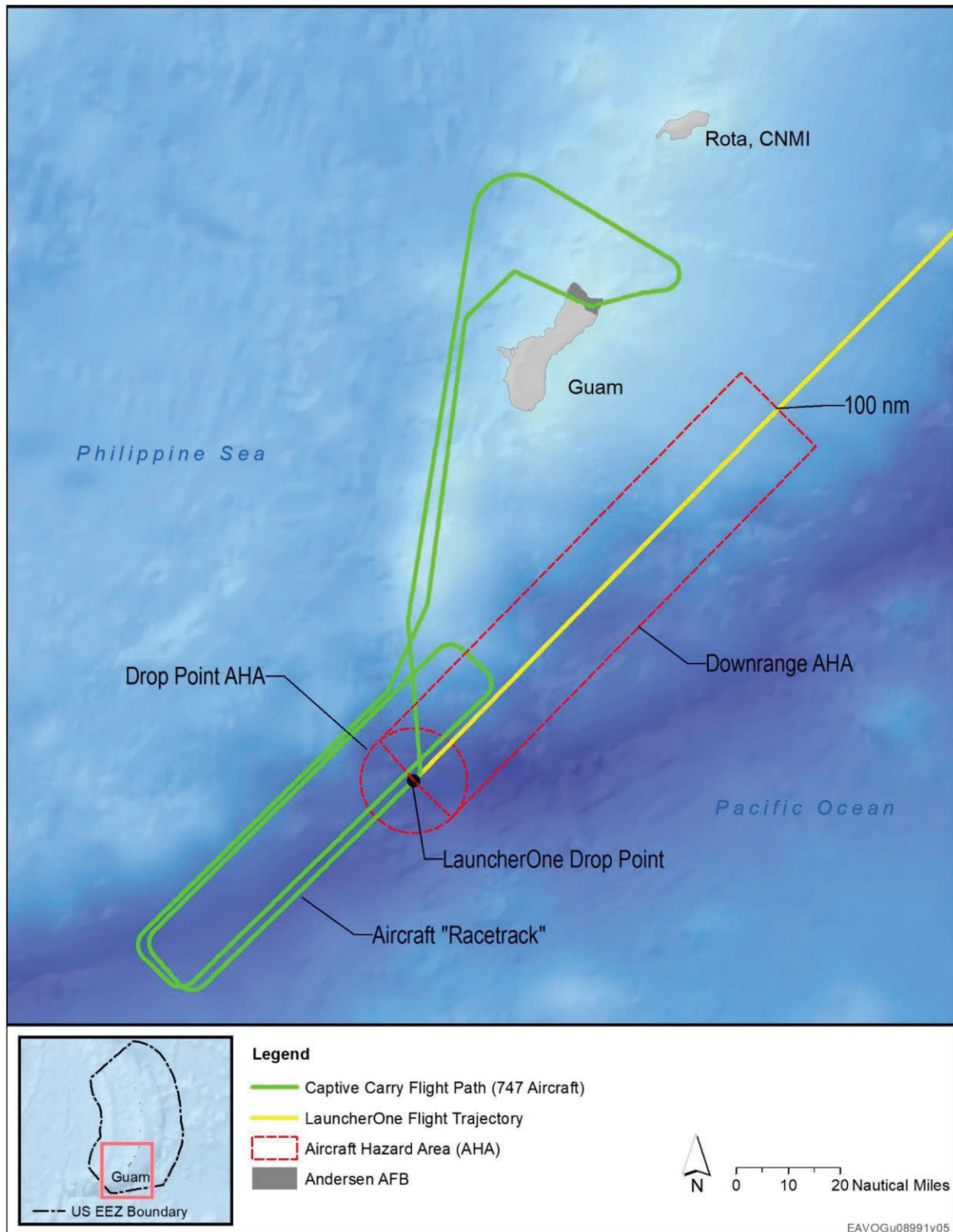


Figure 4. 747 Carrier Aircraft Flight Corridors, LauncherOne Drop Point, LauncherOne Trajectory, and Associated AHAs

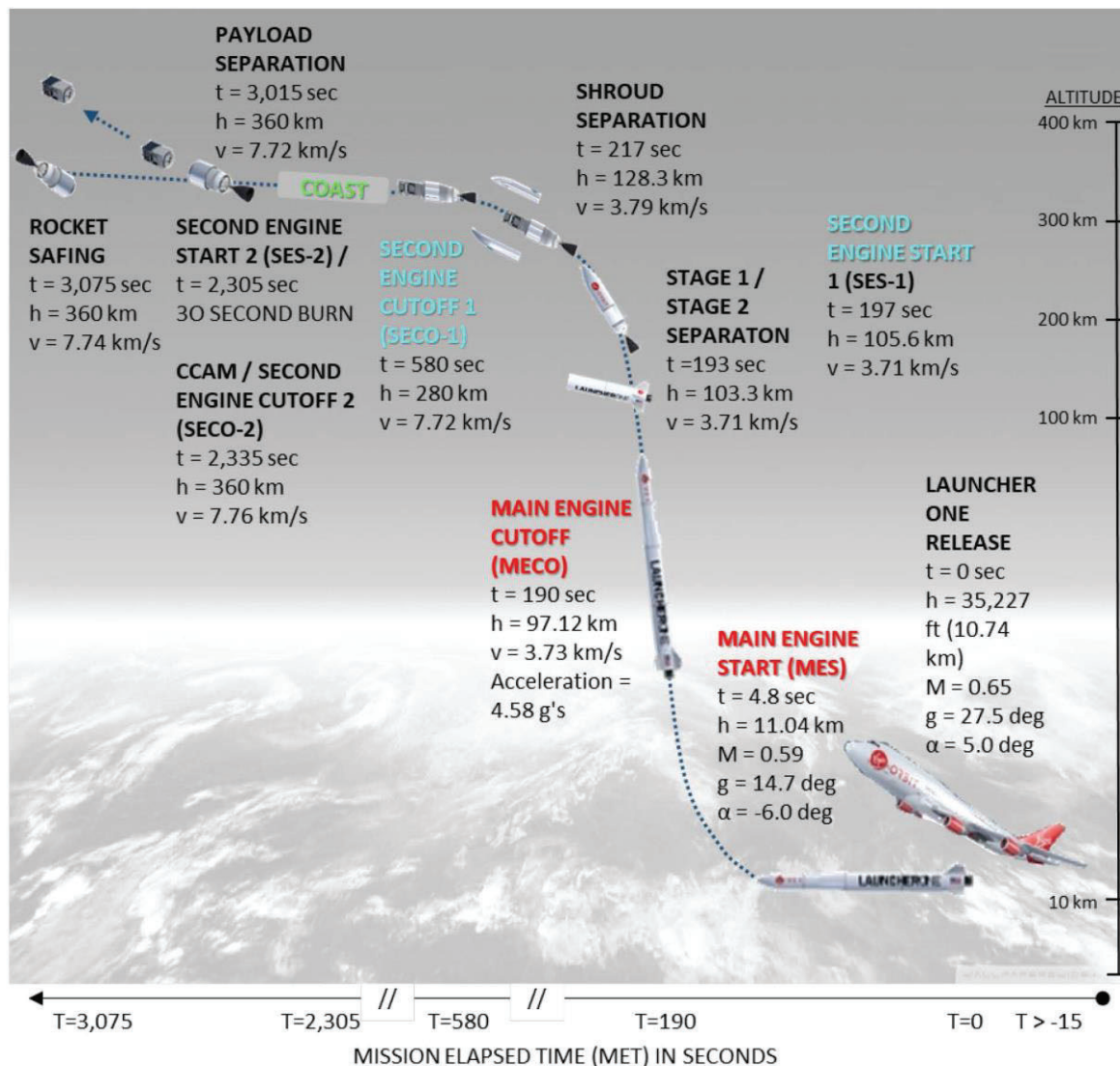


Figure 5. Typical LauncherOne Rocket Mission Profile from Release from Carrier Aircraft to Release of Satellite Payload

Legend: α = angle of attack
 CCAM = Collision and Contamination Avoidance Maneuver
 ft = feet
 g = flight path angle
 h = height above sea level
 km = kilometers
 km/s = kilometers per second
 M = Mach number
 sec = seconds
 t = time since release of LauncherOne
 v = velocity

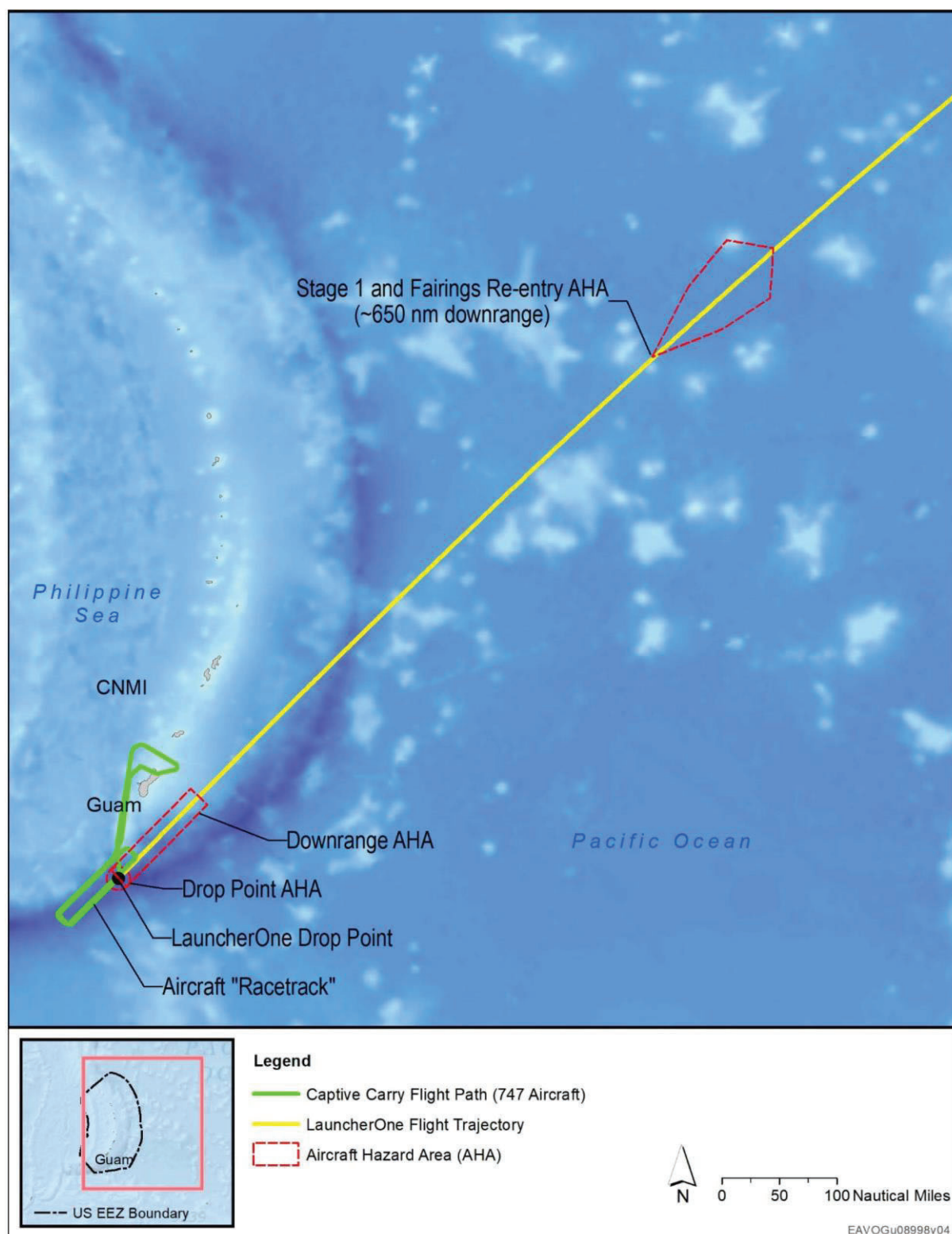


Figure 6. LauncherOne Flight Trajectory Including Drop Point, Downrange AHA, and Stage 1 and Fairings Re-entry AHA

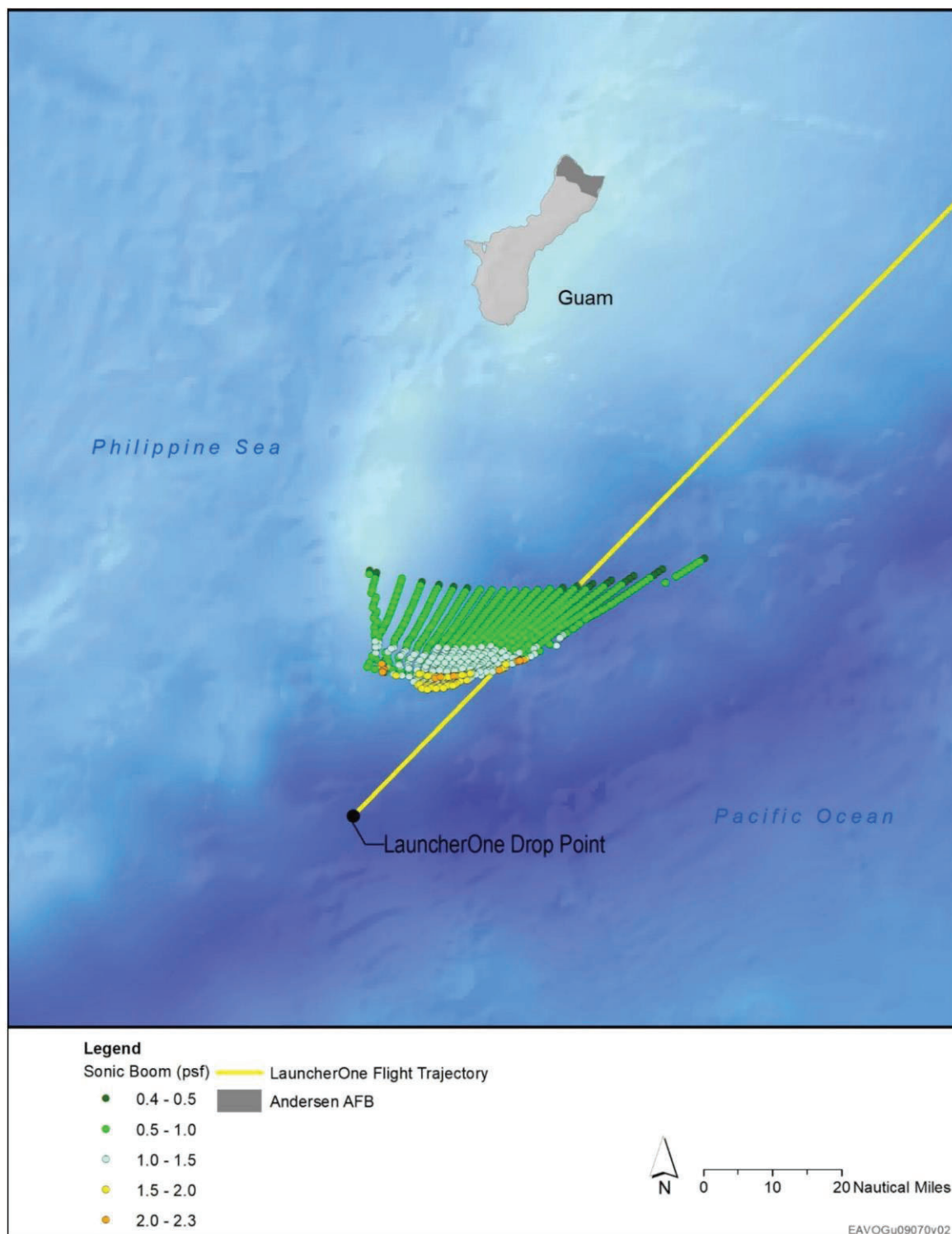


Figure 7. Modeled Potential Sonic Boom from LauncherOne Vehicle



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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December 29, 2020

U.S. Department of Transportation
Federal Aviation Administration
Office of the Associate Administrator for Commercial Space Transportation Action Agency
800 Independence Ave., SW Washington, DC 20591

RE: Request for Informal ESA Consultation on Virgin One LauncherOne Operations from
Andersen AFB, Guam (I-PI-20-1874-AG; PIRO-2020-02971)

Dear Ms. Grey:

On October 16, 2020, NOAA's National Marine Fisheries Service (NMFS) received your written request for concurrence and biological evaluation (BE) that the U.S. Department of Transportation Federal Aviation Administration (FAA) proposed action to issue a launch license to Virgin Orbit, LLC (VO) to conduct launches using a 747 carrier aircraft from Andersen Air Force Base (AFB), Guam, including LauncherOne rocket operations over the Pacific Ocean east of Guam, for purposes of transporting small satellites into a variety of low earth orbits is not likely to adversely affect (NLAA) the following endangered or threatened species or designated critical habitat under NMFS' jurisdiction: endangered fin, blue, sei, Western North Pacific humpback and sperm whales; endangered Central West Pacific green turtles; endangered hawksbill turtles; endangered loggerhead turtles; threatened Eastern Pacific scalloped hammerhead sharks; threatened oceanic whitetip sharks; threatened giant manta rays. There is no critical habitat in the action area.

On November 16, 2020, NMFS requested clarification regarding potential effects of sound and was provided that information via conference call. Informal consultation began on that date. On December 17, 2020, NMFS requested and received additional information regarding launch debris that may fall into the ocean. Informal consultation began on that date.

This response to your request was prepared by NMFS pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. §1531 et seq.), implementing updated regulations at 50 CFR 402 (84 FR 44976; 10/28/2019), and agency guidance for the preparation of letters of concurrence. We have reviewed the information and analyses relied upon to complete this letter of concurrence in light of the updated regulations and conclude the letter is fully consistent with the updated regulations.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Pacific Island Regional Office, Honolulu, Hawaii.



Proposed Action

The FAA's proposed action is to issue a launch license to allow VO to conduct launches using a 747 carrier aircraft from Andersen AFB, Guam, including LauncherOne rocket operations over the Pacific Ocean east of Guam. VO is proposing to conduct a maximum of 25 launches over the next 5 years (2021-2025), with a maximum of 10 launches in any 1 year during the 5-year period. For example, a potential launch scenario could be the following: 1 launch in 2021, 3 in 2022, 5 in 2023, 6 in 2024, and 10 in 2025.

Launch System

The carrier aircraft, a Boeing 747-400, is a four-engine, wide-body vehicle, similar to other Boeing 747 aircraft that have been extensively used in commercial passenger and cargo transport for the last few decades. The 747-400 has a non-stop range of over 8,055 miles at almost maximum payload weight. To facilitate LauncherOne operations, the port wing of the carrier aircraft has been modified to carry both the rocket and a removable adapter, which houses the structural release mechanism, and quick release electrical and pneumatic connections to the carrier aircraft. The carrier aircraft provides electrical power, purge gasses, and monitoring and control of the rocket by a launch engineer onboard the carrier aircraft.

The LauncherOne is an expendable, air-launched two-stage rocket that is designed to carry small satellites (approximately 661–1,102 lbs. of payload) into a variety of LEOs. The rocket is a liquid oxygen (LOX)/rocket propellant 1 (RP-1) (kerosene) system comprised of a first stage with 29,215-pound mass (lbm) of LOX and 13,279 lbm of RP-1, and second stage with 3,642 lbm of LOX and 1,683 lbm of RP-1. The thrust of the first stage is 69,298 ft. lb.

Rather than launching from ground level, the rocket is carried to an altitude of approximately 35,000-40,000 ft. above mean sea level (MSL) by the carrier aircraft and released into a flight path angle of approximately 28 degrees. The rocket offers a large fairing with a payload adapter capable of accommodating a variety of standard sizes for one or multiple satellites and a simple design that increases reliability while keeping costs low.

Launch Operations

Pre-flight activities consist of preparing the carrier aircraft and rocket for takeoff and launch, mounting and loading propellants on LauncherOne, and support operations, such as gathering and distributing telemetry. In accordance with Andersen AFB requirements, all hazardous pre-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

Virgin Orbit has entered into a Letter of Agreement (LOA) with the USCG District 14 in order to safely operate the LauncherOne over open ocean. The LOA describes the required procedures for both VO and USCG during a launch operation. USCG will be responsible for issuing notices to mariners (NOTMARs) for the local hazard area south of Guam. USCG will also coordinate issuing NOTMARs with the National NGA for stage 1 and fairing splashdown hazard areas in international waters. Virgin Orbit will provide these hazard area locations prior to launch of the rocket.

Advance notices, via notices to airmen (NOTAMs) and NOTMARs, would assist general aviation pilots and mariners in scheduling around any temporary disruption of flight or shipping activities in the area of operation. Launches would be infrequent (up to 10 per year in any one year), of short duration, and scheduled in advance to minimize interruption to airspace.

Launch and Mission Profile

The carrier aircraft flight corridors from Andersen AFB to and from the drop point would occur within the U.S. Exclusive Economic Zone around Guam. The holding patterns (or ‘Racetrack’) at the drop point are approximately 200 miles around. The drop point was established based on mission-specific needs, communication line of sight (trajectory of the vehicle relative to the location of the ground-based telemetry station), and to avoid sonic boom (SB) impacts to land. The carrier aircraft and LauncherOne rocket would take off from Runway 24R at Andersen AFB and fly south to the designated drop point approximately 75 nautical miles (nm) south-southwest of Guam. Figure 1 depicts the flight trajectory of the LauncherOne rocket from the drop point to the release of satellites and fairing re-entry.

LauncherOne would be carried to an altitude of approximately 35,000–40,000 ft. MSL where it would be released. The carrier aircraft would then immediately pull away and return to Runway 6L at Andersen AFB. With a drop flight path angle of approximately 28 degrees and an angle of attack of approximately 5 degrees, the rocket would maintain the flight angle required for vehicle safety through the 5-second drop, prior to ignition of the rocket’s first stage.

The drop point includes a 10-nm radius Aircraft Hazard Area (AHA) where no other aircraft can be present prior to the drop of the LauncherOne rocket. In addition, one or more AHAs are defined for the initial flight of the rocket trajectory and associated hardware jettisons (Figure 1). Mission-specific AHAs will be defined in the NOTAMs.

Following ignition of the rocket’s first stage, the rocket would be at supersonic speed (in excess of 768 miles per hour [mph]), and the engine would burn until all of the propellant is consumed. At approximately 700 nm downrange from the drop point, the rocket’s first stage would detach and fall into the Pacific Ocean within a defined AHA (Figure 1). After release of the first stage, the rocket’s second stage would ignite until reaching its desired LEO. At approximately 750 nm downrange of the drop point, the shroud or fairings covering the satellites would be released and would fall into the Pacific Ocean within a defined AHA (Figure 1) reaching the desired LEO, the second stage rocket would coast while releasing the small satellites at predetermined LEO heights and then re-ignite its engine (or blow-down (1)) until all of the propellants are consumed, per FAA regulations (14 CFR §417.129). The second stage would remain in orbit for months or years, eventually burning up upon reentry.

If after the LauncherOne rocket has been released from the carrier aircraft and there is a malfunction or other issue that results in the abort of the flight, the rocket is expected to maintain structural integrity until impact with the Payload Fairing Separation ocean if there is no secondary explosive failure. There is no destruct component on the vehicle. The vehicle safety system will shut down all thrust as soon as a failure is detected, preventing it from moving to a different area. As the drop of LauncherOne from the carrier aircraft occurs at approximately 35,000 ft. MSL, if propellant tanks are ruptured, the RP-1 will vaporize when exposed to the ambient environment. The oxidizer in the rocket is LOX that will simply boil off into the atmosphere with no adverse effects. Once the rocket impacts the ocean surface, it will break up into small pieces and most will sink.

In the event the mission is aborted and the rocket is not released, or in case of an emergency, the carrier aircraft and LauncherOne rocket would return to Andersen AFB.

Virgin One may identify additional flight corridors, trajectories, and drop points to support future mission needs. However, the current analysis is based on the launch and mission parameters as described above. If VO requests to modify the launch license to include additional launch and mission parameters, the FAA will review any new information to determine whether it falls outside the scope of the current analysis and whether it would require additional environmental review, including consultation under ESA section 7.

Post-flight Operations

For nominal launches, all of the oxidizer would be consumed during the rocket's powered flight. For a nominal launch, no hazardous post-flight ground operations would be required to return the carrier aircraft to safe conditions, so the carrier aircraft would be returned to Andersen AFB. For aborted flights, LOX and RP-1 would remain on-board the rocket for the return to Andersen AFB. After the carrier aircraft returns to Andersen AFB, for safety purposes, the LOX would be off-loaded (takes approximately 2 hours to unload), and the aircraft would be moved so it does not interfere with runway operations. The RP-1 may stay on board if there is an intent to re-attempt launch, and the carrier aircraft would be moved to an area at Andersen AFB that would not interfere with runway or other aircraft operations. In accordance with Andersen AFB requirements, any hazardous post-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

Action Area

Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (see 50 CFR 402.02). The action area for these proposed activities includes the Pacific Ocean south and east of Guam under the LauncherOne trajectory, including those areas subject to SBs and the area beneath the Stage 1 and Fairings Re-entry AHA (Figure 1).

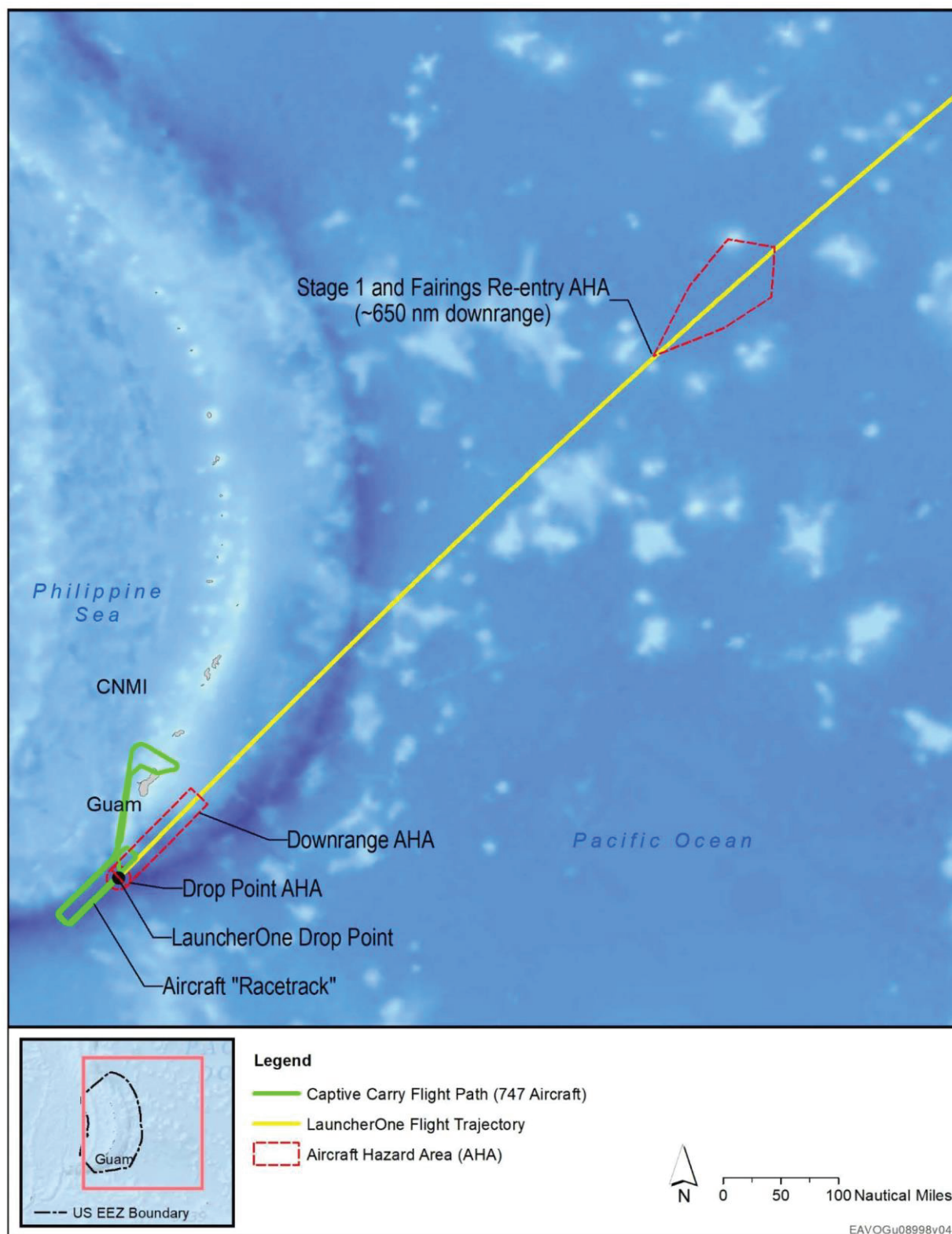


Figure 1. LauncherOne Flight Trajectory Including Drop Point, Downrange AHA, and Stage 1 and Fairings Re-entry AHA

Listed Species

The ESA-listed threatened and endangered species under NMFS' jurisdiction listed in Table 1 are known to occur, or could reasonably be expected to occur, in the action area, and may be affected by the proposed activities. Detailed information about the biology, habitat, and conservation status of the animals listed in Table 1 can be found in their status reviews, recovery plans, federal register notices, and other sources at

<https://www.fisheries.noaa.gov/topic/endangered-species-conservation>.

Table 1. Common name, scientific name, ESA status, effective listing date, and Federal Register reference for ESA-listed species considered in this consultation.

| Species | Scientific Name | ESA Status | Effective Listing Date | Federal Register Reference |
|--|--------------------------------|------------|------------------------|----------------------------|
| Green Sea Turtle Central West Pacific | <i>Chelonia mydas</i> | Endangered | 05/06/2016 | 81 FR 20057 |
| Hawksbill Sea Turtle | <i>Eretmochelys imbricata</i> | Endangered | 06/03/1970 | 35 FR 8491 |
| North Pacific Loggerhead Sea Turtle | <i>Caretta caretta</i> | Endangered | 10/24/2011 | 76 FR 58868 |
| Fin Whale | <i>Balaenoptera physalus</i> | Endangered | 12/02/1970 | 35 FR 18319 |
| Sei Whale | <i>Balaenoptera borealis</i> | Endangered | 12/02/1970 | 35 FR 18319 |
| Blue Whale | <i>Balaenoptera musculus</i> | Endangered | 12/02/1970 | 35 FR 18319 |
| Sperm Whale | <i>Physeter macrocephalus</i> | Endangered | 12/02/1970 | 35 FR 18319 |
| Western North Pacific Humpback Whale | <i>Megaptera novaeangliae</i> | Endangered | 9/8/2016 | 81 FR 62259 |
| Scalloped Hammerhead Shark Indo West Pacific | <i>Sphyrna lewini</i> | Threatened | 09/02/2014 | 79 FR 38213 |
| Oceanic Whitetip Shark | <i>Carcharhinus longimanus</i> | Threatened | 03/01/2018 | 83 FR 4153 |
| Giant Manta Ray | <i>Manta birostris</i> | Threatened | 02/21/2018 | 83 FR 2916 |

Critical Habitat

ESA-designated critical habitat does not occur in the action area, and no further discussion will occur in this consultation.

Analysis of Effects

In order to determine that a proposed action is not likely to adversely affect ESA-listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable¹, or completely beneficial. As defined in the joint USFWS-NMFS Endangered

¹ When the terms “discountable” or “discountable effects” appear in this document, they refer to potential effects that are found to support a “not likely to adversely affect” conclusion because they are extremely unlikely to occur.

Species Consultation Handbook, beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs². Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: 1) be able to meaningfully measure, detect, or evaluate insignificant effects; or 2) expect discountable effects to occur (USFWS & NMFS 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species, as is described in the consultation request and biological evaluation (BE). Only activities that have the potential to adversely affect ESA-listed species are discussed here.

The FAA identified the following stressors that have the potential to affect listed marine species in the action area:

- Acoustic impacts from SBs under the LauncherOne trajectory
- Debris strikes from Stage 1 and the fairings debris underlying the Drop Point and Stage 1 and Fairings AHAs and/or launch failure and associated physical debris and debris fallout into open waters during LauncherOne rocket launches.
- Fuel discharges into the ocean from unspent RP-1 fuel from Stage 1 when it impacts the Pacific Ocean

Acoustic Impacts

The carrier aircraft would take off from Andersen AFB and fly south to the drop point. Once at the drop point, the rocket would be released at an altitude of 35,000–40,000 ft. MSL. Within 20 seconds of releasing the rocket, it would be flying at supersonic speeds. Impulse sounds may include a SB from the LauncherOne rocket. To determine the potential for a SB, the FAA used the PCBOOM modeling program. The closest boom to the coast with a magnitude of 1.0 pounds per square foot (psf) or greater would be approximately 75 nautical miles south-southwest of Guam. Received SB levels at the water's surface would be <1 psf.

NMFS uses conservative thresholds of received sound pressure levels from broad band sounds for determining potential behavioral disturbance and injury (NMFS 2018). Noise associated with the SB is expected to transmit from the air to water and propagate some distance in the water column.

Using PCBOOM the FFA found that the predicted 1.0 psf SB would produce sound at 127.6 dB Sound Pressure Level (SPL) at the water's surface. Sohn et al (2000) studied SB decay rates to depth. All of the boom pressure signals measured by Sohn et al. (2000) decayed to ambient

The use of these terms should not be interpreted as having any meaning inconsistent with our regulatory definition of "effects of the action."

² Take" is defined by the ESA as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. NMFS defines "harass" as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." NMFS defines "harm" as "an act which actually kills or injures fish or wildlife." Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Take of species listed as endangered is prohibited at the time of listing, while take of threatened species may not be specifically prohibited unless NMFS has issued regulations prohibiting take under section 4(d) of the ESA.

levels in all frequency bands by 131-164 ft. Based on Sohn et al. (2000), a 2.0 psf SB at the surface (this is 2-4 times greater than the anticipated SB from the proposed LauncherOne activities) would have the following sound decay characteristics: at 23 ft. below the surface a 2.0 psf SB sound would decay to approximately 152 dB_{rms} re 1 µPa; at 72 ft. below the surface a 2.0 psf SB would decay to 140 dB_{rms} re 1 µPa; at 121 ft. below the surface a 2.0 psf SB would be equal to ambient noise levels.

For marine mammals, the Navy (2017), in coordination with NMFS (2018), has established acoustic thresholds using the best available science that identifies the received level of underwater sound above which exposed marine species would reasonably be expected to experience a potentially significant disruption in behavior, or to incur temporary threshold shifts (TTS) or permanent threshold shifts (PTS) of some degree.

The Navy (2017) identified acoustic thresholds in decibels (dB) (referenced to 1 µPa) that identify the onset of TTS and PTS for marine mammals experiencing non-impulsive sounds. For marine mammal species, the TTS threshold ranged from 179-199 dB and the PTS threshold ranged from 199-219 dB. The predicted SB sound levels at the water surface is 127.6 dB SPL, and sound would decay at depth as described by Sohn et. al. (2000). Direct injury and hearing impairment in marine mammals is unlikely to occur because the SB is below the TTS and PTS for marine mammals. In addition, due to the brief and infrequent nature of the SB's, masking of biologically relevant sounds is also extremely unlikely.

Very limited information exists regarding hearing and sea turtles. To date, no studies have been conducted specifically related to the onset of TTS or PTS in sea turtles. Therefore, the Navy (2017) has developed thresholds for other similar ESA consultations based on the most current literature on sea turtle and fishes (including as sharks and manta rays) hearing and recommendations made by Popper et al. (2014a) in *Sound Exposure Guidelines for Fishes and Sea Turtles*. The Navy's (2017) approach employs the same statistical methodology to derive thresholds as in NMFS' technical guidance for auditory injury of marine mammals (NOAA 2018). Based on a composite audiogram and data on the onset of TTS in fishes, an auditory weighting function was created to estimate the susceptibility of sea turtles to TTS. Data from fishes were used since there are currently no data on TTS for sea turtles and fishes are considered to have hearing more similar to sea turtles than do marine mammals (Popper et al. 2014a). Table 2 shows the results for impulsive sounds, however, we use the thresholds here as a conservative estimate of the effects of non-impulsive sounds from SBs.

Table 2. Acoustic thresholds identifying the onset of PTS and TTS for sea turtles exposed to impulsive sounds (Navy 2017).

| Hearing Group | Generalized Hearing Range | Permanent Threshold Shift Onset | Temporary Threshold Shift Onset |
|---------------|---------------------------|---|---|
| Sea Turtles | 30 Hz to 2 kHz | 204 dB re 1 µPa ² ·s SEL _{cum} 232 dB re: 1 µPa SPL (0-pk) | 189 dB re 1 µPa ² ·s SEL _{cum} 226 dB re: 1 µPa SPL (0-pk) |

Hz = hertz

O'Hara and Wilcox (1990b) found that loggerhead turtles exhibited avoidance behavior at estimated sound levels up to 175 dB_{rms}(referenced to 1 µPa), in a shallow canal. McCauley et al. (2000) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB_{rms}). At 175 dB_{rms}, both green and loggerhead turtles

displayed increased swimming speed and increasingly erratic behavior (McCauley et al. 2000a). Based on these data, we assume that sea turtles would exhibit a behavioral response when exposed to received levels of 175 dB_{rms} and higher. The predicted SB sound level at the water surface is 127.6 dB SPL, and sound would decay further to depth as per studies by Sohn et al. (2000). Direct injury and hearing impairment in marine mammals is unlikely to occur because the SB is below the TTS and PTS for marine mammals. In addition, due to the brief and infrequent nature of the SB's, masking of biologically relevant sounds is also extremely unlikely.

Direct injury and hearing impairment in marine mammals and sea turtles is unlikely to occur because SBs lack the amplitude or duration to cause any physical damage to these species underwater. Furthermore, due to the brief and infrequent nature of the SBs, masking of biologically relevant sounds is also extremely unlikely. Marine mammals or sea turtles at or near the surface when an SB occurs may startle, divert their attention to the aircraft, or avoid the immediate area by swimming away or diving. Any physiological stress and behavioral reactions would likely be short-term (seconds or minutes) and are expected to return to normal shortly after the disturbance ceases. Therefore, effects on marine mammals and sea turtles from SBs are anticipated to be minor, temporary and will not lead to a significant disruption of normal behavioral patterns. As such, the effects from SBs on marine mammals and sea turtles are considered insignificant.

For fishes, PTS has not been documented in any of the studies researching fish hearing (including sharks and manta rays) and potential impairment from various sound sources. This is attributed to the ability for regeneration of inner ear hair cells in fishes, which differs from marine mammals and sea turtles. For this reason, thresholds for fish hearing impairment only includes the SPL related to the potential onset of TTS. A TTS in fishes is considered recoverable, although the rate of recovery is based upon the degree of the TTS sustained. Thus, auditory impairment in fishes is considered recoverable over some duration; and auditory impairment thresholds are based solely on the onset of TTS for fishes.

Stadler and Woodbury (2009) reported the onset of physical injury for fish, sharks and manta rays are expected if the peak sound levels exceed 206 dB re 1 μ Pa. The SBs would be significantly less than 206 dB re 1 μ Pa in the water column. As described above, SB sound is expected to decay at depth. The probability of fishes being located at or near the surface of the water and within the limited area where SB sound would occur is low. Additionally, due to the short-term, infrequent and transient nature of the SB, sharks and manta rays would not be exposed multiple times within a short period of time, which could lead to ongoing behavioral disruptions or stress. Any physiological stress and behavioral reactions would likely be short-term (seconds or minutes) and are expected to return to normal shortly after the SB disturbance ceases. Therefore, the effects on sharks and manta rays from SBs are anticipated to be minor, temporary and will not lead to a significant disruption of normal behavioral patterns. As such the effects from SBs on sharks and manta rays are considered insignificant.

Debris Strikes

Using a statistical probability analysis for estimating direct strike impact developed by the U.S. Navy (Navy 2019), the probability of impact of debris with a single marine mammal (P) is then multiplied by the number of animals to obtain the number of exposures (T). Refer to the Appendix A for details on the methodology and assumptions. Using this procedure, P and T

were calculated for ESA-listed marine mammals (and non-ESA listed marine mammal species with the highest average month density, pantropical spotted dolphin) and the sea turtle species with the highest average month density in the AHA (green sea turtle).

VO proposes to conduct up to a maximum of ten LauncherOne launches per any one year during the 5-year operating period; the other four years will see fewer than 9 LauncherOne launches, not exceeding 25 operations across five years, and therefore fewer potential strikes.

The BE estimated the potential number of individuals impacted per year (Table 3). Training and Testing (MITT) Study Area and associated transit corridor in support of the MITT Draft Supplemental EIS/Overseas EIS (Navy 2019) identified a MITT Study Area that extends 450 nautical miles (nm) north of Guam, 250 nm east of Guam, and 300 nm south of Guam and includes the LauncherOne drop point. The transit corridor is located on the eastern edge of the MITT Study Area and is 300 nm south of the Stage 1 and Fairings Re-entry AHA. Information from the MITT Supplemental EIS/Overseas EIS provides the best available data regarding the occurrence of marine mammals in the vicinity of the proposed LauncherOne operations. Density estimates for each species are provided in Appendix A.

Table 3. Estimated Representative Marine Mammal and Sea Turtle Exposures from a Potential Direct Strike of the LauncherOne Stage 1 and Fairings in a Single Year

| Species | Estimated density in AHA | Probability of impact |
|-------------------|--------------------------|-----------------------|
| Sei whale | 0.00013 | 0.00000002 |
| Fin whale | 0.00006 | 0.00000001 |
| Green sea turtle* | 0.00039 | 0.000000005 |

*hawksbill sea turtle density was estimated at 0.000024, thus the probability of an impact would be less than green sea turtle.

The impact of debris striking a marine mammal or sea turtle may result in injury or mortality to individuals including potential strike of marine species from Stage 1 and the fairings debris underlying the Drop Point and Stage 1 and Fairings AHAs (Figure 1). For ESA-listed marine mammals, modeling based on the estimated density of individuals for each species results in estimates of the probability of a direct strike of debris with an individual during each event of 0.0000002 or less (Table 3). For green sea turtles, the probability was estimated to be 0.000000005 (hawksbill turtles have a lower estimated density and less probability than green turtles), sei whales was 0.00000002, and fin whales was estimated to be 0.00000001. The BE describes the model as being intentionally conservative and overestimates the parameters and assumptions. Thus, the results indicate that it is extremely unlikely the re-entry of Stage 1 would result in debris impacting an ESA-listed species. These probabilities are sufficiently low to reasonably conclude that it would be extremely unlikely that listed marine mammals, or green or hawksbill sea turtles, would be struck by debris as a result of conducting up to 10 LauncherOne operations/year and the impact of Stage 1 and the fairings debris in the ocean.

Sufficient density data are not available to conduct a debris strike analysis for ESA-listed fish species including for sharks and manta rays in the manner conducted above for marine mammals and sea turtles. However, it is assumed that sharks would be swimming below the surface at all times. Should debris hit the water, it is expected that the initial impact at the water's surface or even slightly below the surface, would absorb much of the energy from that impact. If they were present, ESA-listed fish would be expected to be below this initial area of impact, and therefore no direct impacts are expected.

Giant manta rays are found offshore, in oceanic waters, and near productive coastlines. Giant manta rays also appear to exhibit a high degree of plasticity in terms of their use of depths within their habitat. During feeding, giant manta rays may be found aggregating in shallow waters at depths less than 10 meters. However, tagging studies have also shown that the species conducts dives of up to 200 to 450 meters and is capable of diving to depths exceeding 1,000 meters. This diving behavior may be influenced by season and shifts in prey location associated with the thermocline. Stewart et al. (2016b) found diving behavior may be influenced by season, and more specifically, shifts in prey location associated with the thermocline, with tagged giant manta rays (n=4) observed spending a greater proportion of time at the surface from April to June and in deeper waters from August to September. For *M. birostris*, Burgess et al. (2016) used stable isotope analysis of muscle tissues of individuals collected off Ecuador and surface zooplankton to examine the giant manta ray diet. The authors found that, on average, mesopelagic sources contributed 73% to the giant manta ray's diet, compared to 27% for surface zooplankton (Burgess et al. 2016). Overall, both of these studies indicate that manta rays have a more complex depth profile of their foraging habitat than previously thought, and may actually be supplementing their diet with the observed opportunistic feeding in near-surface waters (Couturier et al. 2013; Burgess et al. 2016). While we do not have the data to precisely predict the probability of a giant manta rays being struck by debris from the proposed activities, it may be more likely that a giant manta ray would be exposed to impacts to debris than other elasmobranchs because they are more likely to occur near the surface. However, the likelihood of being stuck by debris is also expected to be extremely low for this species, given the wide distribution of individuals and the low frequency of events.

First stage and fairings debris, which is comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials, is anticipated to sink relatively quickly. Therefore, any potential interaction of ESA-listed marine species with the first stage or fairings debris is expected to be short as the relatively large and heavy items will quickly sink to the bottom of the Pacific Ocean, at depths of ~20,000 ft. As the fairings and first stage are neither chemically or biologically reactive, and they would end up at a depth of ~20,000 ft, any potential decay within the marine environment is expected to be very slow or nonexistent due to the oxygen poor environment at those extreme depths. Lastly, the number of proposed annual operations is relatively small with a potential for 1 launch in 2021, 3 in 2022, 5 in 2023, 6 in 2024, and a maximum of 10 in 2025. Therefore, the debris associated with the stage 1 and fairings components would not significantly affect ESA-listed marine species in the short term (while the debris is briefly floating or rapidly descending through the water column) or in the long term (when the debris has settled into benthic habitats at ~20,000 ft depth). Based on the above information, there is an extremely low probability of exposure to debris associated with LauncherOne operations, and NMFS has determined that effects are therefore considered discountable.

Fuel Discharges

Although extremely unlikely, ESA-listed animals may be exposed to fuel and debris discharges in the event of a launch failure. Air breathing ESA-listed marine mammals and sea turtles may respond to fuel exposure when surfacing. This exposure could irritate their mouths, eyes and mucus membranes, and may be toxic if ingested in any significant quantities. ESA listed fish would be less likely to be exposed to fuel due to remaining submerged. The propellant type used by LauncherOne is a mixture of a kerosene-based fuel (known as RP-1) and liquid oxygen

(LOX). In the event of a launch failure, and the LauncherOne rocket impacting the Pacific Ocean, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 “Very Light Oil,” which is characterized as being highly volatile and having low viscosity and low specific gravity. Due to its high volatility, RP-1 evaporates quickly when exposed to the air, and would completely dissipate within hours or days after a spill in the water (NOAA 2019). Cleanup following a spill of very light oil is usually not necessary or possible, particularly with such a small quantity of oil that would enter the ocean in the event of an unsuccessful launch. Therefore, no attempt would be made to boom or recover RP-1 fuel from the ocean. Although it would require 1–2 days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatilized rapidly because of increased agitation and dissipation. This conclusion is also applicable for any unspent RP-1 fuel that remains in the Stage 1 after a successful launch, separation from Stage 2, and when Stage 1 impacts the ocean.

Based on the above information, and low probability of marine species being beneath the LauncherOne flight trajectory, the potential for exposure to fuels in the extremely unlikely event of a launch failure is expected to be limited in scope and time, and NMFS expects the impact of unspent RP-1 fuel on ESA-listed whales, sharks, giant manta rays, and sea turtles to be low (not result in any “take”), and therefore to be insignificant.

Conclusion

Considering the information and assessments presented in the consultation request and available reports and information, and in the best scientific information available about the biology and expected behaviors of the ESA-listed marine species considered in this consultation; NMFS concurs with your determination that the proposed action is not likely to adversely affect the following ESA-listed species: endangered fin, blue, sei, Western North Pacific humpback and sperm whales; endangered Central West Pacific green turtles; endangered hawksbill turtles; endangered loggerhead turtles; threatened Eastern Pacific scalloped hammerhead sharks; threatened oceanic whitetip sharks; threatened giant manta rays. There is no critical habitat in the action area.

This concludes your consultation responsibilities under the ESA for species under NMFS’s jurisdiction. If necessary, consultation pursuant to Essential Fish Habitat would be completed by NMFS’ Habitat Conservation Division in a separate communication.

Reinitiation Notice

ESA Consultation must be reinitiated if: 1) take occurs to an endangered species, or to a threatened species for which NMFS has issued regulations prohibiting take under section 4(d) of the ESA; 2) new information reveals effects of the action that may affect ESA-listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the identified action is subsequently modified in a manner causing effects to ESA-listed species or designated critical habitat not previously considered; or 4) a new species is listed or critical habitat designated that may be affected by the action.

If you have further questions, please contact Alice Berg at alice.berg@noaa.gov. Thank you for working with NMFS to protect our nation's living marine resources.

Sincerely,

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M.1365883323 Date: 2020.12.29 14:07:24
-10'00'

Ann M. Garrett
Assistant Regional Administrator
Protected Resources Division

Cc: Lesley Grey
Leslie.grey@faa.gov
NMFS File No.: PIRO-2020-02971
PIRO Reference No.: I-PI-20-1874-AG

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<https://www.fisheries.noaa.gov/webdam/download/64572719>

Appendix A

Statistical Probability Analysis for Estimating Direct Strike Impacts to Marine Mammals and Sea Turtles from Stage 1 of the LauncherOne Rocket¹

This appendix from the Navy BE discusses the methods and results for calculating the probability of the direct strike of an ESA-listed marine mammal or sea turtle by the Stage 1 of the LauncherOne rocket within the Stage 1 and Fairings Re-entry AHA. Only marine mammals and sea turtles are analyzed using these methods because animal densities are necessary to complete the calculations, and density estimates are currently only available for marine mammals and sea turtles within the Study Area (Table A-1).

Table A-1. Summary of Density Values for Marine Mammals and Sea Turtles within the Stage 1 and Fairings Re-entry AHA

| Species | Season* | | | |
|-----------------------------|---------|---------|---------|---------|
| | Spring | Summer | Fall | Winter |
| MARINE MAMMALS | | | | |
| Blainville's beaked whale | 0.00070 | 0.0007 | 0.00070 | 0.00070 |
| Blue whale | 0.00005 | 0 | 0.00005 | 0.00005 |
| Bryde's whale | 0.00030 | 0.00030 | 0.00030 | 0.00030 |
| Common bottlenose dolphin | 0.00077 | 0.00077 | 0.00077 | 0.00077 |
| Cuvier's beaked whale | 0.00374 | 0.00374 | 0.00374 | 0.00374 |
| Dwarf sperm whale | 0.00430 | 0.00430 | 0.00430 | 0.00430 |
| False killer whale | 0.00057 | 0.00057 | 0.00057 | 0.00057 |
| Fin whale | 0.00006 | 0 | 0.00006 | 0.00006 |
| Fraser's dolphin | 0.00252 | 0.00252 | 0.00252 | 0.00252 |
| Ginkgo-toothed beaked whale | 0.00189 | 0.00189 | 0.00189 | 0.00189 |
| Humpback whale | 0.00089 | 0 | 0.00089 | 0.00089 |
| Killer whale | 0.00009 | 0.00009 | 0.00009 | 0.00009 |
| Longman's beaked whale | 0.00025 | 0.00025 | 0.00025 | 0.00025 |
| Melon-headed whale | 0.00267 | 0.00267 | 0.00267 | 0.00267 |
| Minke whale | 0.00015 | 0 | 0.00015 | 0.00015 |
| Omura's whale | 0.00004 | 0.00004 | 0.00004 | 0.00004 |
| Pantropical spotted dolphin | 0.01132 | 0.01132 | 0.01132 | 0.01132 |
| Pygmy killer whale | 0.00006 | 0.00006 | 0.00006 | 0.00006 |
| Pygmy sperm whale | 0.00176 | 0.00176 | 0.00176 | 0.00176 |
| Risso's dolphin | 0.00046 | 0.00046 | 0.00046 | 0.00046 |
| Rough-toothed dolphin | 0.00185 | 0.00185 | 0.00185 | 0.00185 |
| Sei whale | 0.00013 | 0 | 0.00013 | 0.00013 |
| Short-finned pilot whale | 0.00211 | 0.00211 | 0.00211 | 0.00211 |
| Sperm whale | 0.00222 | 0.00222 | 0.00222 | 0.00222 |
| Spinner dolphin | 0.00187 | 0.00187 | 0.00187 | 0.00187 |

| Species | Season* | | | |
|------------------------|----------|----------|----------|----------|
| | Spring | Summer | Fall | Winter |
| Striped dolphin | 0.00584 | 0.00584 | 0.00584 | 0.00584 |
| SEA TURTLES | | | | |
| Green sea turtle | 0.000390 | 0.000390 | 0.000390 | 0.000390 |
| Hawksbill sea turtle | 0.000024 | 0.000024 | 0.000024 | 0.000024 |
| Leatherback sea turtle | 0.000022 | 0.000022 | 0.000022 | 0.000022 |
| Loggerhead sea turtle | 0.000022 | 0.000022 | 0.000022 | 0.000022 |

Notes: *Numerical values are animals/km². 0 = species is not expected to be present.

Source: Navy 2018.

⁽¹⁾Adapted from Navy (2019a).

The values presented in Table A-1 are based on estimated marine mammal and sea turtle densities for the Mariana Islands Training and Testing (MITT) Study Area and associated transit corridor (Navy 2018) in support of the Public Draft Supplemental EIS/Overseas EIS (Navy 2019b). The MITT Study Area extends 450 nm north of Guam, 250 nm east of Guam, and 300 nm south of Guam. The transit corridor is located on the eastern edge of the MITT Study Area and is 300 nm south of the Stage 1 and Fairings Re-entry AHA. These density estimates are the best available data regarding the occurrence of marine mammals and sea turtles in the vicinity of the LauncherOne operations.

These calculations estimate the impact probability (P) and number of exposures (T) associated with direct impact of the LauncherOne Stage 1 on marine animals on the sea surface within the Stage 1 and Fairings Re-entry AHA. The statistical probability analysis is based on probability theory and modified Venn diagrams with rectangular “footprint” areas for the individual animal (A) and total impact (I) inscribed inside the AHA (R). The analysis is over-predictive and conservative, in that it assumes: (1) that all animals would be at or near the surface 100% of the time, when in fact, marine mammals spend the majority of their time underwater, and (2) that the animals are stationary.

1. $A = \text{length} \times \text{width}$, where the individual animal’s width (breadth) is assumed to be 20% of its length for marine mammals and 112% of its length for sea turtles. A is multiplied by the estimated number of animals N_a in the AHA (i.e., product of the highest average seasonal animal density [D] and area of AHA [R]: $N_a = D \times R$) to obtain the total animal footprint area ($A \times N_a = A \times D \times R$) in the AHA. As a conservative scenario, the total animal footprint area is calculated for the species with the highest average seasonal density (pantropical spotted dolphins).
2. $I = \text{length} \times \text{diameter of Stage 1} = \text{impact footprint area}$.

The analysis is expected to provide an overestimation of the probability of a strike for the following reasons: (1) it calculates the probability of the Stage 1 hitting a single animal at its species’ highest seasonal density, and (2) it does not take into account the possibility that an animal may not be at the water surface.

The likelihood of an impact is calculated as the probability (P) that the animal footprint (A) and the impact footprint (I) will intersect within the AHA (R). This is calculated as the area ratio A/R or I/R , respectively. Note that A (referring to an individual animal footprint) and I (referring to the impact footprint resulting from the Stage 1) are the relevant quantities used in the following calculations of single-animal impact probability [P], which is then multiplied by the number of animals to obtain the number of exposures (T). The probability that the animal in the AHA is within both types of footprints (i.e., A and I) depends on the degree of overlap of A and I. The probability that I overlaps A is calculated by adding a buffer distance around A based on one-half of the impact area (i.e., $0.5 \cdot I$), such that an impact (center) occurring anywhere within the combined (overlapping) area would impact the animal. Thus, if L_i and W_i are the length and width of the impact footprint such that $L_i \cdot W_i = 0.5 \cdot I$ and $W_i/L_i = L_a/W_a$ (i.e., similar geometry between the animal footprint and impact footprint), and if L_a and W_a are the length and width (breadth) of the individual animal such that $L_a \cdot W_a = A$ (= individual animal footprint area), then, assuming a purely static, rectangular scenario, the total area $A_{tot} = (L_a + 2 \cdot L_i) \cdot (W_a + 2 \cdot W_i)$, and the buffer area $A_{buffer} = A_{tot} - L_a \cdot W_a$. The static, rectangular impact assumes no additional aerial coverage effects of the Stage 1 beyond the initial impact.

Impact probability P is the probability of impacting one animal by the Stage 1 occurring in the area per year, and is given by the ratio of total area (A_{tot}) to AHA (R): $P = A_{tot}/R$. Number of exposures is $T = N \cdot P = N \cdot A_{tot}/R$, where N = number of animals in the AHA per year (given as the product of the animal density [D] and AHA size [R]). Thus, $N = D \cdot R$ and hence $T = N \cdot P = N \cdot A_{tot}/R = D \cdot A_{tot}$.

Using this procedure, P and T were calculated for the five species of ESA-listed marine mammals and the non-ESA listed marine mammal species with the highest average month density (pantropical spotted dolphin), and the sea turtle species with the highest average month density in the AHA (green sea turtles). The potential number of individuals impacted/year are reported in Table A-2.

Table A-2. Estimated Representative Marine Mammal and Sea Turtle Exposures from a Potential Direct Strike of LauncherOne Stage 1 in a Single Year

| Species (ESA Status) | Est. Density (km ²)* | Probability of Impact (T) | Est. No. Impacts/Year† |
|-------------------------------|----------------------------------|---------------------------|------------------------|
| Humpback whale (Endangered) | 0.00089 | 0.0000001 | 0.000001 |
| Sei whale (Endangered) | 0.00013 | 0.00000002 | 0.0000002 |
| Fin whale (Endangered) | 0.00006 | 0.00000001 | 0.0000001 |
| Blue whale (Endangered) | 0.00005 | 0.00000001 | 0.0000001 |
| Sperm whale (Endangered) | 0.00222 | 0.0000003 | 0.000003 |
| Pantropical spotted dolphin | 0.01132 | 0.0000002 | 0.000002 |
| Green sea turtle (Endangered) | 0.00039 | 0.000000005 | 0.00000005 |

Note: †Based on the maximum of 10 proposed launches in any one year of the 5-year operating period; all other years would be <9 launches/year.

*Source: Navy 2018.

Appendix References

Navy. 2018. U.S. Navy Marine Species Density Database Phase III for the Mariana Islands Training and Testing Study Area, Technical Report. Prepared for U.S. Pacific Fleet, Joint Base Pearl HarborHickam, HI by ManTech International, Solana Beach, CA. July.

Navy. 2019a. Appendix J: Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures from Military Expended Materials in Mariana Islands Training and Testing Activities Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement. Prepared for Naval Facilities Engineering Command Pacific, Pearl Harbor, HI by ManTech International, Solana Beach, CA. January.

Navy. 2019b. Mariana Islands Training and Testing Activities Draft Supplemental Environmental Impact Statement/Overseas Environmental Impact Statement. Prepared for Naval Facilities Engineering Command Pacific, Pearl Harbor, HI by ManTech International, Solana Beach, CA. January.

DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the letter addresses these DQA components, documents compliance with the DQA, and certifies that this letter has undergone pre-dissemination review.

Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this letter are Corps. Other interested users could include permittees and others interested in the conservation of listed species and their ecosystems. Individual copies of this were provided to the FHWA. The document will be available promptly at the NOAA Library Institutional Repository [<https://repository.library.noaa.gov/welcome>]. The format and naming adheres to conventional standards for style.

Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III: *Security of Automated Information Resources*, Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, and the ESA regulations, 50 CFR 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this letter contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and reviewed in accordance with Pacific Island Region ESA quality control and assurance processes.

D.2 National Historic Preservation Act (NHPA) Section 106 Consultation with the Guam Historic Resources Division



U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Associate Administrator for
Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

August 19, 2020

Mr. Patrick Lujan
State Historic Preservation Officer
Department of Parks & Recreation
490 Chalan Palasyo
Agana Heights, Guam 96910
patrick.lujan@dpr.guam.gov

RE: Section 106 Consultation for Virgin Orbit Launch Operations at Andersen Air Force Base

Dear Mr. Lujan,

The Federal Aviation Administration (FAA) is currently evaluating a proposal by Virgin Orbit, LLC (VO) to conduct commercial space launch operations at Andersen Air Force Base (AFB), Guam. To conduct commercial space launches from Andersen AFB, VO must obtain a launch license from the FAA Office of Commercial Space Transportation. Issuing a launch license is considered a major federal action under the National Environmental Policy Act (NEPA) of 1969 and requires an environmental review. The FAA is in the process of preparing an Environmental Assessment (EA) to analyze the potential environmental impacts of the proposed issuance of a launch license to VO. The U.S. Air Force's 36th Wing is participating as a cooperating agency in the preparation of the EA due to its management of Andersen AFB and jurisdiction over associated airspace. The FAA's proposed action is considered an undertaking under Section 106 of the National Historic Preservation Act (NHPA; 36 CFR 800.16(y)). The FAA plans to coordinate the Section 106 process concurrent with the FAA's NEPA process. The purpose of this letter is to initiate Section 106 consultation with the Guam State Historic Preservation Officer (SHPO) and request concurrence on the definition of the Area of Potential Effects (APE) and assessment of effects.

PROJECT DESCRIPTION

The FAA's Proposed Action is to issue a launch license to VO to conduct launches of VO's launch vehicle from Andersen AFB. VO's launch vehicle consists of a carrier vehicle (a Boeing 747-400) and a rocket, called LauncherOne. VO is proposing to conduct a maximum of 25 launches over the next 5 years (2021-2025), with a maximum of 10 launches in any given year during the 5-year period. For example, a potential launch scenario could be the following: 1 launch in 2021, 3 in 2022, 5 in 2023, 6 in 2024, and 10 in 2025. The Proposed Action does not include any construction activities. Launches would use existing infrastructure at Andersen AFB.

The carrier vehicle, a Boeing 747-400, is a four-engine, wide-body vehicle, similar to other Boeing 747 aircraft that have been extensively used in commercial passenger and cargo transport for the last few

decades (Attachment 1). To facilitate launches, the port wing of the carrier vehicle has been modified to carry both the rocket and a removable adapter, which houses the structural release mechanism, and quick release electrical and pneumatic connections to the carrier vehicle. The carrier vehicle provides electrical power, purge gasses, and monitoring and control of the rocket by a launch engineer onboard the carrier vehicle.

Pre-flight activities consist of preparing the carrier vehicle and LauncherOne for takeoff and launch, mounting and loading propellants on LauncherOne, and support operations, such as gathering and distributing telemetry. In accordance with Andersen AFB requirements, all hazardous pre-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

The carrier vehicle and LauncherOne would take off from Runway 24R at Andersen AFB and fly south to the designated drop point approximately 75 nautical miles south-southwest of Guam. LauncherOne would be carried to an altitude of approximately 35,000–40,000 feet where it would be released over the Pacific Ocean.

DEFINITION OF AREA OF POTENTIAL EFFECTS

In accordance with 36 CFR § 800.4(a)(1), the FAA has defined the APE in consideration of the undertaking's potential direct and indirect effects. The APE is defined as the airfield runways and immediately adjacent areas on Andersen AFB (Attachment 2). Because the rocket is air-launched over the Pacific Ocean at a high altitude, rocket operations south and east of Guam would not have the potential to affect historic properties.

IDENTIFICATION OF HISTORIC PROPERTIES

The APE includes potential historic properties that are part of the built environment, including the airfield proper (e.g., taxiways, runways, aprons) and the Munitions Storage Area 2 (MSA-2) Historic District. The airfield is eligible for listing in the National Register of Historic Places (NRHP) due to its use during WWII. The MSA-2 is eligible for listing in the NRHP due to its Cold War association. There are no other NRHP-listed properties or properties eligible for listing within the APE (Naval Facilities Engineering Command Marianas 2015).

The MSA-2 Historic District was first identified by Mason Architects, Inc. (2004) and recommended eligible for listing in the NRHP under Criteria A and C. The 2004 study defined the district as including “the various types of storage igloos” on MSA-2. A 2017 architectural history study of MSA-2 assessed the conditions and significance of architectural resources located within MSA-2 (Dixon et al. 2017). The same study found the Type 4 igloos and Facility 51150 (Munitions Support Equipment Maintenance) in MSA-2 to be eligible for the NRHP under Criterion A for their associations with Strategic Air Command's Cold War era nuclear program. Type 4 igloos and Facility 51150 are also eligible under NRHP Criterion C for their specialized designs that were specific to their direct roles in supporting Strategic Air Command's program. Furthermore, a historic district comprising the individually eligible structures and secondary supporting structures is eligible under NRHP Criterion A. The boundary of the district encompasses the fenced area of MSA-2.

ASSESSMENT OF EFFECTS

Routine aircraft operations at Andersen AFB have not been an issue for any previous Section 106 consultations for federal undertakings at Andersen AFB. Almost 24,000 flights of a variety of commercial

and military aircraft occur at Andersen AFB every year. Future impacts to historic properties that are part of the built environment, which include the airfield proper and MSA-2, have been addressed with Historic American Engineering Records. While both the airfield and the MSA-2 structures are built to withstand the vibrations inherent in use of the airfield (e.g., B-52s have routinely used the runways and have done their power checks on the parking aprons, exercises are routinely conducted that result in ramped-up flight activities with a variety of aircraft, and the MSA-2 structures are built to contain the effects of explosions), any damage that might result from enhanced vibrations associated with carrier vehicle takeoffs and landings on the airfield would not affect eligibility of the airfield-related properties (36 CES/CEV 2020).

The Proposed Action would not result in any ground-disturbing activities and would not require any construction or modification of facilities at Andersen AFB. Proposed carrier vehicle operations would occur on existing apron, taxiway, and runway surfaces and there would be no changes to these areas. Carrier vehicle operations would be similar to military activities currently conducted on the same aprons, taxiways, and runways. The Proposed Action represents a very small percentage of existing military operations at Andersen AFB. Given the above, the FAA is making a finding of “no historic properties affected” for the Proposed Action.

The FAA requests your concurrence on the definition of the APE and assessment of effects. **Please provide any comments you have by September 21, 2020.** If you have any questions or need additional information on the project, please contact Ms. Leslie Grey at (907) 227-2113 or via email at Leslie.Grey@faa.gov.

Sincerely,

**DANIEL P
MURRAY**

Daniel Murray

Manager, Safety Authorization Division

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Date: 2020.08.19 17:56:26
-04'00'

Enclosures:

Attachment 1 – Area of Potential Effects

References

36 CES/CEV. 2020. Status of Cultural Resources in Vicinity of Andersen AFB Runways. Personal communication via email from R. Olmo, Archaeologist and Cultural Resources Manager, 36 CES, Andersen AFB, Guam to R. Spaulding, Project Manager, ManTech International, Bainbridge Island, WA. May 17.

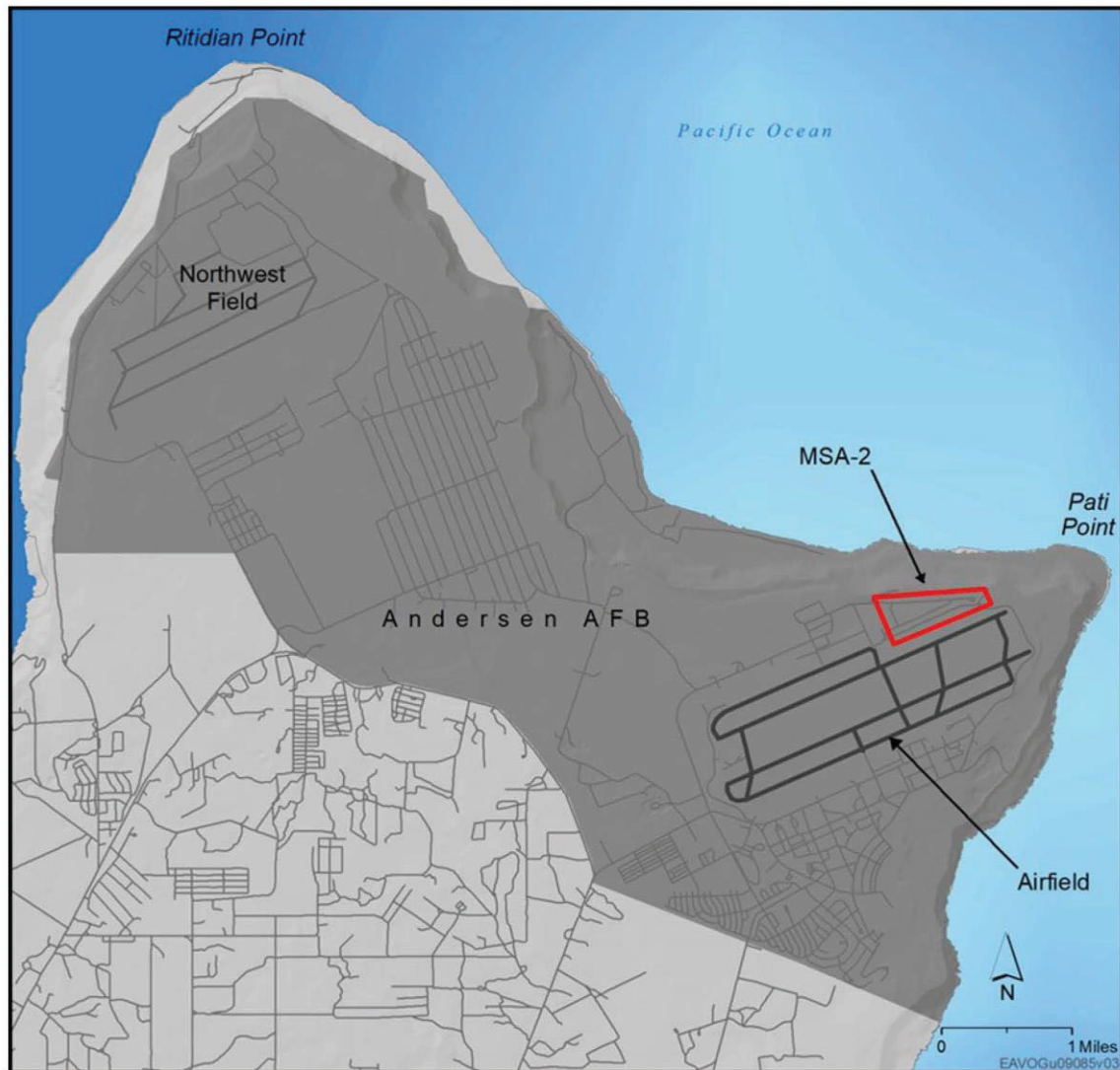
Dixon, B., T. Meiser, R. Jones, and I. Nelson. 2017. Cultural Resources Survey with the Munitions Storage Area, Andersen Air Force Base, Yigo, Guam.

Mason Architects, Inc. 2004. Historic Building and Associated Landscape/Viewsheds Inventory and Evaluation for Andersen Air Force Base, Guam, 2004 Update. Prepared for Naval Facilities Engineering Command Pacific Division, Pearl Harbor, HI.

Naval Facilities Engineering Command Marianas. 2015. Final Integrated Cultural Resources Management Plan, Andersen Air Force Base, Joint Region Marianas. Prepared by Naval Facilities Engineering Command Pacific, Joint Base Pearl Harbor-Hickam, HI. May.

Attachment 1. Carrier Vehicle with LauncherOne Attached



Attachment 2. Location of MSA-2 at Andersen AFB



Lourdes A. Leon Guerrero
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Joshua F. Tenorio
Lt. Governor

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Guam Historic Resources Division:
490 Chalan Palasyo, Agaña Heights, Guam 96910
(671) 475-6294/6355; Facsimile (671) 477-2822



Roque A. Alcantara
Director
Victor R. Villagomez
Deputy Director

October 23, 2020

In reply refer to:
RC2020-0879

Daniel Murray
Federal Aviation Administration
Office of the Associate Administrator for Commercial Space Transportation
800 Independence Ave., SW
Washington, DC 20591

Subject: Review of: Letter Regarding Section 106 Consultation for Virgin Orbit Launch Operations at Anderson Air Force Base

Mr. Murray,

We reviewed Letter Regarding Section 106 Consultation for Virgin Orbit Launch Operations at Anderson Air Force Base and the additional information sent to us by Ms. Grey. We agree that both North Field, and MSA-2 at Anderson Air Force base is also eligible for inclusion in the National Register. In the future please, visit our website and send in a Request for Assistance Form to get the proper information such as the Guam Historic Properties Inventory number for each site. This should be included in your Section 106 documentation.

Both of these sites have been mitigated by a Historic American Engineering Records and through archaeological mitigation. Therefore, we concur on the findings of no historic properties affected for the proposed action.

Should you have any questions please contact John Mark Joseph, State Archaeologist
(JohnMark.Joseph@dpr.guam.gov).

Sincerely,

Roque A. Alcantara
Acting State Historic Preservation Officer

Cc. Leslie Grey, FAA

D.3 Coastal Zone Management Act (CZMA) Consistency Determination

COASTAL ZONE MANAGEMENT ACT CONSISTENCY DETERMINATION FOR GUAM

Submitted to:

Government of Guam
Bureau of Statistics and Plans
P.O. Box 2950
Hagatna, Guam 96932

Submitted by:

Virgin Orbit, LLC
4022 E Conant Street
Long Beach, CA 90808

OCTOBER 2020

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COASTAL ZONE MANAGEMENT ACT CONSISTENCY DETERMINATION

Virgin Orbit, LLC (VO), under direction of the Federal Aviation Administration (FAA), has prepared a Draft Environmental Assessment (EA) pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA), as amended (42 United States [U.S.] Code [USC] 4321, et seq.); Council on Environmental Quality NEPA-implementing regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508); and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*. This Consistency Determination is part of VO's environmental compliance for carrier aircraft operations at Andersen Air Force Base (AFB), Guam.

VO has prepared this Consistency Determination to provide the Guam Coastal Management Program (GCMP) with VO's Consistency Determination under the Coastal Zone Management Act (CZMA) section 307(c)(1) and 15 CFR § 930, Subpart D, for aircraft activities that may have reasonably foreseeable effects on any coastal use or resource of Guam. The information in this consistency determination is provided pursuant to 15 CFR §§ 930.57 and 930.58. Proposed VO activities are described in Chapter 2 (Description of Proposed Action and Alternatives) of the Draft EA for Issuing a Launch Operator License to Virgin Orbit, LLC for LauncherOne Operations from Andersen Air Force Base, Guam. Potential environmental impacts on coastal resources are described in Chapters 3 (Affected Environment and Environmental Consequences) and 4 (Cumulative Impacts) of the Draft EA, and foreseeable coastal effects are summarized below.

The GCMP defines the "coastal zone" of Guam to include all non-federal property within the Territory, including offshore islands and the submerged lands and waters extending seaward to a distance of 3 nautical miles (nm). The United States federal government retained the rights to certain lands and mineral rights to include "all submerged lands adjacent to property owned by the United States above the line of mean high tide" in 48 USC § 1705(b)(ii). The National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resources oversees implementation of the CZMA and the GCMP provides day-to-day implementation of coastal management of waters or submerged lands outside of U.S. federal jurisdiction.

Proposed VO activities do not have the potential to affect uses and natural resources of Guam's coastal zone, as described in the attached completed GCMP Assessment Form and in the Draft EA. Per 15 CFR § 930.53, VO assessed reasonably foreseeable direct and indirect effects on Guam's defined coastal zone and Guam's resources, and reviewed relevant management programs (enforceable policies) of the GCMP in accordance with the CZMA. Proposed actions that could affect coastal uses or resources are subject to CZMA federal consistency requirements. This consistency determination has been prepared in accordance with Guam's Bureau of Statistics and Plans *Procedures Guide for Achieving Federal Consistency with the Guam Coastal Management Program*.

Based on the information, data, and analysis contained in the attached completed GCMP Assessment Form and in the enclosed Draft EA, VO finds that the proposed activities are consistent to the maximum extent practicable with the enforceable policies of the GCMP.

Pursuant to 15 CFR § 930.62, at the earliest practicable time, GCMP shall notify the Federal agency and the applicant whether the GCMP concurs with or objects to a consistency certification or object to this Consistency Determination, or to request an extension under 15 CFR § 930.62(b).

Guam CZMA Consistency Determination
Virgin Orbit Aircraft Operations at Andersen AFB

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**GUAM COASTAL MANAGEMENT PROGRAM
ASSESSMENT FORM**

DATE OF APPLICATION: October 14, 2020
NAME OF APPLICANT: Virgin Orbit, LLC
ADDRESS: 4022 E Conant Street, Long Beach, CA 90808
TELEPHONE NUMBER: 661-754-4371 Fax: Cell: 661-754-4371
E-MAIL ADDRESS: Collin.Corey@virginorbit.com

TITLE OF PROJECT:
LauncherOne Operations from Andersen Air Force Base, Guam

COMPLETE FOLLOWING PAGES

FOR BUREAU OF STATISTICS AND PLANS ONLY:

DATE APPLICATION RECEIVED:
OCRM NOTIFIED: LIC. AGENCY NOTIFIED:
APPLICANT NOTIFIED: PUBLIC NOTICE GIVEN:

OTHER AGENCY REVIEW
REQUESTED:

DETERMINATION:
() CONSISTENT () NON-CONSISTENT () FURTHER INFORMATION REQUESTED
OCRM NOTIFIED: LIC. AGENCY NOTIFIED:
APPLICANT NOTIFIED:

ACTION LOG:

1.
2.
3.
4.
5.
6.

DATE REVIEW COMPLETED:

DEVELOPMENT POLICIES (DP)**DP 1. SHORE AREA DEVELOPMENT**

Intent: To ensure environmental and aesthetic compatibility of shore area land uses.

Policy: Only those uses shall be located within the Seashore Reserve that enhance, are compatible with, or do not generally detract from the surrounding coastal area's aesthetic and environmental quality and beach accessibility; or can demonstrate dependence on such a location and the lack of feasible alternative sites.

Discussion: **Not applicable.** The Proposed Action does not include any shore area development on Guam or shore area/land-based training activities.

DP 2. URBAN DEVELOPMENT

Intent: To cluster high-impact uses to ensure coherent community design, function, infrastructure support, and environmental compatibility.

Policy: Commercial, multi-family, industrial, and resort-hotel zone uses and uses requiring high levels of support facilities shall be concentrated within appropriate zone as outlined on the Guam Zoning Code.

Discussion: **Not applicable.** The Proposed Action does not involve the development of commercial, multi-family, industrial, or resort-hotel zone uses or uses requiring high levels of support facilities.

DP 3. RURAL DEVELOPMENT

Intent: To provide a development pattern compatible with environmental and infrastructure support suitability and which can permit traditional lifestyle patterns to continue to the extent practicable.

Policy: Rural districts shall be designated in which only low-density residential and agricultural uses will be acceptable. Minimum lot size for these uses should be one-half acre until adequate infrastructure including functional sewerage is provided.

Discussion: **Not applicable.** The Proposed Action does not involve residential development and agricultural uses.

DP 4. MAJOR FACILITY SITING

Intent: To include the national interest in analyzing the siting proposals for major utilities, fuel, and transport facilities.

Policy: In evaluating the consistency of proposed major facilities with the goals, policies, and standards of the comprehensive development and coastal management plans, Guam shall recognize the national interest in the siting of such facilities, including those associated with electric power production and transmission, petroleum refining and transmission, port and air installations, solid waste disposal, sewage treatment, and major reservoir sites.

Discussion: **Not applicable.** The Proposed Action does not involve construction or siting of major utilities, fuel, or transport facilities.

DP 5. HAZARDOUS AREAS

Intent: Development in hazardous areas will be governed by the degree of hazard and the land use regulations.

Policy: Identified hazardous lands, including flood plains, erosion-prone areas, air installations, crash and sound zones, and major fault lines, shall be developed only to the extent that such development

*Guam CZMA Consistency Determination
Virgin Orbit Aircraft Operations at Andersen AFB*

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does not pose unreasonable risks to the health, safety, or welfare of the people of Guam and complies with the land use regulations.

Discussion: **Not applicable.** The Proposed Action does not involve development in hazardous areas.

DP 6. HOUSING

Intent: To promote efficient community design placed where the resources can support it.

Policy: The government shall encourage efficient design of residential areas, restrict such development in areas highly susceptible to natural and manmade hazards, and recognize the limitations of the island's resources to support historical patterns of residential development.

Discussion: **Not applicable.** The Proposed Action does not involve residential development.

DP 7. TRANSPORTATION

Intent: To provide transportation systems while protecting potentially impacted resources.

Policy: Guam shall develop an efficient and safe transportation system, while limiting adverse environmental impacts on primary aquifers, beaches, estuaries, coral reefs and other coastal resources.

Discussion: **Not applicable.** The Proposed Action does not include the development of transportation systems.

DP 8. EROSION AND SILTATION

Intent: To control development where erosion and siltation damage is likely to occur.

Policy: Development shall be limited in areas of 15 percent or greater slope by requiring strict compliance with erosion, sedimentation, and land use districting guidelines, as well as other related land use standards for such areas.

Discussion: **Not applicable.** The Proposed Action does not involve any development; therefore, erosion and siltation damage due to development would not occur.

RESOURCES POLICIES (RP)

RP 1. AIR QUALITY

Intent: To control activities to ensure good air quality.

Policy: All activities and uses shall comply with all local air pollution regulations and all appropriate federal air quality standards to ensure the maintenance of Guam's relatively high air quality.

Discussion: A comprehensive air quality impact analysis of the Proposed Action is presented in Section 3.3 (Air Quality) of the Draft EA and is summarized in the following paragraphs.

The proposed aircraft activities described in the Draft EA would occur mostly offshore of Guam, although some elements of the Proposed Action would occur within or over Andersen AFB and within or over the Guam coastal zone. Guam meets all national and local ambient air quality standards except for the area of the Cabras Power Plant, 20 miles southwest of Andersen AFB, which is in nonattainment for SO₂ primary NAAQS (U.S. Environmental Protection Agency [USEPA] 2020). The nonattainment area extends in a circle with a radius of 3.8 miles from the power-generating facilities. The study area is not within any nonattainment areas.

Most of the proposed aircraft activities would occur offshore, where attainment status is unclassified and Clean Air Act National Ambient Air Quality Standards (NAAQS) do not apply to nearer shore areas.

Pre-Flight and Post-Flight Activities

Emissions can occur from support equipment used during ground fueling operations, including trucks and equipment. Trucks would be driven to the carrier aircraft and the rocket would be fueled. Approximate travel time to the loading location is anticipated to be less than 10 minutes roundtrip. For each flight event, it is assumed that up to five trucks would be utilized. Given the small number of trucks used, and the short run-time of each truck, the total emissions from pre-flight and post-flight activities would be too small to lead to violations of the NAAQS. Five trucks operating for 1 hour each during 10 fueling operations would create approximately 0.00134 tons of carbon dioxide (CO₂) per year, and proportionately less emissions of other pollutants. Emissions associated with pre- and post-flight operations would be insignificant and would not be distinguishable from the impacts of the other flight and ground operations at Andersen AFB.

Carrier Aircraft Emissions

As described in Section 2.1, the Proposed Action would include a maximum of 10 flights per year in one year of the proposed 5-year operating period; the other 4 years would see <9 flights/year. The pollutants emitted by an aircraft during takeoff and landing operations are dependent on the emission rates and the duration of these operations. The emission rates are dependent upon the type of engine and its size or power rating. An aircraft operational cycle includes landing and takeoff operations and is termed the Landing and Take Off (LTO) cycle. An LTO cycle includes all normal operational modes performed by an aircraft between its descent from an altitude of about 3,000 ft on landing and subsequent takeoff to reach the 3,000 ft altitude. The term “operation” in this context is used by the FAA to describe either a landing or a takeoff cycle. Therefore, two operations make one LTO cycle. The aircraft LTO cycle is divided into five segments or operational “modes” and categorized by:

- landing approach (descent from about 3,000 ft to runway touch down),
- taxi/idle-in,
- taxi/idle-out,
- takeoff, and
- climb out (ascent from runway to about 3,000 ft)

The USEPA’s basic methodology for calculating aircraft emissions at any given airport in any given year can be summarized in six steps: (1) determine airport activity in terms of the number of LTOs; (2) determine the mixing height to be used to define an LTO cycle; (3) define the fleet make-up at the airport; (4) estimate time-in-mode (TIM); (5) select emission factors; and (6) calculate emissions based on the airport activity, TIM, and aircraft emission factors.

The emissions for the Proposed Action are based on the time of operation in each mode and the emission rates of the carrier aircraft engines. The time in the landing approach and climb-out modes are assumed to be 4.7 minutes and 3.0 minutes, respectively. The anticipated takeoff time is 0.5 minute and represents the time for initial climb from ground level to about 500 ft. The time in taxi/idle mode has been estimated as 15 minutes for both taxi/idle in and taxi/idle-out (FAA 2017).

Aircraft emissions for criteria pollutants were calculated by multiplying the TIM against respective emission factors and number of estimated flights. The increase in carrier aircraft

activities would result in a corresponding increase in criteria and precursor pollutant emissions. Although all would increase under the Proposed Action, air pollutant emissions under the Proposed Action would not result in violations of NAASQ because they would not have a measurable impact on air quality. Estimated emissions from the Proposed Action would account for less than 1% of the allowable emissions.

The USEPA has listed 188 hazardous air pollutants regulated under Title III (Hazardous Air Pollutants), Section 112(g) of the Clean Air Act. Hazardous air pollutants are emitted by processes associated with the Proposed Action, including fuel combustion. The amounts of hazardous air pollutants emitted are small compared to the emissions of criteria pollutants; emission factors for most hazardous air pollutants from combustion sources are roughly three or more orders of magnitude lower than emission factors for criteria pollutants. Hazardous air pollutant emissions estimates were not calculated because of the small amounts that would be emitted.

Under the Proposed Action, hazardous pollutant emissions would increase, and the increases would be roughly proportional to the increases observed for the criteria air pollutants emitted. Hazardous air pollutants emissions would be intermittent and distributed over the Andersen AFB study area. Their concentrations would be further reduced by atmospheric mixing and other dispersion processes. After initial mixing, it is possible that hazardous pollutants would be measurable, but they would be in very low concentrations and would not affect the air quality in the region. Therefore, no significant impacts to air quality would occur under the Proposed Action.

Based on the above analysis, VO finds that the proposed aircraft activities at Andersen AFB are fully consistent with the enforceable policy regarding air quality of the GCMP.

RP 2. WATER QUALITY

Intent: To control activities that may degrade Guam's drinking, recreational, and ecologically sensitive waters.

Policy: Safe drinking water shall be ensured and aquatic recreation sites shall be protected through the regulation of uses and discharges that pose a pollution threat to Guam's waters, particularly in estuaries, reefs, and aquifer areas.

Discussion: Carrier Aircraft Operations at Andersen AFB – The Proposed Action does not involve construction activities that would potentially introduce non-point source pollution at Andersen AFB. The potential impact of operations is negligible as the LauncherOne propellants and pressurants are similar to those already in use at Andersen AFB with appropriate safety and pollution control measures in place. Any accidental spills associated with pre- and post-flight activities would be addressed by Andersen AFB emergency response procedures (refer to Draft EA Section 3.9). Therefore, implementation of the Proposed Action would not have significant impacts on water resources on Andersen AFB.

Based on the above analysis, VO finds that the proposed aircraft activities at Andersen AFB are fully consistent with the enforceable policy on drinking, recreational, and ecologically sensitive waters of the GCMP.

RP 3. FRAGILE AREAS

Intent: To protect significant cultural areas, and natural marine and terrestrial wildlife and plant habitats.

Policy: Development in the following types of fragile areas, including Guam's marine protected areas, shall be regulated to protect their unique character.

- Historical and archeological sites
- Wildlife habitats

Guam CZMA Consistency Determination
Virgin Orbit Aircraft Operations at Andersen AFB

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- Pristine marine and terrestrial communities
- Limestone forests
- Mangrove stands and other wetlands
- Coral reefs

Discussion: The proposed aircraft activities do not include any development activities. The Draft EA provides detailed analyses of impacts on fragile areas (i.e., cultural and biological resources) listed above including federally owned lands.

Historical and Archeological Sites. Section 3.6 (Cultural Resources) discusses cultural resources on Andersen AFB. Routine aircraft operations at Andersen AFB have not been an issue for any previous National Historic Preservation Act (NHPA) Section 106 consultations. Future impacts to historic properties that are part of the built environment, which include the airfield proper (eligible for its WWII inception) and MSA-2 (eligible for its Cold War association), have been addressed with Historic American Engineering Records. While both the airfield and the MSA-2 structures are built to withstand the vibrations inherent in use of the airfield (e.g., B-52s have routinely used the runways and have done their power checks on the parking aprons, exercises are routinely conducted that result in ramped-up flight activities with a variety of aircraft, and the MSA-2 structures are built to contain the effects of explosions), any damage that might result from enhanced vibrations associated with the proposed B-747 carrier aircraft operations on the airfield would not affect eligibility of the airfield-related properties (36th Civil Engineer Squadron Environmental Flight [36 CES/CEV] 2020).

The Proposed Action, known as an undertaking per NHPA Section 106, would not result in any ground-disturbing activities and would not require any construction or modification of facilities at Andersen AFB. Proposed carrier aircraft operations would occur on existing apron, taxiway, and runway surfaces and there would be no changes to these areas under the Proposed Action. Carrier aircraft operations would be similar to military activities currently conducted on the same aprons, taxiways, and runways. Therefore, the Proposed Action would not result in significant impacts on historical, architectural, archeological, or cultural resources. The FAA has made a finding of No Historic Properties Affected in accordance with 36 CFR § 800.

Wildlife Habitats. **Not applicable.** Section 3.9 (Biological Resources) discusses wildlife and associated habitat on Andersen AFB. There would be no ground-disturbing activities associated with the Proposed Action and proposed aircraft operations would not impact wildlife habitat.

Pristine Marine and Terrestrial Communities. Section 3.9 (Biological Resources) of the Draft EA discusses marine and terrestrial communities. The Proposed Action does not involve land- or marine-based areas on Guam or activities that would affect terrestrial or marine communities on Guam.

Limestone Forests, Mangrove Stands, and Other Wetlands. **Not applicable.** The Proposed Action does not involve land-based areas on Guam or activities that would affect limestone forests, mangrove stands, and other wetlands on Guam.

Coral Reefs. **Not applicable.** The Proposed Action does not involve marine-based areas on Guam or activities that would affect coral reefs on Guam.

Aircraft activities occurring 3 nm beyond Guam would not result in effects to Guam coastal zone waters. Based on the analysis presented in the Draft EA, Section 3.6 (Cultural Resources) and Section 3.9 (Biological Resources) and information summarized above, VO has determined that the Proposed Action would be carried out in a manner that would protect

submerged cultural resources, and natural marine wildlife and plant habitats, from disruption and minimize adverse impacts on these fragile resources. Based on the above analysis, VO finds that the proposed aircraft activities at Andersen AFB are fully consistent with the enforceable policy on fragile areas of the GCMP.

RP 4. LIVING MARINE RESOURCES

Intent: To protect marine resources in Guam's waters.

Policy: All living resources within the waters of Guam, particularly fish, shall be protected from overharvesting and, in the case of corals, sea turtles, and marine mammals, from any taking whatsoever.

Discussion: Section 3.9 (Biological Resources) of the Draft EA provides analyses of impacts on biological resources, including marine resources. Based on the analysis presented in the Draft EA, Section 3.9 (Biological Resources), VO has determined that the Proposed Action would be carried out in a manner that would not impact marine resources. Aircraft activities occurring 3 nm beyond Guam would not result in effects to living marine resources in Guam coastal zone waters. Therefore, VO finds that the proposed aircraft activities at Andersen AFB are fully consistent to the maximum extent practicable with the enforceable policy to provide protection for living marine resources within the waters of Guam of the GCMP.

RP 5. VISUAL QUALITY

Intent: To protect the quality of Guam's natural scenic beauty.

Policy: Preservation and enhancement of, and respect for, the island's scenic resources shall be encouraged through increased enforcement of and compliance with sign, litter, zoning, subdivision, building, and related land-use laws. Visually objectionable uses shall be located to the maximum extent practicable so as not to degrade significant views from scenic overlooks, highways, and trails.

Discussion: **Not applicable.** All proposed aircraft activities would be in the areas currently used for aircraft activities, including military activities at Andersen AFB, and would have no impact on the aesthetic quality of the island of Guam's scenic views. There would be no reasonably foreseeable direct or indirect effects to the uses and resource of the Guam coastal zone from impacts on visual quality from proposed aircraft activities at Andersen AFB.

RP 6. RECREATION AREAS

Intent: To encourage environmentally compatible recreational development.

Policy: The Government of Guam shall encourage development of varied types of recreational facilities located and maintained to be compatible with the surrounding environment and land uses, adequately serve community centers and urban areas, and protect beaches and such passive recreational areas as wildlife, marine conservation and marine protected areas, scenic overlooks, parks, and historical sites.

Developments, activities, and uses shall comply with the Guam Recreational Water Use Management Plan.

Discussion: **Not applicable.** The Proposed Action does not involve recreational development.

RP 7. PUBLIC ACCESS

Intent: To ensure the right of public access.

Policy: The public's right of unrestricted access shall be ensured to all non-federally owned beach areas and all Guam recreation areas, parks, scenic overlooks, designated conservation areas, and their public lands. Agreements shall be encouraged with the owners of private and federal property for the provision of releasable access to and use of resources of public nature located on such land.

Discussion: **Not applicable.** The Proposed Action does not involve restrictions to public access to non-federally owned beach areas, Guam recreation areas, parks, scenic overlooks, designated conservation areas, and their public lands.

RP 8. AGRICULTURAL LANDS

Intent: To stop urban types of development on agricultural land.

Policy: Critical agricultural land shall be preserved and maintained for agricultural use.

Discussion: **Not applicable.** The Proposed Action does not involve development on agricultural land.

REFERENCES

- 36 CES/CEV. 2020. Status of Cultural Resources in Vicinity of Andersen AFB Runways. Personal communication via email from R. Olmo, Archaeologist and Cultural Resources Manager, 36 CES, Andersen AFB, Guam to R. Spaulding, Project Manager, ManTech International, Bainbridge Island, WA. May 17.
- FAA. 2017. Final Environmental Assessment and Finding of No Significant Impact for Issuing a License to Virgin Orbit (LauncherOne), LLC for LauncherOne Launches at the Mojave Air and Space Port, Kern County, California. July.
- USEPA. 2020. Status of Guam Designated Areas, Guam Areas by NAAQS. https://www3.epa.gov/airquality/urbanair/sipstatus/reports/gu_areabypoll.html. Last updated May 23; accessed May 24.

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Virgin Orbit Aircraft Operations at Andersen AFB

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Guam CZMA Consistency Determination
Virgin Orbit Aircraft Operations at Andersen AFB

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FEDERAL CONSISTENCY SUPPLEMENTAL INFORMATION FORM

Date: October 14, 2020

Project/Activity Title or Description: LauncherOne Operations from Andersen AFB as described in the Draft EA for Issuing a Launch Operator License to Virgin Orbit, LLC for LauncherOne Operations from Andersen Air Force Base, Guam

Location: Andersen AFB

Other applicable area(s) affected, if appropriate:

Est. Start Date: March 2021 Est. Duration: 5 years

APPLICANT

Name & Title: Collin Corey, Manager, Systems Engineering/FAA Launch License

Agency/Organization: Virgin Orbit, LLC

Address: 4022 E Conant St.

Long Beach, CA Zip Code: 90808

Telephone No. during business hours:

A/C (661) 754-4371

E-mail Address: Collin.Corey@virginorbit.com

AGENT

Name & Title: Rick Spaulding, Senior Project Manager

Agency/Organization: ManTech International Corp.

Address: 6765 NE Day Rd, Bainbridge Island, WA Zip Code: 98110

Telephone No. during business hours:

(206) 855-4997 (office)

(206) 890-2400 (cell)

E-mail Address: Rick.Spaulding@mantech.com

CATEGORY OF APPLICATION (check one only)

- () I Federal Agency Activity
- (X) II Permit or License
- () III Grants & Assistance

*Guam CZMA Consistency Determination
Virgin Orbit Aircraft Operations at Andersen AFB*

October 2020

TYPE OF STATEMENT (check one only)

- ☒ Consistency
☐ General Consistency (Category I only)
☐ Negative Determination (Category I only)
☐ Non-Consistency (Category I only)

APPROVING FEDERAL AGENCY (Categories II & III only)

Agency: Federal Aviation Administration
Contact Person: Leslie Grey
Telephone No. during business hours: (907) 227-2113

FEDERAL AUTHORITY FOR ACTIVITY

Title of Law: 51 USC Chapter 509, Commercial Space Launch Activities
Section: 50905, License Applications and Requirements

OTHER GUAM APPROVALS REQUIRED

Date of: _____

| Agency | Type of Approval | Date of Application | Status |
|--------|------------------|---------------------|--------|
| _____ | _____ | _____ | _____ |
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Lourdes A. Leon Guerrero
Governor of Guam

Joshua F. Tenorio
Lieutenant Governor



**BUREAU OF
STATISTICS & PLANS**
SAGAN PLANU SIHA YAN EMFOTMASION

Government of Guam
P.O. Box 2950 Hagåtña, Guam 96932
Tel: (671) 472-4201/3
Fax: (671) 477-1812



Tyrone J. Taitano
Director
Matthew Santos
Deputy Director

DEC 10 2020

Collin Corey
Manager, Systems Engineering
Virgin Orbit, LLC
4022 E Conant Street
Long Beach, CA 90808

RE: Coastal Zone Management Act (CZMA) Federal Consistency Review for Virgin Orbit, LLC's proposed LauncherOne Operations at Andersen Air Force Base (GCMP FC No. 2020-0020)

Hafa adai! The Guam Coastal Management Program of the Bureau of Statistics and Plans (Bureau) has completed its review of the Federal Consistency Certification by Virgin Orbit, LLC received on October 14, 2020. Virgin Orbit, LLC ("the applicant") is an applicant for a Commercial Space Launch license from the Federal Aviation Administration for its proposed LauncherOne Operations at Andersen Air Force Base, an activity with an effect on a coastal use or resource within Guam.

The Bureau coordinated this review with partnering agencies, provided Public Notice, and received no comments. Furthermore, the Bureau hereby concurs with the applicant's certification that the proposal is consistent with the enforceable policies of the Bureau's Guam Coastal Management Program (GCMP) based upon the following comments and conditions:

Resource Policy 1. Air Quality. *All activities and uses shall comply with all local air pollution regulations and all appropriate Federal air quality standards in order to ensure the maintenance of Guam's relatively high air quality.*

The proposed carrier aircraft activity would involve emissions from support equipment during fueling operations and carrier aircraft operation.

Pursuant to Resource Policy 1, Air Quality, the applicant shall comply with the provisions of the Air Pollution Control Act, 10 GCA Chapter 49.

Resource Policy 2. Water Quality. *Safe drinking water shall be assured and aquatic recreation sites shall be protected through the regulation of uses and discharges that pose a pollution threat to Guam's waters, particularly in estuarine, reef and aquifer areas.*

The carrier aircraft activities are based in Andersen Air Force Base, which is located over the Northern Guam Lens Aquifer. The applicant represents that any accidental spills associated with pre- and post-flight activities would be addressed

Guam Coastal Management Program-Land Use Planning-Socio-Economic Planning-Planning Information-Business & Economic Statistics Program

GCMP FC No. 2020-0020

RE: Virgin Orbit, LLC's proposed LauncherOne Operations
Andersen Air Force Base

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by Andersen Air Force Base's emergency response procedures. Ground operations may have water impacts.

Pursuant to Resource Policy 2, Water Quality, the applicant shall comply with the Water Pollution Control Act, 10 GCA Chapter 47.

Resource Policy 4. Living Marine Resources. *All living resources within the territorial waters of Guam, particularly corals and fish, shall be protected from over harvesting and, in the case of marine mammals, from any taking whatsoever.*

There is potential take of endangered marine species, particularly Green sea turtles and a number of marine mammals. Based upon the estimated impacts per year, it appears that annual probability of take is approximately 0.0006% based upon 10 launches per year. It should be noted, however, that any take would most likely occur from Stage 1 or Fairings Re-entry, both of which would occur within the designated Aircraft Hazard Areas, which are outside of the Guam's coastal zone.

Pursuant to Resource Policy 4, Living Marine Resources, the applicant shall consult with the Guam Department of Agriculture's Division of Aquatic and Wildlife Resources should there be unanticipated impacts to endangered or threatened species within Guam's coastal zone.

Therefore, based on the conditional concurrence stated above and the Bureau's review of all other information submitted, we find the application to be consistent with the approved development and resource policies of the Guam Coastal Management Program (GCMP), in accordance with the Coastal Zone Management Act of 1972, (P.L. 92-583) as amended, (P.L. 94-370). The Federal Consistency concurrence, however, does not preclude the need for securing other federal and Government of Guam permits, clearances and approvals prior to the start of this project.

Per 15 CFR §930.4(b), if the requirements for conditional concurrences specified in 15 CFR §930.4(a), (1) through (3), are not met, then all parties shall treat this conditional concurrence letter as an objection pursuant to 15 CFR Part 930 subpart D. Furthermore, if an objection is determined, you are hereby notified that, pursuant to 15 CFR §930.63(e) and 15 CFR Part 930, subpart H, you have the opportunity to appeal an objection resulting from not meeting the requirements of 15 CFR §930.4(a), (1) through (3), to the Secretary of Commerce within 30 days after receiving this conditional concurrence letter, or 30 days after receiving notice from the Federal agency that your application will not be approved as amended by the conditions required by this concurrence.

The proposed action shall be operated and completed as represented in the Coastal Zone Management (CZM) federal consistency certification. Significant changes to the subject proposal shall be submitted to the Bureau for review and approval and may require a full CZM federal consistency review, including publication of a public notice and provision for public review and comment. This condition is necessary to ensure that the proposed actions are implemented as reviewed for consistency with the enforceable policies of GCMP. Guam Land Use

GCMP FC No. 2020-0020

RE: Virgin Orbit, LLC's proposed LauncherOne Operations
Andersen Air Force Base

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policies (E.O. 78-37), are the federally approved enforceable policies of GCMP that applies to this condition.

Please do not hesitate to contact Mr. Julian Janssen, Federal Consistency Coordinator at 475-9664 or email julian.janssen@bsp.guam.gov or Mr. Edwin Reyes, Coastal Program Administrator at 475-9672 or email edwin.reyes@bsp.guam.gov. *Si Yu'os Ma'ase'.*

Sincerely,



TYRONE TAITANO
Director

Cc: FAA
NOAA-OCM
DoAgr-DAWR
DLM
DPR-SHPO
GEPA
GWA