DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration
Office of Commercial Space Transportation

Finding of No Significant Impact and Record of Decision
for
Tiered Environmental Assessment for SpaceX Starship Indian Ocean Landings

Summary

In 2022, the Federal Aviation Administration (FAA) prepared a Final Programmatic Environmental Assessment (PEA) to analyze the potential environmental impacts of issuing an experimental permit(s) and/or a vehicle operator license to SpaceX for Starship/Super Heavy launch operations at its existing Boca Chica Launch Site in Cameron County, Texas. The federal action also included the FAA's issuance of temporary airspace closures. The Mitigated Finding of No Significant Impact and Record of Decision for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Chica Launch Site in Cameron County, Texas was issued in June 2022.

The FAA prepared the attached Final Tiered Environmental Assessment (EA) to analyze the potential environmental impacts of modifying SpaceX's vehicle operator license for Starship Super/Heavy launches from Boca Chica (VOL-23-129) that would allow SpaceX to land its Starship launch vehicle in the Indian Ocean. The Final Tiered EA was prepared in accordance with the National Environmental Policy Act of 1969, as amended (NEPA); 42 United States Code [U.S.C.] § 4321 et seq.); Council on Environmental Quality (CEQ) NEPA-implementing regulations (40 Code of Federal Regulations [CFR] parts 1500 to 1508); and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*.

After reviewing and analyzing this EA, including all available data and information on existing conditions and potential impacts, the FAA has determined that modifying SpaceX's vehicle operator license supporting Starship Indian Ocean landings would not significantly impact the quality of the human environment within the meaning of NEPA. Therefore, the preparation of an Environmental Impact Statement is not required, and the FAA is independently issuing this Finding of No Significant Impact (FONSI) and Record of Decision (ROD). The FAA has made this determination in accordance with

applicable environmental laws and FAA regulations. The Final Tiered EA is incorporated by reference into this FONSI/ROD.

For any questions or to request a copy of the Final Tiered EA, contact the following FAA Environmental Protection Specialist. A copy of the Final Tiered EA may also be obtained from the FAA's website: https://www.faa.gov/space/stakeholder_engagement/spacex_starship

Amy Hanson
Environmental Protection Specialist
Federal Aviation Administration
800 Independence Ave., SW, Suite 325
Washington DC 20591
Amy.Hanson@faa.gov
847-243-7609

Purpose and Need

The purpose of SpaceX's proposal is to provide greater mission capability to the National Aeronautics and Space Administration (NASA), Department of Defense, and commercial customers. SpaceX's activities would continue to fulfill U.S. expectation that space transportation costs are reduced to make continued exploration, development, and use of space more affordable. The Space Transportation section of the National Space Transportation Policy of 1994 addressed the commercial launch sector, stating that "assuring reliable and affordable access to space through U.S. space transportation capabilities is fundamental to achieving National Space Policy goals."

The purpose of SpaceX's proposal is to enhance operational capabilities of Starship/Super Heavy launches by extending the operational area to include the Indian Ocean. The need for expanding into the Indian Ocean stems from the increasing complexity and requirements of the Starship mission objectives. The current operational constraints limit optimization of launch trajectories and decrease the probability of success for early mission objectives. Landing operations in the Indian Ocean would give SpaceX the flexibility to design and execute launch trajectories that meet mission objectives.

Proposed Action

SpaceX's Proposed Action is to conduct up to a total of ten nominal operations, including up to a maximum of five overpressure events from Starship intact impact and up to a total of five reentry debris or soft water landings in the Indian Ocean, within a year of issuance of a concurrence letter from that

National Marine Fisheries Service (NMFS). The following subsections provide a description of the project's location and proposed reentry operations.

Federal Action

The FAA's federal action is modifying SpaceX's vehicle operator license that would allow SpaceX to land its Starship vehicle in the Indian Ocean, along with potential renewals and modifications to licenses within the scope of operations analyzed in the Final Tiered EA. In addition, the FAA's federal action also includes issuance of temporary airspace closures for Starship reentry operations.

Alternatives

Alternatives analyzed in the EA include (1) the Proposed Action and (2) the No Action Alternative. The No Action alternative provides the basis for comparing the environmental consequences of the Proposed Action. Under the No Action Alternative, the FAA would not modify a license to SpaceX for landing the Starship vehicles in the Indian Ocean. In this situation, as permitted under existing licenses, SpaceX could land the Starship vehicle at the VLA or downrange in the Gulf of Mexico, or Pacific Ocean (on a floating platform or expended in the Pacific Ocean).

Environmental Impacts

The potential environmental impacts of the Proposed Action and No Action Alternative were evaluated in the attached Final Tiered EA for each environmental impact category identified in FAA Order 1050.1F. Chapter 3 of the Final Tiered EA describes the affected environment and regulatory setting and identifies the environmental impact categories that are not analyzed in detail: Air Quality and Climate, Noise and Noise-Compatible Land Use, Visual Effects, Cultural Resources, Department of Transportation Act Section 4(f), Water Resources, Coastal Resources, Land Use, Hazardous Materials, Solid Waste, and Pollution Prevention, Natural Resources and Energy Supply, and Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks. Chapter 3 of the Final Tiered EA also provides evaluations of the potential environmental consequences of the Proposed Action for Biological Resources and documents the finding that no significant environmental impacts would result from the Proposed Action. A summary of the documented findings for Biological Resources, including requisite findings with respect to relevant special purpose laws, regulations, and executive orders, is presented below.

- **Biological Resources (Marine Environment)**, Final Tiered EA Section 3.3. Under the Proposed Action, Starship operations would occur in the Indian Ocean. Starship may land or, in the event of an anomaly or early unmanned missions, be expended in the ocean no closer than 200 nautical miles offshore. SpaceX will, to the maximum extent practicable, avoid areas determined to be sensitive to disturbance or highly productive and presumed to have an increased probability of supporting higher densities of marine life. These areas include seamounts, upwellings, coastal areas, coral reefs, and other predominant oceanic habitat areas; these habitats are not described in detail due to their exclusion from the Proposed Action.

  Direct strikes by debris from Starship are extremely unlikely for all species of concern, fish, sea turtles, and marine mammals. This is due to the small size of the components as compared to the vast open ocean in addition to the low population density of marine life within the landing area. If debris from the vehicle struck an animal near the water's surface, the animal would be injured or killed. Additionally, there are no known interactions with any of these species after decades of similar rocket launches and reentries. Given the low frequency of the Starship/Super Heavy ocean descent and landing operations, and the fact that marine wildlife, marine mammals, and special status species spend the majority of their time submerged as opposed to on the surface, it is extremely unlikely that any adverse impacts from fallen objects would occur.

  SpaceX expects residual liquid oxygen (LOX) and methane to remain on Starship during descent and landing. Unlike other launch vehicle propellants and fuels, LOX and methane are not toxic pollutants. Starship is expected to experience an explosive event upon impact with the ocean's surface and subsequent vehicle failure. When Starship is not configured to survive atmospheric reentry, the vehicle would tumble and break apart as it descends through the atmosphere, and residual fuel would be dispersed and evaporated before reaching the ocean's surface such that only structural debris would remain. Structural debris of Starship is made of inert materials, such as steel, carbon composite, silica heat tiles and is not anticipated to affect water quality. For these reasons, after considering the new information, the chance for marine species to be exposed to the residual propellant is still extremely low and therefore discountable.

  Sonic booms that would occur during descent and landing would intercept the ocean's surface. However, exceptionally little energy from in-air noise is transmitted into water. Due to the limited occurrences of ocean landings, the low magnitude of the sonic booms (no greater than 2 pounds/sq. ft. (psf) for Starship), the substantial attenuation of the sonic booms at the air/water

interface, and the exponential attenuation with water depth, sonic booms would not result in impacts on marine species beneath the surface, even when the new information regarding the vehicle landings is considered.

Indirect Effects

Water quality would not be impacted by residual fuel remaining after a Starship breakup. Starship is expected to experience an explosive event upon impact with the ocean's surface and subsequent vehicle failure. The explosive event would be expected to consume all remaining fuel. As all liquid fuel is likely to be consumed during vehicle breakup, only structural debris would remain. For events where the vehicle would break up in the atmosphere, residual propellant would be dispersed and evaporated such that only structural debris would remain. Structural debris is made of inert materials, such as steel, carbon composite, silica heat tiles and is not anticipated to affect water quality. In the event of an intact landing without vehicle breakup, residual propellant would be retained and not released into the ocean but may eventually warm up, turn gaseous, and vent to the atmosphere through open valves. Accordingly, indirect effects on biological resources resulting from water quality changes attributable to the Proposed Action should be considered insignificant (not measurable) (NMFS 2024).

It is unlikely bioaccumulation would measurably impact marine species for the following reasons: (1) the few landing events included in the Proposed Action would limit the amount of chemicals that could become available for trophic transfer; and (2) the discreet localized areas where fragments would descend to benthic habitats. Therefore, indirect effects to biological resources from bioaccumulation of expended Starship components would be insignificant and not measurable.

Prey availability could be further impacted by fallen objects generated by the overpressure event as they strike the surface and descend through the water column. Secondary impacts on fish could occur after the Starship fragments sink to the seafloor. Over time, the fragments may be colonized by marine organisms that attach to hard surfaces, with a greater probability of colonization at shallower depths within the photic zone (down to about 200 m). For fishes that feed on these types of organisms, or whose abundances are limited by available hard structural habitat, the fragments that sink during an overpressure event could provide an incidental beneficial impact. The sound from an overpressure event might induce startle reactions and

temporary dispersal of schooling fishes if they are within close proximity, however, uninjured fish would likely resume normal activities in a short period after the initial stimulus. Invertebrate prey species, including krill, jellyfish, and other planktonic species, in the immediate vicinity of an explosion and overpressure event would be directly affected with the potential for injury or mortality. Farther from the impact site, these species are less likely to be affected by changes in pressure since many are generally the same density as water and few, if any, have air cavities that would function like the fish swim bladder in responding to a pressure change. Invertebrates directly affected by an event would represent only a marginal fraction of the overall abundance of prey available to cetaceans and sea turtles in the Indian Ocean. Therefore, indirect effects to biological resources associated with prey availability would not be measurable or expected to occur.

ESA Section 7 Consultation

On February 7th, 2024, FAA initiated informal consultation with NMFS for Indian Ocean Landings for the SpaceX Starship/Super Heavy at Boca Chica. FAA determined that the Proposed Action may affect but is unlikely to adversely affect all ESA-listed sharks, sea turtles, and marine mammals potentially present within the Action Area (See Table 1 of the EA for a complete listing of all potentially present ESA-listed species). On March 7, 2024, NMFS provided concurrence. Overall impacts on biological resources, considering the new information related to the Proposed Action, would not be expected to result in significant impacts on marine habitats and wildlife (EA Section 3.3, pages 3-27).

Public Involvement

Neither NEPA, nor the CEQ implementing regulations, nor applicable FAA guidance requires the FAA to solicit public comments or hold public hearings or meetings for a tiered EA, or for any EA. In this case, given the extensive public engagement opportunities for the PEA and the limited scope of the tiered EA, the FAA did not believe that additional public engagement for the tiered EA would have been productive.

On March 12, 2024, the FAA published the Final Tiered EA and FONSI/ROD on the FAA's website at https://www.faa.gov/space/stakeholder_engagement/spacex_starship.

Conditions

As prescribed by 40 CFR §1505.3, 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 SpaceX implements avoidance and minimization measures as set forth in Chapter 3 of the Final Tiered EA under Biological Resources. The NMFS concurrence letter includes the following discretionary conservation recommendations:

- SpaceX will perform landings in the Indian Ocean greater than 200 nm from any land area. Areas within 200 nm of land in the Indian Ocean are not planned to be used for landings and are therefore excluded from the Action Area.
- SpaceX will, to the maximum extent practicable, avoid areas determined to be sensitive to disturbance or highly productive and presumed to have an increased probability of supporting higher densities of marine life, including:
    - Important Marine Mammal Areas (IMMAs): IMMAs are defined as discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation;
    - Ecologically or Biologically Significant Area (EBSA). An EBSA is an area of the ocean that has special importance in terms of its ecological and biological characteristics: for example, by providing essential habitats, food sources or breeding grounds for particular species;
- SpaceX would avoid if possible, locations that include physiographic features (e.g., plateaus, ridges, spreading zones, known seamounts and ocean vents)

The NMFS concurrence letter also includes the following project design criteria and reporting requirements:

- After each Starship-Super Heavy flight, FAA will provide information to NMFS detailing the results of launch and landings, based on available telemetry data received from the vehicles, including:
    - Whether Starship and Super Heavy resulted in an anomaly or nominal landing, and where (expressed in the last known GPS location) the anomaly or landing occurred.

- The debris catalog generation, approximate location, and any other information that can corroborate assumptions about the debris and/or debris field from a launch failure anomaly (of each vehicle).
- Whether Starship landings occurred in the expected manner (i.e., belly flop or soft-water landing or atmospheric breakup with debris field within the Indian Ocean landing area). For landings resulting in explosion, information reported to NMFS shall include the amount of fuel/propellant remaining in main and header tanks, Starship orientation upon landing, debris catalog generation, and any other data that can corroborate whether the assumptions about the explosion and area of impact (physically and acoustically) were appropriate.

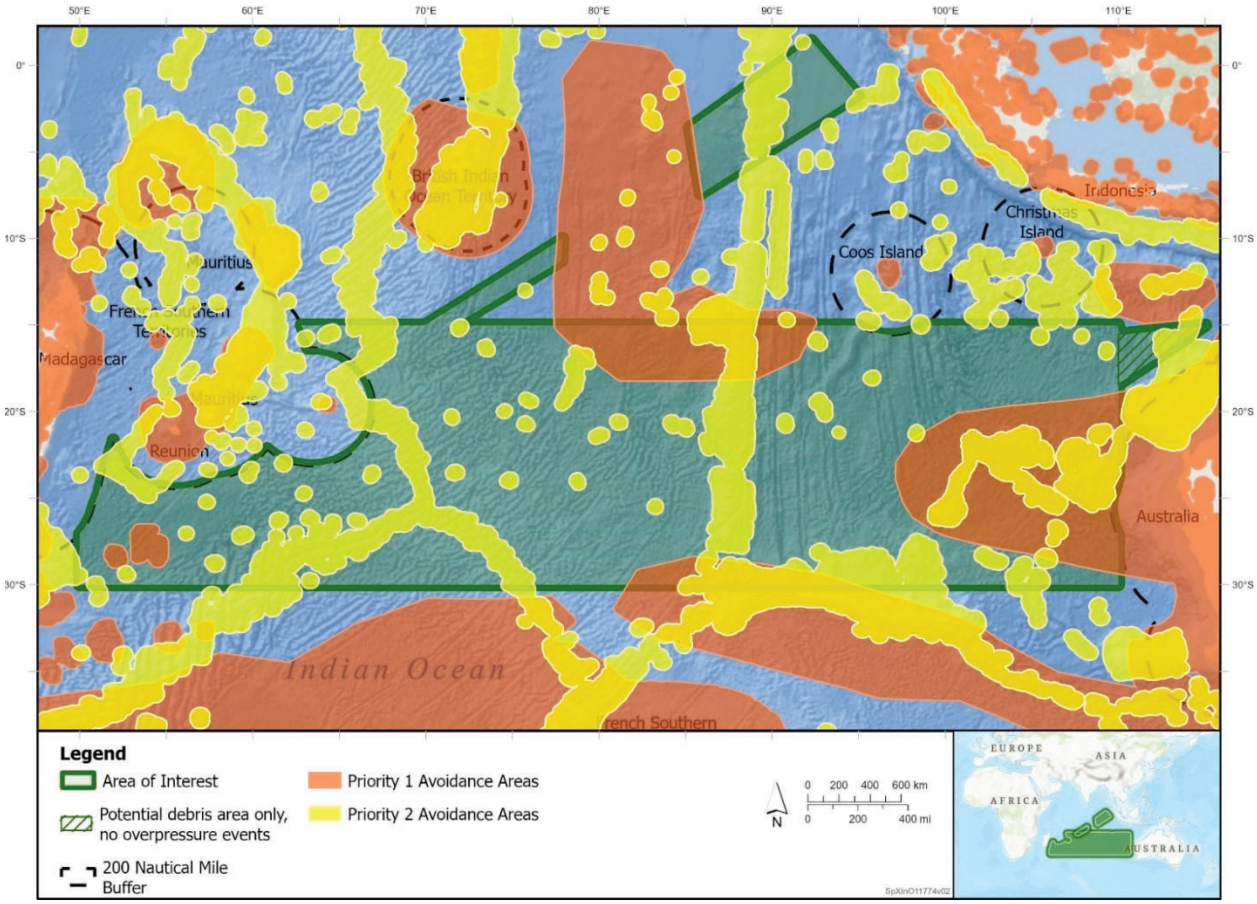
The FAA has previously consulted with NMFS regarding EFH adverse effect determination associated with the 2022 PEA. NMFS provided two Conservation Recommendations pursuant to 50 CFR § 600.920, which SpaceX and the FAA have agreed to implement for Indian Ocean landing operations:

- Conservation Recommendation 1: Prior to any in-water work (i.e., debris recovery or sinking), SpaceX will ensure all ballast and vessel hulls do not pose a risk of introducing new invasive species and that project implementation will not increase abundance of invasive species present at the project site. SpaceX will sanitize any equipment that has been previously used in an area known to contain invasive species prior to its use for project activities.

- Conservation Recommendation 2: The FAA will coordinate with NMFS in the case of a launch failure and any vessel grounding to determine if consultation re-initiation is appropriate. Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the Proposed Action would not result in significant impacts on biological resources.

SpaceX contractors and subject matter experts completed a literature review in October 2023 that identified locations within the Action Area that may: (1) aggregate Marine Mammal Protection Act (MMPA) species and their prey; (2) offer other refugia for MMPA species; or (3) otherwise provide conservation benefit. These areas are shown in Figure 1. Potential Indian Ocean Landing Areas within the Action Area will be prioritized to avoid these locations.

Figure 1 Avoidance Level 1 and 2 Areas within the Action Area



Finding and Decision

The FAA decision in this FONSI/ROD is based on a comparative examination of environmental impacts for each of the alternatives studied during the environmental review process. The Tiered EA discloses the potential environmental impacts for each of the alternatives and provides a full and fair discussion of those impacts. The FAA has determined that no significant impacts would occur as a result of the Proposed Action and, therefore, that preparation of an EIS is not warranted and no conservation measures beyond the ones identified by the Office of Commercial Space Transportation (AST) in the Final Tiered EA are required as a condition of approval, and a FONSI/ROD in accordance with 40 CFR §1501.6 is appropriate.

The FAA believes the Proposed Action best fulfills the purpose and need identified in the PEA. In contrast, the No Action Alternative fails to meet the purpose and need identified in the PEA. The FAA

has determined that the Proposed Action is a reasonable, feasible, practicable, and prudent alternative for a federal decision in light of the established goals and objectives. An FAA decision to take the required actions and approvals is consistent with its statutory mission and policies supported by the findings and conclusions reflected in the environmental documentation and this FONSI/ROD. After reviewing the Final Tiered EA and all its related materials, the undersigned has carefully considered the FAA's goals and objectives in relation to various aspects of the launch activities described in the Final Tiered EA, including the purpose and need to be met, the alternative means of achieving them, the environmental impacts of these alternatives, and the costs and benefits of achieving the stated purpose and need.

After careful and thorough consideration of the attached Final Tiered EA and the facts contained herein, the undersigned finds that the FAA's federal action is consistent with existing national environmental policies and objectives as set forth in Section 101(a) 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. Therefore, the FAA will not prepare an EIS for this action.

The undersigned hereby directs that actions be taken, together with the necessary related and collateral actions, to carry out the agency decisions as detailed in this FONSI/ROD, including:

- FAA modifying SpaceX's vehicle operator license under 14 CFR Part 150.

STACEY MOLINICH ZEE

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APPROVED: _____

Stacey M. Zee
Manger, Operations Support Branch