# DRAFT FINDING OF NO SIGNIFICANT IMPACT
# LANDING AND RECOVERY OF THE BOEING STARLINER SPACECRAFT AT EDWARDS AIR FORCE BASE, CALIFORNIA

Pursuant to the Council on Environmental Quality regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA), Title 40 of the Code of Federal Regulations (CFR) Sections (§§) 1500-1508; the United States Air Force (USAF)[1] Environmental Impact Analysis Process (EIAP), 32 CFR Part 989; and the Procedures of Implementation of NEPA for the National Aeronautics and Space Administration (NASA) (Title 14, CFR, part 1216 subparts 1216.1 and 1216.3), the Department of the Air Force (DAF) and NASA, as the lead agencies, have prepared an Environmental Assessment (EA) (attached) to identify and evaluate potential effects of emergency landing and recovering the Boeing Starliner spacecraft and crew at the Rogers Dry Lake Bed at EAFB in Kern County, California. The DAF is the federal land owner for this action. NASA, as the proponent of this action, is contracting with Boing to shuttle astronauts to and from the International Space Station. Boeing will be required to obtain a re-entry license from the Federal Aviation Administration (FAA) for the Starliner, therefore the FAA was a cooperating agency on this action, ensuring analysis complied with their NEPA regulations as defined in FAA Order 1050.1F, Environmental Impacts: Policies and Procedures.

**Purpose and Need (EA §§ 1.3 and 1.4, page 11)**: The purpose of the proposed action is to allow for the landing and recovery of the Starliner spacecraft and flight crew at EAFB for emergency scenarios beginning in early 2022. Routine missions would begin upon completion of two test flights and take place up to two times per year. EAFB would only be used as an emergency landing site for scenarios where the alternative is to land the Starliner in the ocean. EAFB is the only terrestrial site available for a failure of the launch rocket during ascent that prevents the Starliner from reaching a stable orbit and forces an early return in the first three orbits after launch. Spacecraft failures or crew medical emergencies could also drive the need to perform an emergency landing at EAFB.

## DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

**Selection Criteria for Alternative Sites (EA § 2.2, page 13)**: To be considered a reasonable alternative, the location for the Starliner landing had to meet the following criteria:

1. The 4 km radius clear landing area free from obstacles. This was determined to be the smallest available area needed to protect for landing dispersions based on the winds of the day to ensure that the Starliner has a safe environment for landing.
2. An acceptable area outside this 4 km radius landing area to allow for additional landing opportunities on days when the wind blows parts jettisoned from the spacecraft during the landing sequence outside the 4 km radius.
3. Preferably, in a controlled environment like a military range for ease of establishing protected keep out zones and for allowing use of DoD personnel and equipment during

[1] The Department of the Air Force (DAF) was established as the parent agency for both the USAF and the U.S. Space Force on 12/20/2019. USAF is still utilized in this document when referencing titles of regulations or documents that were in place before the agency name change.

landing and recovery operations. Also for the ease of negotiations, one owner familiar with the NASA Human Space Flight Program.

4. Near a Level 1 Trauma Center, within a one-hour Medical Evacuation (MEDEVAC) capability to provide the best possible care for an injured astronaut.
5. Access for recovery – no standing water or extremely muddy/soft soil for large portions of the year to maximize the number of landing opportunities.
6. Acceptable weather/winds, that fit within the wind restrictions established for safely landing the Starliner, for a large portion of the year.
7. Geographic location for a 51.6 degree inclination mission, the latitude trajectory limits of the ISS, and allowing for the SM disposal in the Pacific to ensure the SM pieces that survive re-entry to not impact on land.
8. On the proper trajectory to allow for a terrestrial landing in the event of an Atlas V rocket failure late in the launch sequence that prevents the Starliner from reaching a stable orbit that allows either docking with the ISS or targeting one of the other identified landing sites

Criteria 8 drove the need for a landing site in the vicinity of Los Angeles California. Criteria 1-3 lead to an evaluation of three sites at EAFB (Rogers Dry Lake Bed, Rosamond Dry Lake Bed, and the Precision Impact Range Area) and a fourth site at the Naval Air Weapons Station at China Lake. Site investigations showed none of these areas fully met the selection criteria. A screening of each site against the selection criteria (EA Table 2-1, page 14) showed the Rogers Dry Lake Bed site was the only site to fully or partially meet all the criteria. This site has a small number of obstacles within the 4km landing zone but those were evaluated and determined to be an acceptable risk for an emergency landing. It also has seasonal flooding but is dry for a majority of the year so this was also deemed acceptable. The other three sites all had multiple obstacles within the 4km landing zone (criteria 1) and/or not enough adjacent land for the landing of jettisoned parts (criteria 2).
Note there are four other landing sites (Dugway Proving Grounds in Utah, Willcox Playa in Arizona and two at White Sands Missile Range in New Mexico) available for planned landing of the Starliner that are covered under separate EAs. All landings would be targeted to one of these four sites if possible prior to attempting a landing at EAFB .

**Proposed Action Alternative – Rogers Dry Lake Bed (EA § 2.7, pages 17-24)**: Under the Proposed Action Alternative, the Boeing Starliner would land at the Rogers Dry Lake Bed for three emergency scenarios: an Atlas V rocket failure late in the launch sequence that prevents the Starliner from reaching a stable orbit that allows either docking with the ISS or targeting one of the other identified landing sites; a Starliner or ISS failure that prevents docking; an ISS, Starliner, or crew medical emergency that requires the need for the Starliner to land on short notice. For the latter two scenarios, Boeing would attempt to target one of the other landing sites if available and only target EAFB to prevent a water landing.

An uncrewed Orbital Flight Test 2 (OFT-2) mission is scheduled for the first half of 2022 followed by the Crewed Flight Test (CFT) scheduled for later in the year. OFT-2 is the first mission requiring the availability of EAFB as an emergency site. Routine missions would begin upon completion of the CFT mission and take place 1-2 times per year however, given EAFB would only utilized for emergency landings the likelihood of having a landing at EAFB is small.

An emergency landing and recovery operations of the Starliner and its flight crew would include landing and recovery of the flight crew from the Starliner; securing the Starliner until arrival of the Boeing recovery forces; recovering the Starliner and jettisoned parts for shipment back to Kennedy Space Center (KSC); and repairing any damage to the lakebed if required. The landing and crew recovery takes a few hours and utilizes 20-30 EAFB personnel. Recovery of the spacecraft from the lake bed would take place 3-4 days later after the arrival of the Boeing shipping container and involves around 10 EAFB and Boeing personnel. This is followed by configuring the spacecraft for final shipment to KSC, which takes around 7 days and involves 5-10 Boeing personnel.

Boeing has established a contract with EAFB to fund Air Force support to this action. Upon notification of an emergency landing EAFB personnel would clear the landing zone, perform a safety check to ensure the spacecraft is safe to approach, recover the flight crew, and cover the spacecraft to protect it until the Boeing recovery team arrives to remove the spacecraft and the jettisoned parts from the landing site.

The spacecraft and all jettisoned hardware would be collected and removed from the landing site, unless a decision is made to leave the smaller jettisoned parts in the field to minimize impacts to cultural sites and animal habitat due to vehicle traffic. Based on their composition these would have no significant impacts to the environment if left in place. No impacts are anticipated to the historic part of the lakebed utilized as part of the proposed action. No damage is expected to the lakebed. Only small divots and depressions were visible at the landing locations of the various parts during the first Starliner landing at White Sands Missile Range, the deepest being 2-3 inches. The only evidence of the proposed action will be tire tracks and depressions or holes caused by the impact of the various pieces of the Starliner. These will disappear when the lake bed floods. Should lake bed repairs be needed they will done utilizing EAFB repair processes.

Infrastructure requirements for the landing and recovery activities would not exceed EAFB's existing infrastructure resources. All power and water, as well as sanitation capability in the form of portable toilets if needed, would be brought to the site by the EAFB recovery team and removed at the end of the recovery operations. After removal of the Starliner from the lakebed, the Boeing team would utilize an EAFB or NASA hangar, if available, or set up a tent in a parking lot for up to 10 days to perform that activities needed to process the spacecraft for shipment.

**No Action Alternative (EA § 2.5, page 16)**: Under the no action alternative no emergency landings would occur at EAFB. This would reduce the landing opportunities for the Starliner and increase the chance of a water landing should the Starliner be required to make an emergency landing. Under this alternative, the FAA would not issue Boeing a license for Starliner operations at EAFB. The No Action alternative provides a baseline against which the Proposed Action Alternative can be compared to.

## ENVIRONMENTAL CONSEQUENCES

Environmental analyses focused on the following resource areas: Air Quality; Biological Resource; Climate; Department of Transportation Act, Sec 4(f); Land Use and Airspace; Physical Resources; Cultural Resources; Noise, Noise Compatible Land Use, and Vibration; Socio-economics; Environmental Justice and Children's Health and Safety Risks, Visual Effects; Infrastructure and Utilities;
Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention; and Human Health and Safety.

Farmland and Coastal Areas were dismissed from further analysis within the EA due to these not being present at EAFB. Mineral and Energy Resources were also dismissed as the proposed action would not result in the development of new facilities or result in consumption of natural resources other than the vehicle fuel used during the recovery operations. Table 3-1 on page 25 of the EA provides the rationale for dismissal.

**Air Quality (EA § 3.1, pages 26-30) and Climate (EA § 3.3, page 37)**: EAFB has an arid to semi-arid climate with abundant sunshine, relatively low humidity, modest rainfall, and relatively mild winters typical of low latitude arid areas. The proposed action is located in the Eastern Kern Air Pollution Control District (EKAPCD). The portion of the EKAPCD that includes EAFB is currently in nonattainment status for ozone.

During the landing and recovery operations air emissions would be generated from vehicle and portable generator combustion, man-made dust, and, should a failure occur, fluid release from the Starliner (hydrazine or ammonia) or recovery vehicles (diesel or gasoline). Emissions are well below the de minimis levels set by the NEPA regulations for all pollutants and greenhouse gases for the appropriate containment classification (EA Table 3-2, page 29). Dust suppression methods would be utilized if necessary. Boeing is responsible for cleanup of any spilled hazardous material. Airspace closures associated with reentries would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. The amount of time that affected aircraft spend being re-routed would be short-term and the number of aircraft that would be impacted per reentry would not be expected to produce additional emissions that would have a notable impact on climate.

The Proposed Action would not result in exceedance of any air quality standards or permit levels and therefore would not result in significant air quality impacts.

**Biological Resources (EA § 3.2, pages 30-36)**: There are 50 plant associations at EAFB, of which main plant communities are creosote bush scrub, saltbush scrub, Joshua tree, and mesquite. There are 19 sensitive plant species of interest listed on the California Natural Diversity Database (EA Figure 3-2, page 33). None of these species is present in the 4km radius area of the landing zone. Mohave Spineflower, Desert Cymopterus, Yellow Spinecape, Mojave Wooly Sunflower, Sagebrush Loeflingia, and Rosamond Eriastrum, as well as the Joshua Tree, which is under consideration for addition to the database, are present in the jettisoned parts extension. There is no federal protection for these species at this time and there are no known Endangered Species Act (ESA)-listed plant species in the study area.

The U.S. Fish and Wildlife Service (USFWS) website was consulted in August 2020 to complete an Information for Planning and Conservation (IPaC) search which provided a current list of potential threatened and endangered species (TES) and migratory birds that may occur at the proposed landing site and within the sonic boom footprint of the Starliner. One federally threatened species, the desert tortoise, designated under the ESA is of concern on EAFB. The desert tortoise is a permanent resident and has critical habitat within the landing zone. Desert tortoise densities vary throughout the base, with the highest densities mostly concentrated in USFWS designated critical habitat comprising about 60,800 acres on base (EA Figure 3-3, page 33). The Mohave ground squirrel is currently a threatened species under the California Endangered Species Act (CESA). On EAFB, the Mohave ground squirrel population distribution is widely scattered east, west and south of Rogers Dry Lake in creosote bush scrub and saltbush scrub habitat (including desert tortoise critical habitat on the Precision Impact Range Area southeast of the lake bed (EA Figure 3-4, page 34). In addition to the federal and state listed species listed above there are 3 reptile, 45 bird, 7 mammals, and 3 invertebrates listed as California species of concern that are present on EAFB (EA Appendix H, page 239).

The interior of the lakebed, including the landing site, is entirely barren of vegetation. There are areas of Barstow Woolly Sunflower and Desert Cymopterus within the landing area of the pieces jettisoned from the Starliner during the landing sequence, however these are few in number and spread mostly on the outskirts of the landing zone where items will only travel in higher wind scenarios. In all proposed activities, ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Off-road traffic would be restricted in accordance with EAFB regulations to minimize disturbance to vegetation. Recovery operators would be instructed to minimize disturbance of vegetation and avoid Joshua Trees during the recovery of the jettisoned pieces of the spacecraft. If necessary EAFB biologists would accompany the recovery members to ensure sensitive plants are avoided.

The Starliner landing and recovery activities have the potential to impact animal species, including the desert tortoise, bats, other non-ground dwelling and ground-nesting birds (including any migratory birds present), primarily from vehicle traffic. The probability of directly hitting fauna with the spacecraft or jettisoned pieces is inherently low. The activities would involve only limited aerial activity, consisting of the spacecraft and jettisoned pieces parachuting or falling to the ground, which would pose little threat of bird or bat collisions or mortality to ground animals. The desert tortoise and Mohave Ground Squirrel habitats overlap parts of the landing zone, particularly to the east and southeast of Rogers Dry Lake Bed where jettisoned parts could land depending on the winds during landings. The main risks to either the tortoise or squirrel would be from the vehicles. The recovery operators would use existing roads to the extent possible to reach the jettisoned parts locations. Recovery personnel would be provided desert tortoise awareness training prior to accessing Edwards AFB or the project area. The operators would be instructed to be watchful for and avoid any tortoises or ground squirrels encountered during the recovery of the jettisoned pieces of the spacecraft. Desert tortoise authorized biologist would survey/flag any off-road vehicle access trails required to collect jettisoned parts. While individual mortality may occur, regional populations of species would not be affected. Landing activities would affect only a limited portion of the total available habitat within EAFB.

The Proposed Action would not result in any long-term impacts to the local flora and fauna and therefore would not result in significant biological impacts.

**Department of Transportation Act, Section 4(f) (EA § 3.4, pages 38-39)**: Part of the landing zone for the Starliner includes the National Landmark portion of Rogers Dry Lake Bed (EA Figure 3-10, page 48). The Starliner also creates a sonic boom, equivalent to a clap of lightning that could be heard in large parts of California under the flight path.

The proposed action would not result in a use (physical or constructive) of any Section 4(f) property. While recovery operations could take place in the portion of Rogers Dry Lake Bed that is designated a National Historic Landmark (and thus is a Section 4(f) property), operations would be temporary, lasting only a few hours or days, and occur a maximum of two times per year. Recovery operations would not create any long-term physical impacts on the lakebed. Any damage to the lakebed would be repaired by the U.S. Air Force. The U.S. Air Force controls public access to Edwards Air Force Base, including the lakebed, and therefore the proposed action would not affect public access to the National Historic Landmark. The sonic boom generated prior to landing would be 1-2 seconds in duration and, while possibly noticeable, would not cause any impacts or damage to any Section 4(f) properties due to the small magnitude of the overpressure (maximum of 0.5 pounds per square foot (psf), somewhat less than a clap of thunder). Therefore, sonic booms generated during reentry would not result in a constructive use of any Section 4(f) property.

The proposed action would not result in a use of nor any in significant impacts on Section 4(f) properties.

**Land Use and Airspace (EA § 3.5, pages 39-43)**: There is no new permanent construction as part of the planned action. The proposed action would utilize existing EAFB pad and road infrastructure with utilization of the lakebed and landing zone extension for landing and retrieving the various parts of the Starliner. The spacecraft and all jettisoned hardware would be collected and removed from the landing site unless a decision is made to leave the smaller jettisoned parts in the field to minimize impacts to cultural sites and animal habitat due to vehicle traffic. Existing roads and paths would be used to the extent possible when retrieving all parts. No impacts are anticipated to the historic part of the lakebed utilized as part of the proposed action. Only small divots and depressions were visible at the landing locations of the various parts during the first Starliner landing at White Sands Missile Range, the deepest being 2-3 inches. The only evidence of the proposed action will be tire tracks and depressions or holes caused by the impact of the various pieces of the Starliner. Only small divots and depressions were visible at the landing locations of the various parts during the first Starliner landing at White Sands Missile Range, the deepest being 2-3 inches. These will disappear when the lake bed floods. As part of the Boeing contract with the Air Force, any damage caused to the lakebed during landing would be repaired if necessary using the EAFB repair process.

The proposed action would involve over flight of the base from the west to the EAFB landing site on Rogers Dry Lake Bed. Activities would fall inside the scope of normal activities within EAFB-controlled airspace. Close scheduling and coordination from Edwards Air Traffic Control would minimize any airspace conflicts with other concurrent operations being conducted at Edwards. All airspace re-entry operations would comply with the necessary notification requirements, including

issuance of Notice to Airmen and Notice to Mariners . FAA temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations.

The proposed action would not result in significant impacts related to land use or airspace.

**Physical Resources (EA § 3.6, pages 43-47)**: Rogers Dry Lake Bed is considered a floodplain due to seasonal flooding (EA Figure 3-8, page 44). Executive Order 11988, Floodplain Management, requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Emergency landings would always be targeted to one of the other Starliner landing sites whenever possible. Based on the selection criteria for the landing sites, there is no practicable alternative to utilizing Rogers Dry Lake Bed as a landing site when a landing at EAFB is required as the only alternative is to land in the ocean. This would increase the risk to the crewmembers as search and rescue forces would need to deploy to locate the Starliner. It could take up the 24 to recovery the crew from an ocean landing and several hours after recovery to transfer them to a Level 1 Trauma Center. A landing at EAFB allows transfer of the crew to a trauma center within two hours of landing. Any damage to the lakebed caused by a landing would be repaired to put the lakebed back to its original state; therefore, the floodplain would not be affected by the proposed action. In addition, the lakebed would not be utilized during periods of the year when it is flooded. Boeing notified the public via newspaper ads in January 2020 of the need for utilizing the flood plain for landing of the Starliner and requested comments. No comments were received.

The landing and recovery activities could result in soil compaction or erosion and de-vegetation caused by the spacecraft and jettisoned hardware impacting the soil and accessing of the sites with the vehicles needed to recover the crew, Starliner, and jettisoned parts. In all proposed activities ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Equipment used would be inspected frequently for petroleum, oil, and lubricant leaks and, if needed, appropriate containment would be placed underneath equipment when not in use. Any damage to the lakebed that occurs during landing and recovery operations will be repaired so as not to affect the floodplain.
Overall, the proposed action would not significantly affect the water resources, geology and soil in the area.

**Cultural Resources (EA § 3.7, pages 48-51)**: Previous cultural surveys of the landing site, including both the 4km radius circle and the jettisoned parts landing zone extension, were reviewed and a new survey of approximately 1370 acres, within the inner 2 km radius of the 4k circle and along the shoreline of the lakebed was performed in 2020. The new survey also included an eligibility recommendation for seven known sites within the landing zone. No new cultural resources were found during the survey and none of the sites evaluated was recommended as eligible. There were an additional 41 sites identified outside the 4km radius landing zone of the Starliner but within the jettisoned parts landing zone extension. Of these 31 are identified as eligible, 3 not eligible, and 6 undetermined.

EAFB performed consultations of the action with the State Historic Preservation Officer and local tribes. On July 21,2021 the SHPO concurred with the Air Force finding of no adverse effects on

historic properties from the project (EA Appendix G, page 237). Tribal consultation with the Tejon Indian Tribe, the San Manuel Band of Mission Indians, the Colorado River Indian Tribe, the Morongo Band of Mission Indians, and the Chemehuevi Indian Tribe resulted in comments received from the San Manuel Band of Mission Indians expressing concerns over the culture history and the characterization of two sites. Boeing and the DAF provided additional documentation on these sites and the possible impacts from a Starliner landing. On July 2, 2021 the DAF received documentation confirming that the tribe's concerns were adequately addressed and that there are no remaining issues regarding site eligibility.

A large portion of the Starliner landing zone would be within the NRHP portion of Rogers Dry Lake Bed. Based on previous Starliner testing, including the OFT mission landing impacts (EA Figures 3-5, 3-6, and 3-7, pages 41-42) minimal damage is expected to the lakebed. However, should the lakebed be damaged by any of the pieces of the Starliner during landing, the damage would be repaired and the lakebed put back to its original state using EAFB internal repair processes. All pieces of the Starliner spacecraft would be recovered and removed, if found or unless a decision is made to leave some parts in place. It may not be possible to find and recover all of the mortar lids and sabots due to their small size should they land off the lakebed. Due to the materials used in the construction of these pieces, they do not pose any environmental impacts to the area.

No significant impact to cultural resources is anticipated.

**Noise and Noise-Compatible Land Use (EA § 3.8, pages 51-54)**: Landing recovery vehicle traffic, portable generators, and recovery operations generate noise and vibrations. In addition, the Starliner spacecraft would generate a sonic boom during atmospheric reentry to the EAFB landing site, approximately equivalent to a clap of thunder.
Due to the short timeframe of the activities, no long-term high levels of noise are generated. Any loud noise or vibration generated during landing and recovery activity would be one time and very short in duration, and are not be expected to significantly affect the local people or wildlife.

The proposed action would be consistent with current land use and below the significance noise thresholds so would not result in any significant noise impacts.

**Socioeconomics (EA § 3.9, pages 54-55) and Environmental Justice and Children's Environmental Health and Safety Risks (EA § 3.10, pages 55-56):** No significant impact to employment, population, and economic activity is expected from the proposed action. The current level of socioeconomic activity would not significantly change or be adversely affected. Personnel working in support of the proposed activities would include military, civil servants, and contractors. Proposed activities would provide very small socioeconomic benefits for the counties around EAFB due to the small number of NASA personnel who would travel to the landing site to retrieve the astronauts and the 5-10 Boeing personnel who would travel to and spend up to two weeks in the area for the recovery of the Starliner. The proposed action would not result in an increase in population or employment levels in the area nor impact community or emergency services in the surrounding region.

The proposed action would not have a significant impact on EAFB air quality, noise, soils and other environments as identified above. Direct impacts are not anticipated to extend outside the boundaries

of EAFB to the surrounding communities, with the exception of the sonic boom which is very short term in nature, low in magnitude, and would occur only when an emergency landing is necessary at EAFB. Surrounding communities would not be adversely impacted by the presence of recovery personnel temporarily relocated to support landing and recovery.

The proposed action would not significantly impact socio-economic activity nor result in impacts related to environmental justice and children's environmental health and safety risks.

**Visual Effects (EA § 3.11, page 56-57):** The proposed action would have a slight impact on light emissions at the landing site for those instances where the Starliner lands after sunset or late enough in the day that the crew recovery operations would extend past sunset. For these instances, portable lighting would be required around the landing site until recovery operations are complete. Spacecraft recovery from the lakebed would always take place during daylight hours. The planned action would have no long-term impacts on the visual environment as the recovery team removes all parts of the spacecraft from the landing site with the possible exception of any mortar lids and mortar sabots not found. There are no visually or light-sensitive receptors in the project's region of influence.

The proposed action would not result in significant visual impacts.

**Infrastructure and Utilities (EA § 3.12, page 57-58):** Infrastructure requirements for the landing and recovery activities would not exceed EAFB's existing infrastructure resources. All power and water, as well as sanitation capability in the form of portable toilets if needed, would be brought to the site by the EAFB recovery team and removed at the end of the recovery operations. After removal of the Starliner from the lakebed the Boeing team would utilize an EAFB or NASA hangar, if available, or set up a tent in a parking lot for up to 10 days to perform that activities needed to process the spacecraft for shipment.
Water and septic system use would have a minor increase under the proposed action during the period when 5-10 Boeing personnel are present post landing to process the Starliner for shipment. All existing facilities are considered sufficient to handle an increase in demands for services under the proposed action. No major changes to the demands for public services (e.g. fire protection, solid waste disposal) are anticipated under the proposed action.

The proposed action would have no significant impact to infrastructures or utilities.

**Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention (EA § 3.13, pages 58-60)**: The proposed action would require the use of hydrazine, ordnance, Galden (a perfluoropolyether heat transfer fluid), coolant and ammonia within the Starliner and fuel in ground vehicles and equipment. Solid waste and potentially biohazard material would also be generated. Unless a failure occurs that would allow a release, all hazardous material would remain in the spacecraft for transport back to the Boeing facility at the Kennedy Space Center in Florida and therefore have no impact to EAFB or its surrounding areas. Under the proposed action, removal of all waste, hardware, debris, and other hazardous or potentially hazardous material would be the responsibility of Boeing.

Nonhazardous waste would be handled as solid waste or non-regulated waste. All Air Force generated solid waste at EAFB is collected and disposed of in the EAFB operated landfill. All

nonhazardous waste from privatized housing is hauled to off Base landfills. Nonhazardous waste from contractor projects that are not regular ongoing activities is generally hauled off Base as well, but disposal in the EAFB operated landfill may be considered on a case by case basis. The only petroleum, oil, and lubricants used during the landing and recovery operations would be contained in support equipment, generators, cranes, and vehicles. The established Air Force Flight Test Center Oil and Hazardous Substance Spill Prevention and Response Plan would be followed for both pollution prevention and in the unlikely event of accidental spills. Health and safety risks would be minimized by following established EAFB procedures.

The proposed action would not result in significant impacts related to hazardous materials, hazardous waste, solid waste, and pollution prevention.

**Human Health and Safety (EA § 3.14, pages 60-61):** As a safety precaution, recovery personnel would remain outside the landing zone until after the landing of the spacecraft and all jettisoned pieces. Upon landing, the landing team would reposition to a location approximately 500 feet upwind of the Starliner. After confirmation from the astronauts that the Starliner systems have been powered down, a safety assessment team in protective gear would perform the initial safety assessment. If hazardous conditions are detected the safety assessment team would determine the source of the hazard and mitigate the hazard, if possible. If unable to mitigate the hazard, the EAFB Fire Crash Rescue team would assist in mitigating the hazard and to perform toxic spill or contamination cleanup. Once the area around the Starliner is deemed safe, recovery personnel would reposition around the spacecraft and commence recovery operations. Proper personal protective equipment would be used, as needed, by personnel working on the project and applicable EAFB safety procedures would be followed.

Any public viewers of a landing would be kept outside of EAFB and would not be affected by the landing. All areas located on EAFB and inside of the EAFB landing zone would be cleared and all access to the area on the day of landing is controlled by EAFB Flight Safety.

The proposed action would have no significant impact on human health and safety.

**Mitigation Measures (EA § 4, pages 62-63):** As the proponent for this action, NASA and Boeing are responsible for ensuring mitigations and management actions are fully funded, in place, and being carried out as identified above and within §4.0 of the EA. In addition the DAF will prepare a Mitigation and Monitoring Plan (MMP). The MMP will be developed within 90-days subsequent to this document. The MMP is a living document and as such will be updated by the DAF throughout the life of the project. It is expected mitigation monitoring will generally consist of adherence to permit and reporting requirements and on-the-ground inspections. The DAF will evaluate the effectiveness of these monitoring methods and revise as necessary to address deficiencies discovered during these inspections.

**Scoping and Public Review:** A 30 day scoping comment period was performed due to the potential impacts of utilizing the floodplain on Rogers Dry Lake Bed. Boeing notified the public via newspaper ads in the Bakersfield Californian and Antelope Valley Press in January 2020 of the need for utilizing the flood plain for landing of the Starliner and requested comments. No comments were received.

A Notice of Availability will be published in the Antelope Valley Press and Florida Today kicking off the 30-day public review period of the draft EA and Finding of No Significant Impact. In addition, the DAF and NASA will notify other federal, state, and local agencies, organizations, and interested members of the general public of the availability of the draft documents via the California State Clearinghouse. Printed copies will be made available at the Edwards AFB library; the Palmdale City Library; the Rosamond, California City, and Mojave branches of the Kern County Library; the Lancaster branch of the Los Angeles County Library; the Barstow branch of the San Bernardino County Library. Electronic copies will be made available from a NASA website. Letters and emails with written comments on the draft EA received during the public review period will be considered by the DAF and NASA and will be addressed in the final EA.

**FINDING OF NO SIGNIFICANT IMPACT**

Based on review of the facts and analysis summarized above and contained within the findings of the EA, the DAF and NASA finds the proposed decision to allow landing and recovery of the Starliner spacecraft and its flight crew will not have a significant impact on the natural or human environment at the Rogers Dry Lake Bed at EAFB. Therefore, an environmental impact statement is not required. In addition, the DAF and NASA made a Finding Of No Practicable Alternatives (FONPA) to conducting the Proposed Action Alternative within the floodplain as described in the attached EA. NASA has taken all practicable measures to minimize any impacts to the floodplain by not allowing any landings to occur during times of year when the lakebed is flooded.. This analysis fulfills the NEPA, the President's Council on Environmental Quality 40 C.F.R. §§ 1500 – 1508, the USAF EIAP regulations 32 C.F.R § 989, NASA NEPA regulations 14 CFR § 1216.3 and Executive Order 11988, *Floodplain Management.*

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X _____

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# Draft Commercial Crew Transportation System (CCTS) Environmental Assessment For the Boeing Starliner Landing and Recovery at Edwards Air Force Base

**November 2021**

**National Aeronautics and Space Administration**
**John F. Kennedy Space Center**
**Kennedy Space Center, Florida**


**Prepared by:**
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# Commercial Crew Transportation System (CCTS) Draft Environmental Assessment For the Boeing Starliner Landing and Recovery at Edwards Air Force Base

Co-Lead Agencies: National Aeronautics and Space Administration (NASA) and Department of the Air Force (DAF)[2]

Cooperating Agency: Federal Aviation Administration (FAA)

Proposed Action: Landing and Recovery of the Boeing Starliner Spacecraft at the Edwards Air Force Base

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Date: November 2021

## ABSTRACT

Prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), this Environmental Assessment (EA) evaluates the proposed landing and recovery of the Boeing Commercial Crew Transportation System (CCTS) Starliner spacecraft on the Rogers Dry Lake Bed at Edwards Air Force Base (EAFB) in California. The NASA and the DAF are the co-lead agencies for this EA and the FAA is a cooperating agency.

This EA analyzes impacts on the environment of a site at Rogers Dry Lake Bed for the landing of the Starliner and documents three others that did not meet the selection criteria. Under the Proposed Action Alternative, the Boeing Starliner would land at EAFB under certain emergency scenarios to prevent a landing in the ocean. The No Action Alternative, under which no landing would take place at EAFB and existing conditions would continue, is also analyzed in the EA to provide a baseline against which impacts potentially resulting from the action alternative can be compared. The Proposed Action Alternative is the NASA's Preferred Alternative. Detailed discussions of impacts on physical, biological, and social resources potentially resulting from each of the alternatives are presented in the EA. This EA will also be used as part of Boeing's request for an FAA license to support Starliner spacecraft landings at EAFB.

[2] The Department of the Air Force (DAF) was established as the parent agency for both the USAF and the U.S. Space Force on 12/20/2019. USAF is still utilized in this document when referencing titles of regulations or documents that were in place before the agency name change.

# DCC1-01291-01

## Commercial Crew Transportation System (CCTS) Draft Environmental Assessment For the Boeing Starliner Landing and Recovery at Edwards Air Force Base

Date: 11/19/2021

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|---|---|---|
| - | Initial Release | 11/19/2021 |
| | | |

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# Glossary of Abbreviations and Acronyms

| | |
|---|---|
| AB | Assembly Bill |
| ABW | Air Base Wing |
| ACAM | Air Force Conformity Applicability Model |
| AEGL | Acute Exposure Guideline Level |
| AFTC | Air Force Test Center |
| AFTCI | Air Force Test Center Instruction |
| AFI | Air Force Instruction |
| AFOSH | Air Force Occupational and Environmental Safety, Fire Protection and Health |
| AFRL | Air Force Research Laboratory |
| AGL | Above Ground Level |
| ALOHA | Areal Locations of Hazardous Atmospheres |
| APCD | Air Pollution Control District |
| AQMD | Air Quality Management District |
| ARTCC | Air Route Traffic Control Center |
| AVAQMD | Antelope Valley Air Quality Management District |
| AVCCC | Airbag Vent Cord Cable Cutters |
| BHS | Base Heat Shield |
| BO | Biological Opinion |
| C3PF | Commercial Crew and Cargo Processing Facility |
| CAA | Clean Air Act |
| CAAQS | California Ambient Air Quality Standards |
| CalEEMOD | California Emissions Estimator Model |
| CEQA | California Environmental Quality Act |
| CESA | California Endangered Species Act |
| CCSFS | Cape Canaveral Space Force Station |
| CCDev | Commercial Crew Development |
| CCR | California Code of Regulations |
| CCTS | Commercial Crew Transportation System |
| CDC | Centers for Disease Control and Prevention |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| CFT | Crewed Flight Test |
| CM | Crew Module |
| dB | Decibels |
| DNL | Day-Night average sound Level |
| DoD | Department of Defense |
| DOT | Department of Transportation |
| EA | Environmental Assessment |
| EAFB | Edwards Air Force Base |
| EIAP | Environmental Impact Analysis Process |
| EIS | Environmental Impact Statement |
| EKCAPCD | Eastern Kern County Air Pollution Control District |
| EMFAC | Emission Factors |
| EO | Executive Order |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |

| | |
|---|---|
| FAA | Federal Aviation Administration |
| FHS | Forward Heat Shield |
| FONPA | Finding of No Practicable Alternative |
| FONSI | Finding of No Significant Impact |
| GHG | Greenhouse Gases |
| HFC | Hydro-fluorocarbon |
| hp | horsepower |
| HWMP | Hazardous Waste Management Plan |
| INRMP | Integrated Resource Management Plan |
| in | Inch |
| ISS | International Space Station |
| JICE | Jettisoned Items Containment Evaluator |
| KSC | Kennedy Space Center |
| km | Kilometers |
| lb. | Pound |
| IPaC | Information for Planning and Conservation |
| LOA | Letter of Agreement |
| LPG | Liquefied Petroleum Gas |
| LRT | Landing Recovery Team |
| MBTA | Migratory Bird Treaty Act |
| MCC | Mission Control Center |
| MDAQMD | Mojave Desert Air Quality Management District |
| MEDEVAC | Medical Evacuation |
| mi | Miles |
| MNSR | Major New and Modified Stationary Source Review |
| mph | miles per hour |
| MSDS | Material Safety Data Sheet |
| NAAQS | National Ambient Air Quality Standards |
| NAS | National Airspace System |
| NASA | National Aeronautics and Space Administration |
| NEPA | National Environmental Policy Act |
| NIOSH | National Institute for Occupational Safety and Health |
| NOAA | National Oceanic and Atmospheric Administration |
| NOTAM | Notice to Airmen |
| NOTMAR | Notice to Mariners |
| NPR | NASA Procedural Requirement |
| NRHP | National Register of Historic Places |
| NSR | New Source Review |
| OFT | Orbital Flight Test |
| OSHA | Occupational Safety and Health Administration |
| PIRA | Precision Impact Range Area |
| PM | Particulate Matter |
| POL | Petroleum, Oil and Lubricant |
| RCRA | Resource Conservation and Recovery Act |
| SDS | Safety Data Sheet |
| SHPO | State Historic Preservation Office |
| SLC | Space Launch Complex |
| SM | Service Module |
| SMU | Storm Water Management Units |
| SOP | Standard Operating Procedure |
| SWDA | Storm Water Drainage Area |

| | |
|---|---|
| TES | Threatened, Endangered, or Sensitive |
| TSCA | Toxic Substances Control Act |
| TSE | Tactical Support Equipment |
| TW | Test Wing |
| ULA | United Space Alliance |
| USAF | United States Air Force |
| U.S.C. | United States Code |
| USCB | United States Census Bureau |
| USFWS | U.S. Fish and Wildlife Service |
| UXO | Unexploded Ordnance |
| WSMR | White Sands Missile Range |
| WWTP | Waste Water Treatment Plants |
| XTA | Expanding Tube Assemblies |

# 1.0 Purpose and Need

## 1.1 Introduction

This Environmental Assessment (EA) has been prepared to evaluate the potential environmental impacts from the proposed landing and recovery of the Boeing Commercial Crew Transportation System (CCTS) Starliner spacecraft on the Rogers Dry Lake Bed at Edwards Air Force Base (EAFB) in California for certain emergency scenarios that would result in the need to land the Starliner at EAFB to prevent a landing in the ocean. The proposed action would include performing recovery activities for the Starliner Crew Module (CM) and its crew post-landing. An additional area outside this 4km radius circle, but still on EAFB property, would be utilized when needed due to winds for landing of parts that jettison from the CM during that landing sequence. Boeing is developing the Starliner to ferry astronauts to and from the International Space Station (ISS) as part of the National Aeronautics and Space Administration (NASA) funded Commercial Crew Development (CCDev) initiative. Four additional landing sites would be provided by White Sand Missile Range (WSMR) in New Mexico (2 sites), Willcox Playa in Arizona, and Dugway Proving Grounds in Utah that allow for both nominal end of mission and emergency landing capability. All landings would be targeted to one of these four sites if possible prior to attempting a landing at EAFB. Due to the need to have the individual landing sites available at different times to support the program schedule, the separate Department of Defense (DoD) locations involved, and the Army request to produce the EA for the Dugway location, Boeing recommended and NASA concurred with developing separate EA's for each selected location (listed below). Other sites were evaluated but failed to meet one or more of the criteria required for a landing site (See section 2).

Boeing Starliner Environmental Assessments for the Primary Landing Sites

- Environmental Assessment for Boeing Commercial Space Transport Testing at U. S. Army Dugway Proving Ground, Dugway, Utah (April 2016)
- Supplemental Environmental Assessment for Boeing Commercial Space Transport Landing at U. S. Army Dugway Proving Ground, Dugway, Utah (March 2019)
- Commercial Crew Transportation System (CCTS) Environmental Assessment For the Boeing Starliner Launch from Cape Canaveral Air Force Station and Landing and Recovery at the U.S. Army White Sands Missile Range (June 2019)
- Commercial Crew Transportation System (CCTS) Supplemental Environmental Assessment For the Boeing Starliner Landing and Recovery at the U.S. Army White Sands Missile Range (August 2020)
- Commercial Crew Transportation System (CCTS) Environmental Assessment For the Boeing Starliner Launch from Cape Canaveral Air Force Station and Landing and Recovery at the U.S. Army Willcox Range (July 2019)

The Commercial Space Launch Act of 1984, as amended and codified at 51 United States Code (U.S.C.) 50901–50923, authorizes the Secretary of Transportation to oversee, license, and regulate commercial launch and reentry activities, and the operation of launch and reentry sites within the United States or as carried out by U.S. citizens. Section 50905 directs the Secretary to exercise this responsibility consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. In addition, Section 50903 requires the Secretary to encourage, facilitate, and promote commercial space launches and reentries by the private sector. As codified at 49 Code of Federal Regulations (CFR) § 1.83(b), the Secretary has delegated authority to carry out these functions to the FAA Administrator.

NASA and the DAF are acting as the co-lead agencies for this EA, with the FAA acting as a cooperating agency.

This EA has been prepared in compliance with the following:

- *National Environmental Policy Act (NEPA) of 1969,* as amended (42 U.S.C. Sections4321-4370d)
- The National Historic Preservation Act (NHPA) of 1966, as amended (16 U.S.C. Section 470)
- The Council on Environmental Quality (CEQ) NEPA implementing regulations (40 Code of Federal Regulations (CFR) Parts 1500 to 1508)
- *The Procedures of Implementation of NEPA for the National Aeronautics and Space Administration (NASA)* (Title 14, CFR, part 1216 subparts 1216.1 and 1216.3)
- *The NASA Procedural Requirement (NPR) for Implementing NEPA and Executive Order (EO) 12114* (NPR 8580.1).
- Federal Aviation Administration (FAA) Order 1050.1F , *Environmental Impacts: Policies and Procedures*
- CFR Title 32, Part 989, *Air Force Environmental Impact Analysis Process (EIAP)*

The first three test missions of the Starliner spacecraft (one complete in December 2019, the other two scheduled for 2022) are under oversight of NASA. For follow-on operational missions, Boeing intends to apply for a commercial space license from the FAA to support Starliner spacecraft landings at EAFB.

## 1.2 Location and Setting

EAFB is located in the Antelope Valley region of the western Mojave Desert in southern California. It is approximately 100 miles northeast of Los Angeles, California. The base occupies an area of approximately 308,000 acres or 470 square miles. Portions of the base lie within Kern, Los Angeles, and San Bernardino counties. It is the home of the Air Force Test Center and is the Air Force Materiel Command center of excellence for conducting and supporting research and development of flight, as well as testing and evaluation of aerospace systems from concept to combat. It operates the U.S. Air Force Test Pilot School and is home to NASA's Armstrong Flight Research Center and considerable test activities conducted by America's commercial aerospace industry. EAFB includes the Rogers Lake and Rosamond Lake dry lakes. These have served as emergency and scheduled landing sites for many aerospace projects including the Bell X-1, Lockheed U-2, Lockheed SR-71 Blackbird, and the Space Shuttle. Rogers is the larger of the two dry lakes, encompassing 44 square miles (110 kilometers2 (km2)) of desert, and is the location of the proposed action to land the Boeing Starliner spacecraft (Figure 1-1).

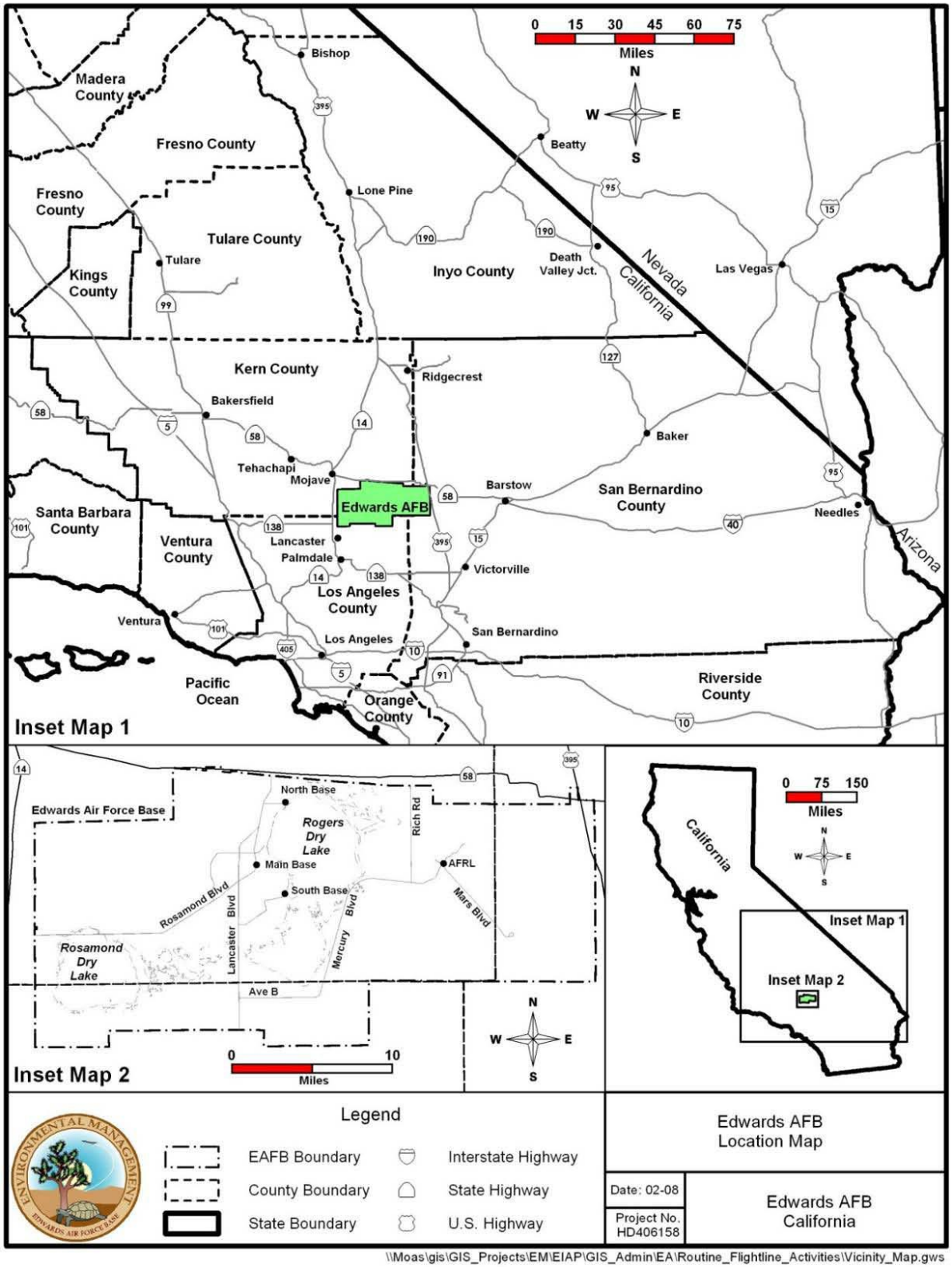


**Figure 1-1: Edwards Air Force Base Location**

## 1.3 Purpose of the Proposed Action

The purpose of the proposed action is to allow for the Boeing Starliner landing and recovery at EAFB beginning in 2022 to provide a landing site for Boeing's Starliner spacecraft and NASA's astronauts to return to Earth for certain emergency scenarios, as identified in section 1.4. This allows a terrestrial landing opportunity at EAFB for these cases, thereby avoiding the need to land in the ocean. The Starliner is one of the crew transport vehicles for access to the ISS to replace the retired Space Shuttle capability. An uncrewed Orbital Flight Test 2 (OFT-2) mission is scheduled for the first half of 2022 followed by the Crewed Flight Test (CFT) later in the year. OFT-2 is the first mission requiring the availability of EAFB as an emergency site. Routine missions would begin upon completion of the CFT mission and take place 1-2 times per year.

## 1.4 Need for the Proposed Action

Boeing identified a need for a Starliner landing site to cover the scenario of an Atlas V rocket failure late in the launch sequence that prevents the Starliner from reaching a stable orbit that allows either docking with the ISS or targeting one of the other identified landing sites. The limited cross range capability of the Starliner, the trajectory of the ISS, the need for the service module section of the Starliner to target an ocean landing, and the need to return to the ground within 3 orbits of the launch drives this landing site to be in the vicinity of Los Angeles, California.

This landing site would also be utilized for two additional scenarios that force an emergency return from orbit of the Starliner:

- A Starliner or ISS failure that prevents docking. For this scenario Boeing would attempt to target one of the other landing sites if available and only target EAFB to prevent a water landing. In this scenario a landing will take place within the first four days of the mission.
- An ISS, Starliner, or crew medical emergency that requires the need for the Starliner to land on short notice. Similar to the previous scenario, Boeing would attempt to target one of the other landing sites if available and only target EAFB to prevent a water landing.

## 1.5 Cooperating Agencies

As the landowner of the landing site, the Air Force is responsible for its real property assets and infrastructure in support of the landing and recovery of the Starliner spacecraft at EAFB. Under the proposed action the EAFB would provide the personnel and equipment necessary to recover the flight crew and protect the Starliner CM until the arrival of Boeing recovery personnel. A support contract has been established between Boeing and EAFB for Air Force support to the proposed action.

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, as authorized by chapter 509 of Title 51 of the U.S. Code. To ensure the safety of the Starliner's reentry, the FAA is also responsible for creating airspace closure areas in accordance with FAA Order 7400.2M. The FAA also conducts several reviews during the license application evaluation process before making a determination on the license, including a safety review and a review of financial responsibility requirements. The FAA has previously provided a license to United Launch Alliance (ULA) for Atlas V launches from Cape Canaveral Space Force Station (CCSFS)[3]. The FAA licenses required for this action are listed in Appendix J.

[3] The environmental impacts of launching the Atlas V, among several other rockets, from SLC-41 were analyzed in the 1998 U.S. Air Force (USAF) Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program and 2000 USAF Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program (USAF 1998, 2000). The FAA was a cooperating agency on both Environmental Impact Statements (EISs) and formally adopted them to support issuing launch licenses to vehicle operators for launch

## 1.6 Scoping

Rogers Dry Lake Bed is considered a floodplain due to seasonal flooding. Executive Order 11988, Floodplain Management, requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Due to the proposed action impacting a floodplain, a Finding of No Practicable Alternative (FONPA) would also be required along with the Finding of No Significant Impact (FONSI). In anticipation of the need for a FONPA, Boeing notified the public via newspaper ads in January 2020 of the need for utilizing the flood plain for landing of the Starliner and requested comments. No comments were received.

## 1.7 Distribution and Review of the Draft EA

Results of the agency and public review of the draft EA will be included in the final version of this document.

## 1.8 Conclusion

This EA provides NASA, the DAF, and the FAA with the documentation of environmental impacts associated with the Starliner landing and recovery at EAFB. The decision to be made by the agencies is: (1) Approve a FONSI and FONPA based upon the proposed analysis contained within the EA; (2) Determine a FONSI and FONPA are not applicable, resulting in the need for an Environmental Impact Statement (EIS); or (3) Select the No Action Alternative.

operations described in the EISs. At the time the 1998 and 2000 EISs were prepared, Starliner reentry was not anticipated, and thus was not included in the analyses. In 2018, as part of the environmental review for evaluating ULA's launch license application for Atlas V launches at SLC-41, the FAA prepared a Written Re-evaluation (WR) of the EISs. The WR concluded that the contents of the EISs remained current and substantially valid and the decision to issue a launch license to ULA for Atlas V launches from SLC-41 did not require the preparation of a new or supplemental EA or EIS. The FAA issued ULA a license on June 1, 2018, and the license expires on May 31, 2023. This license authorizes ULA to conduct Atlas V launches at SLC-41 with payloads, including the Starliner.

# 2.0 Proposed Action and Alternatives

## 2.1 Proposed Action

The proposed action is to perform post-landing recovery activities for the spacecraft on the un-crewed test flight and the crew and spacecraft for crewed flights, including recovery of several parts jettisoned from the spacecraft during the landing sequence.

The FAA's proposed action is the issuance of a vehicle operator license to Boeing for reentry and landing at the EAFB site. The FAA's proposed action also includes its issuance of temporary airspace closures to ensure the safety of the spacecraft as it passes through the National Airspace System.

## 2.2 Selection Standards

NEPA and the CEQ regulations implementing NEPA mandate the consideration of reasonable alternatives for the Proposed Action. "Reasonable alternatives" are those that also could effectively meet the purpose and need for the Proposed Action.

Boeing completed a review of potential landing sites at multiple locations throughout the western U.S. using the following criteria:

1. The 4 km radius clear landing area free from obstacles. This was determined to be the smallest available area needed to protect for landing dispersions based on the winds of the day to ensure that the CM has a safe environment for landing.
2. An acceptable area outside this 4 km radius landing area to allow for additional landing opportunities on days when the wind blows parts jettisoned from the spacecraft during the landing sequence outside the 4 km radius.
3. Preferably, in a controlled environment like a military range for ease of establishing protected keep out zones and for allowing use of DoD personnel and equipment during landing and recovery operations. Also for the ease of negotiations, one owner familiar with the NASA Human Space Flight Program.
4. Near a Level 1 Trauma Center, within a one-hour Medical Evacuation (MEDEVAC) capability to provide the best possible care for an injured astronaut.
5. Access for recovery – no standing water or extremely muddy/soft soil for large portions of the year to maximize the number of landing opportunities.
6. Acceptable weather/winds, that fit within the wind restrictions established for safely landing the CM, for a large portion of the year.
7. Geographic location for a 51.6 degree inclination mission, the latitude trajectory limits of the ISS, and allowing for the SM disposal in the Pacific to ensure the SM pieces that survive re-entry to not impact on land.
8. On the proper trajectory to allow for a terrestrial landing in the event of an Atlas V rocket failure late in the launch sequence that prevents the Starliner from reaching a stable orbit that allows either docking with the ISS or targeting one of the other identified landing sites

## 2.3 Screening of Alternative

The following alternatives were initially identified that could potentially meet the purpose and need:

- At EAFB
  - Rogers Dry Lake Bed
  - Rosamond Dry Lake Bed
  - Precision Impact Range Area (PIRA)
- Naval Air Weapons Station at China Lake

The selection standards described in Section 2.2 were applied to these alternatives to determine which alternative(s) fulfill the purpose and need for the action (Table 2-1). Those items listed as "acceptable" do not completely meet the criteria, but an assessment has determined the risk to the Starliner landing is low.

**Table 2-1: Evaluation of Reasonable Alternatives**

| Selection Criteria | Rogers | Rosamond | PIRA | China Lake |
|---|---|---|---|---|
| 1 | Acceptable | No | No | No |
| 2 | Yes | No | No | No |
| 3 | Yes | Yes | Yes | Acceptable |
| 4 | Yes | Yes | Yes | Yes |
| 5 | Acceptable | Acceptable | Yes | Yes |
| 6 | Yes | Yes | Yes | Yes |
| 7 | Yes | Yes | Yes | Yes |
| 8 | Yes | Yes | Yes | Yes |

## 2.4 Detailed Description of Alternatives

### 2.4.1 EAFB Alternatives

Three sites at EAFB were assessed, as shown in Figure 2-1. The inner circles show the 4 km radius landing zone for the CM. The outer circles show the 15 km radius circles used in the analysis of possible landing zones for the jettisoned parts.

#### 2.4.1.1 Rogers Dry Lake Bed (labeled EAFB Center on Figure 2-1)

The lake bed provides an adequate 4 km radius landing zone for the CM within the lake bed. There are small number of obstacles within the 4 km radius but these are along the outer rim of the circle and are considered an acceptable risk for emergency landings. There is also an acceptable area to the east, southeast, and south to allow space for a jettisoned parts landing zone when needed due to winds. This is the direction the parts are most likely to travel based on historical prevailing winds at EAFB.

#### 2.4.1.2 Rosamond Dry Lake (labeled EAFB 2 on Figure 2-1)

The lake bed cannot accommodate a 4 km radius circle for the CM. The rougher terrain on the shoreline areas to the north and south only allow an approximately 3.5 km radius area on the lake bed. It also does not provide adequate area surrounding the lake bed to allow a landing zone for the jettisoned parts except to the north and directly east. The prevailing winds at EAFB are historically from the northwest, which would blow the parts off the lakebed to the southeast and onto private land off the base. This would limit the landing opportunities available at this site based on historical winds.

#### 2.4.1.3 Precision Impact Range Area (PIRA) (labeled EAFB 3 on Figure 2-1)

The PIRA area also does not provide adequate space for a 4 km radius CM landing zone. The southern part of this landing zone has some rough terrain due to some washout areas. Trying to move the circle farther north encroaches on Martin Road and the Air Force Research Lab (AFRL) area. There are also several obstructions in this landing zone. Similar to Rosamond Lake Bed, this location also does not provide adequate area to allow for an acceptable landing zone for the jettisoned parts before encroaching on private land outside the base. This would limit the landing opportunities available at this site based on historical winds. This landing zone also has a much greater potential to impact the desert tortoise as the 4km circle encroaches on critical habitat.

As a result of the above, it was determined the Rogers Dry Lake Bed was the best alternative at EAFB for an emergency landing site.

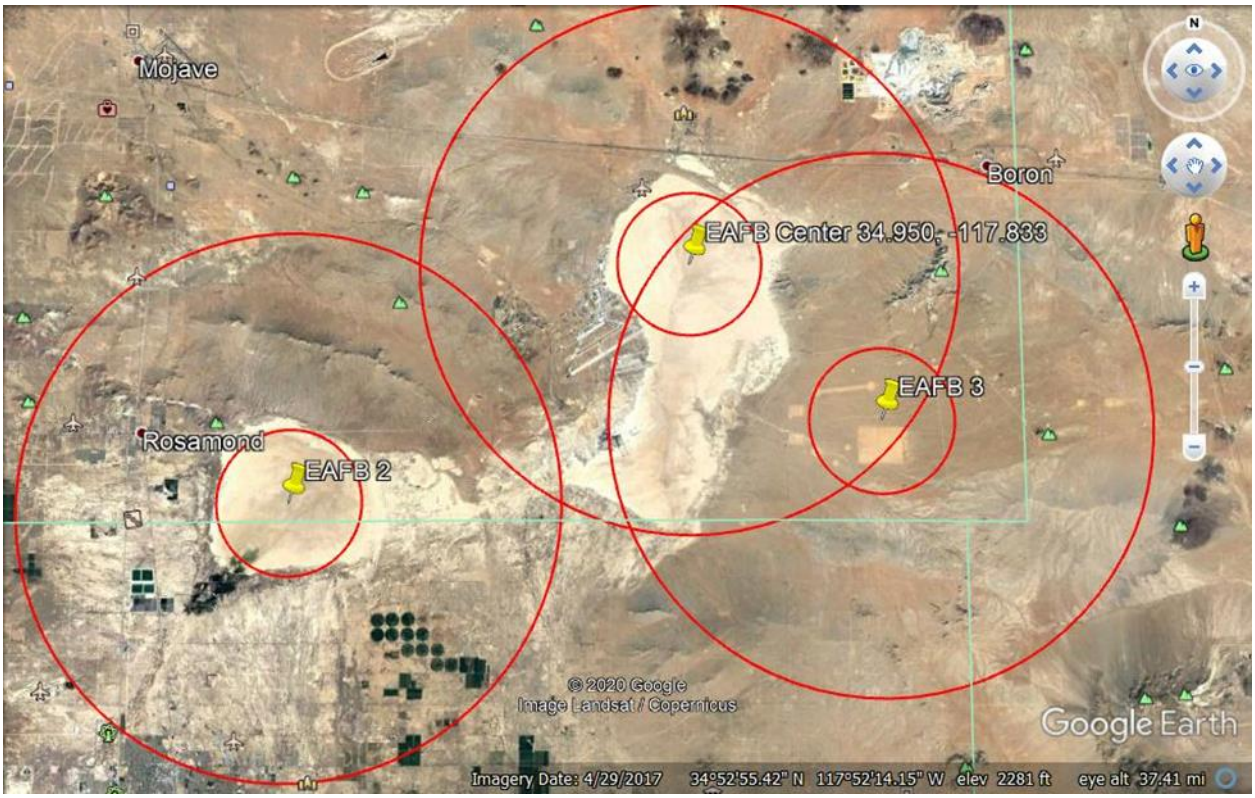


**Figure 2-1: EAFB Alternatives**

### 2.4.2 Naval Air Weapons Station at China Lake Alternative

One alternative at China lake was assessed as shown in Figure 2-2. The inner circle shows the 4 km radius landing zone for the CM. The outer circle shows the 15 km radius circles used in the analysis of possible landing zones for the jettisoned parts.

China Lake has several roads and other structures in the 4km landing circle needed for the CM. It also does not have available area to allow for an adequate landing zone for the jettisoned parts based on historical prevailing winds without impacting on other base structures or going off base onto private land. This would limit the landing opportunities available at this site based on historical winds.


**Figure 2-2: China Lake Alternative**

## 2.5 No Action Alternative

No emergency landings would occur under the No Action Alternative. This would reduce the landing opportunities for the Starliner and increase the chance of a water landing should the Starliner be required to make an emergency landing. Under this alternative, the FAA would not issue Boeing a license for Starliner operations at EAFB.

## 2.6 Alternatives Eliminated from Further Consideration

As result of the above, it was determined the Rogers Dry Lake Bed is the only acceptable alternative in this area of the United States that could be utilized for emergency landings caused by a failure of the launch vehicle. The other two alternatives at EAFB and the alternative at China Lake do not have enough area available to provide an adequate landing site for the CM or the jettisoned parts. As Rogers Dry Lake bed can support this scenario, a decision was made to also target it for other emergency landing scenarios, as described in Section 1.4, where a landing there eliminates the need to land the Starliner in the ocean. Rogers Dry Lake Bed does have seasonal flooding that would prevent a landing there when flooded. Should an emergency landing be required during those periods of time the landing would be targeted to the ocean. No further analysis was done for the other three alternatives and only a detailed analysis of the Rogers Dry Lake Bed alternative is included in this EA.

## 2.7 Details of the Proposed Action

### 2.7.1 Activities to be Performed

An emergency landing and recovery operations of the Starliner and its flight crew would include:

A. Landing and recovery of the flight crew from the Starliner.
    1. As soon as FAA and DAF are notified of an emergency landing, all parties will immediately start the necessary coordination, including the closure of airspace necessary to complete the reentry, in accordance with the Letter of Agreement (LOA).
    2. EAFB would be notified at least 3 hours prior to an emergency landing and would muster equipment and personnel outside the landing zone.
    3. Crew recovery would take 1-2 hours post landing utilizing pickup trucks, fire/crash/rescue, ambulances, and (if landing at night) light carts.
    4. The CM would be covered with an environmental cover. Power would be supplied by an EAFB-provided portable generator.
    5. Parachutes would be recovered and bagged, utilizing pickup trucks.
B. Securing the Starliner until arrival of the Boeing recovery forces
    1. EAFB would provide 24/7 security to prevent access to the area around the CM which would utilize vehicles and light carts.
    2. Boeing personnel would arrive as early as the day after landing.
    3. The Boeing shipping container would take up to 3 days to arrive from WSMR.
C. Recovering the Starliner and jettisoned parts (unless a decision is made to leave any in place) for shipment back to KSC.
    1. Recovering the Starliner from the lake bed would take 1 day utilizing a crane, flatbed pulling a trailer, and pickups.
    2. Preparing the Starliner for shipment would take up to 10 days. This would take place in a hangar at EAFB, if one is available, or in a Boeing-provided tent that would be set up in a non-interference location along the flight line or in a parking lot.
D. Repairing any damage to the lakebed if required

Boeing has established a contract with EAFB to fund Air Force support to this action. The proposed action would be performed by current EAFB staff. Boeing is required to apply to the FAA for a license for all commercial missions that begin after completion of the three test flights. Therefore, the FAA action of issuing Boeing a license for reentry and landing at the EAFB site is considered part of the proposed action analyzed in this EA.

### 2.7.2 EAFB Landing Location

The center of the landing area is located at a latitude of 34.950 degrees and a latitude of -117.883 degrees (Figure 2-1). The Starliner CM would be targeted to land within a 1 km radius circle around this center point although, to allow for margin based on the winds on landing day, a 4km radius landing zone from the center point would be available. Based on historical winds at EAFB several small pieces that are jettisoned during the parachute deployment process could land up to 12 km from this center point during the winter months that experience higher winds. This would require landing zone cutouts be established for landing at EAFB to ensure no parts of the spacecraft go outside the approved landing zone. After consultation between Boeing and the Air Force, a “keyhole” has been established outside the 4 km radius landing zone that allows use of EAFB when the winds could push the jettisoned items outside the 4km landing area. The 1 km (in red) and 4 km (in red/yellow) radius circles and the total approved landing zone for EAFB (in yellow) is shown in Figure 2-3. Note the “keyhole” was established out to 15km from the center point to the southeast based on preliminary analysis on the travel distance of some of the

smaller parts. The most recent analysis limits this distance to 12 km but the original keyhole was kept to allow for margin in that direction.

A wind forecast at landing would be generated using both available weather service forecasts and data provided by any weather balloons that could be launched at the landing site prior to landing, time permitting. The forecast winds would be utilized by the Mission Control Center in Houston to both determine if conditions are acceptable for landing the CM and to predict the landing locations of each part of the Starliner jettisoned during the landing sequence. The predictions include dispersions. Table 2-2 shows the acceptable weather landing conditions for the CM. Figure 2-4 shows an example of the output of the model for an historical wind case at EAFB. Should any part of any box fall outside the approved landing zone boundary EAFB, Boeing and NASA management would determine if the landing can proceed or the Starliner would be targeted to the water. The example shown would allow for the landing to proceed. This landing location data would also be utilized by EAFB and Boeing personnel retrieving the jettisoned parts to minimize the area that must be traversed during their recovery. This map would also allow EAFB to determine if any of the parts landed in potentially sensitive areas so a decision could be made whether to leave those parts in place. More information on the model used to predict the landing areas for the jettisoned parts can be found in Appendix F.

All airspace reentry operations would comply with the necessary notification requirements, including issuance of Notices to Airmen (NOTAMs) and, if necessary, Notices to Mariners (NOTMARs) , as defined in agreements required for a license issued by the FAA. 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]*). Similarly, the National Geospatial-Intelligence Agency, in conjunction with the U.S. Coast Guard, publishes NOTMARs weekly and as needed, informing the maritime community of temporary changes in conditions or hazards in navigable waterways.

Boeing has executed a Letter of Agreement (LOA) with Albuquerque Air Route Traffic Control Center (ARTCC), Los Angeles ARTCC, Oakland ARTCC, Anchorage ARTCC, Salt Lake ARTCC, Joshua Control Facility, Air Traffic Control System Command Center, Utah Training and Test Range, White Sands Missile Range, Edwards Air Force Base, and Fort Huachuca to accommodate Starliner reentry. The LOA outlines coordination responsibilities and procedures for all signatories prior to, during, and upon completion of a reentry including any associated airspace closures. The proposed action would not require the FAA to alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace will be necessary to ensure public safety during the proposed operations. Reentries would be infrequent (up to two per year in any given year), of short duration, and scheduled in advance as much as possible to minimize interruption to airspace and waterways.

For all reentry missions, the FAA and Boeing would take steps to reduce the airspace closure duration as the mission unfolds. First, Boeing plans to conduct its reentry at the beginning of its reentry window. While Boeing may request a window that spans hours to have more opportunity to work around weather or technical issues, Boeing would make every effort to reenter as soon as it is ready in the reentry window. While percentages are not readily available, far more reentries occur at or near the reentry window opening than the closing. As the reentry unfolds successfully, the FAA incrementally releases airspace as it is no longer affected. For example, the airspace nearest the reentry point can generally be released within minutes of reentry as the spacecraft descends 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 projected maximum values defined in a given NOTAM.

For the above reasons, significant environmental impacts of the temporary closures of airspace and waterways under the Proposed Action are not anticipated.

**Table 2-2: Landing Weather Limits**

| Weather Criteria | Limit |
|---|---|
| Emergency Near-Surface Steady and Peak Wind (Altitude = 110 Ft Above Ground Level (AGL)) | ≤ 23 Knots (11.8 M/S) |
| Temperature | ≥ 15 Deg F (-9.4 C) |
| Ceiling/Visibility | ≥ 1000 Ft (305 M) / 1 Nautical Mile (1.9km) |
| Precipitation | None Within 35 Km of Center Point |
| Thunderstorm | None Within 35 Km of Center Point |
| Lightning | None Within 35 Km of Center Point |

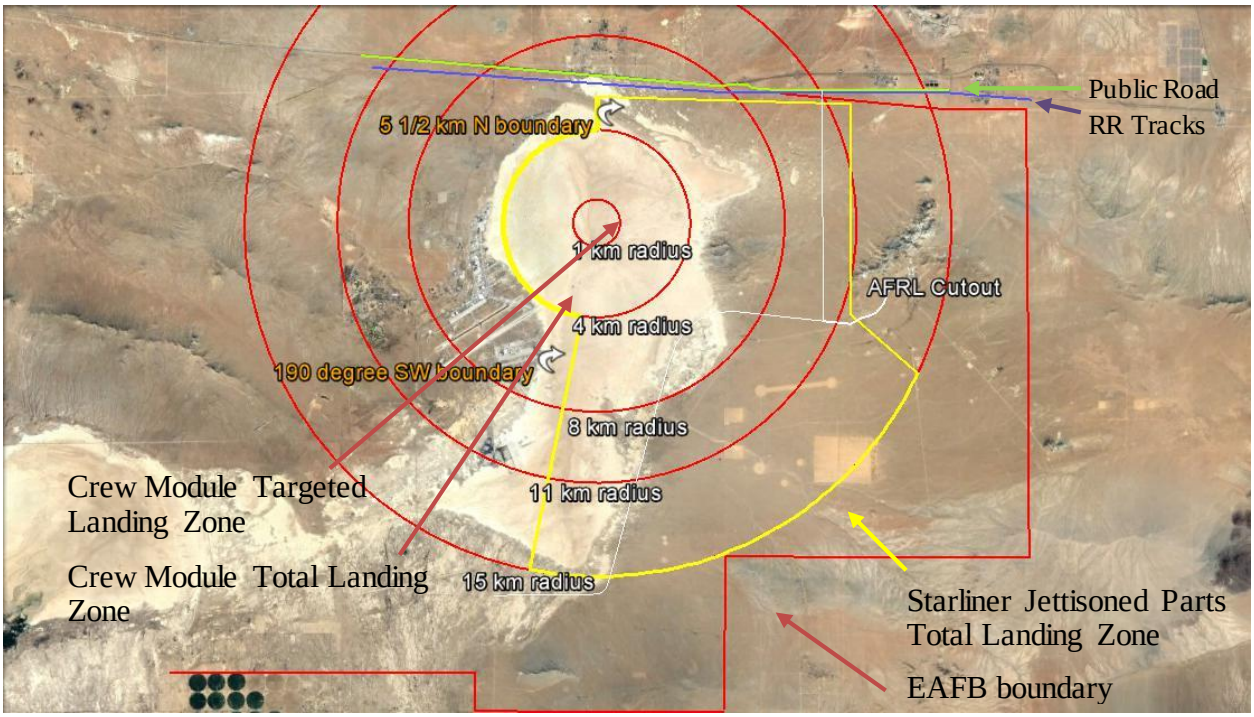


**Figure 2-3: Edwards Total Landing Area**

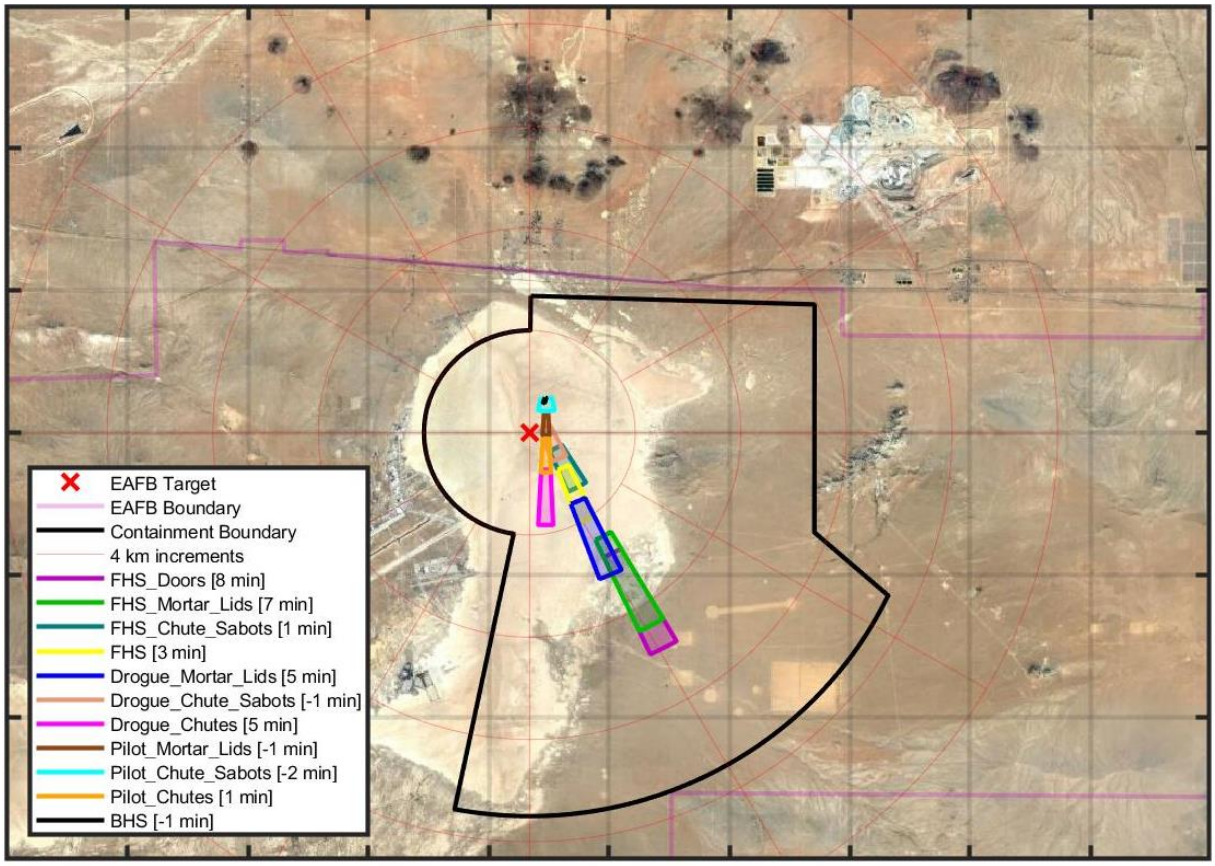


**Figure 2-4: Example Output from Jettisoned Parts Landing Area Prediction Model**

### 2.7.3 Starliner Description

Boeing's CCTS Starliner spacecraft is being developed in collaboration with NASA's Commercial Crew Program. The Starliner is designed to accommodate seven passengers, or a mix of crew and cargo, for missions to low-Earth orbit. For NASA service missions to the ISS, it will carry up to four NASA-sponsored crew members and time-critical scientific research. The CCTS system consists of three segments: the Starliner spacecraft, the Atlas V launching rocket, and the ground support infrastructure. The Starliner segment includes the CM and Service Module (SM). This segment supports the flight crew through launch, on-orbit, and return operations. The CM and several jettisoned parts (unless a decision is made to leave any in place) are the only portions of the Starliner that are recovered at the end of a mission at one of the terrestrial landing sites. They are returned to the Kennedy Space Center (KSC) for refurbishment and processing for a future mission. The Starliner is reusable up to 10 times with a six-month turnaround time.

Boeing will build, integrate, test and service the Starliner in the Commercial Crew and Cargo Processing Facility (C3PF) at KSC before transporting it to the CCSFS for integration onto the Atlas V rocket. The Starliner launches flight crew and cargo from Space Launch Complex (SLC) 41 at the CCSFS, maneuvers in orbit to rendezvous with the ISS, and docks for up to 210 days. It returns to either a primary or backup terrestrial landing site at the end of each mission. For an emergency landing that does not allow time for targeting one of the four nominal end of mission landing sites, the landing will take place at EAFB if possible. The Boeing Landing Recovery Team (LRT) will deploy to EAFB to recover the CM and jettisoned parts following any emergency return landings at that location.

The Starliner spacecraft jettisons several pieces of hardware during the landing phase of the mission (Figure 2-5). The Forward Heat Shield (FHS) (less than 10 ft. in diameter, less than 2 feet tall, and less

than 350 pounds) would jettison at approximately 30,000 feet altitude and parachute to the ground under two pilot chutes (each less than 10 feet in diameter and weighing less than 15 pounds). The CM drogue parachutes (2 chutes each less than 25 feet in diameter and weighing less than 75 pounds) would jettison at approximately 8000 feet altitude just before deployment of the main parachutes and continue to the ground. Three additional pilot chutes, identical to the FHS chutes, pull out the main chutes before releasing and continuing to the ground. Seven mortar lids (thin plates less than 18 inches in diameter and weighing less than one pound) and several mortar sabots (less than 18 inches and weighing less than 3 pounds) would jettison at various altitudes as part of the FHS and parachute deployments described above and would free fall to the ground. The Base Heat Shield (BHS) (less than 15 ft. in diameter, less than 4 feet tall and weighing less than 1700 pounds) would jettison at approximately 4400 feet altitude and would free fall until ground impact. The three main landing parachutes (less than 110 feet in diameter and weighing less than 200 pounds) would jettison at CM landing. All jettisoned pieces would land within the approved landing zone. All items would be located and recovered, if possible. It may not be possible to find and recover all of the mortar lids and sabots due to their small size and the large area of the landing zone for these parts. Based on where these parts are predicted to land, a decision may also be made, after consultation between Boeing management and EAFB environmental personnel, to leave some of the smaller jettisoned parts in the field to avoid potential impacts to cultural sites and desert tortoise habitat caused by driving vehicles to find these parts. The composition of the jettisoned items do not pose any environmental concerns.

The CM contains hazardous material in the form of residual hydrazine, unused explosive devices, ammonia, and heat transfer material.

The CM lands on airbags that deploy just prior to landing. The weight of the CM at landing is less than 16,000 pounds, including dry weight, crew and cargo.

The above landing sequence is identical for an emergency water landing except additional air bags would inflate. For a water landing, a center airbag would inflate for stability and buoyance and air bags at the top of the Starliner inflate if needed to upright the capsule should it flip over after main chute deploy. Only the CM and crew are recovered after an emergency water landing. All jettisoned parts of the spacecraft will sink.

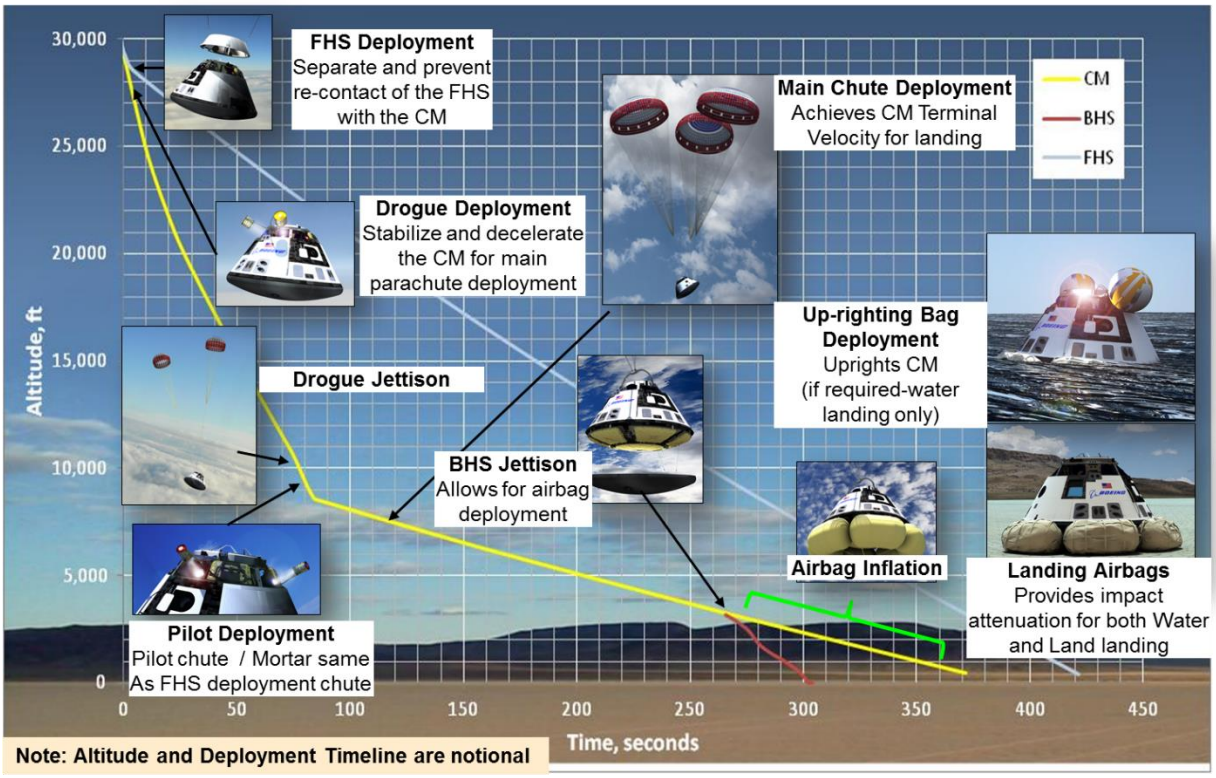


**Figure 2-5: Starliner Landing Sequence**

### 2.7.4 Landing Recovery Forces Description and Tasks

The Mission Control Center (MCC) in Houston controls the Starliner while on orbit. Should an emergency landing be required at EAFB, the MCC will notify landing site personnel of the impending landing. The crew recovery would be performed by EAFB personnel, vehicles and equipment with possible augmentation by local Boeing personnel and, if time permits, members of the Boeing LRT if they can arrive at EAFB before the landing. EAFB would perform the recovery activities with current base personnel. Boeing will also stage some equipment at EAFB needed to ensure the CM is safe for crew egress and to cover the CM after crew extraction.

The activities needed for the recovery are:

- Performing a check to ensure the CM is not leaking hydrazine propellant.
  - Boeing would provide a hydrazine monitor for use by EAFB personnel in protective gear
- Grounding of the CM to eliminate any electrical charge that might build up during entry.
  - Boeing would provide the grounding equipment for use by EAFB personnel
- Accessing and opening the hatch.
  - Performed by EAFB personnel
- Egressing the crew and sending them to a local hospital either via ambulance or life flight helicopter.
  - Performed by EAFB personnel
- Closing the hatch.
  - Performed by EAFB personnel
- Covering the CM with a protective cover.
  - Boeing would provide the cover for installation by EAFB personnel

  - EAFB would provide a generator and portable air conditioner to provide conditioned air to the cover until the CM is recovered at the landing site.
- The vehicles involved in the above post landing activities would consist of:
  - 4 pickup trucks
    - 1 for jettisoned parts and parachute retrieval and towing a light cart if needed for nighttime operations
    - 1 to carry the safing equipment and environmental cover and towing a light cart if needed for nighttime operations
    - 1 to carry the hatch protection equipment and be utilized for hatch access
    - 1 to tow the portable generator
  - 1 Fire/Crash/Rescue Truck
  - 2 Ambulances for transport of the crewmembers
  - All of the above vehicles and the generator would be provided by EAFB
  - All of the above vehicles would travel to the CM and return to base at the end of the crew recovery with the exception of the trucks used for jettisoned parts and parachute recovery
- Providing security around the CM until arrival of the Boeing recovery team.
  - Performed by EAFB personnel
  - This could consist of either a vehicle parked at the CM 24/7 or periodic drive-by

The Boeing recovery personnel and the CM and BHS/FHS shipping containers would arrive at EAFB 2-3 days after landing. These personnel, with support from EAFB, will perform the following activities once on site:

- Collect the remaining jettisoned parts
- Establish a CM preparation area either in an EAFB hangar if one is available or in a Boeing tent set up along the flight line or in a parking lot.
  - If the tent is used EAFB would provide a portable HVAC/generator to provide tent inflation and conditioned air
- Transport a trailer with a portion of the CM shipping container to the landing site.
- Utilizing a crane, put the CM onto the shipping container.
- Utilizing a crave, put the FHS and BHS onto a trailer or in a pickup
- Move the CM off the lake bed to the preparation area.
- Configure the CM, FHS, and BHS for shipment.
- Final load of the CM, FHS, and BHS into the shipping containers for shipment back to KSC.
- Loading of Boeing equipment for shipment back to WSMR.

For the above CM and parts recovery activities the vehicles would consist of:

- 1-2 EAFB-provided or Boeing-rented pickup trucks to collect the jettisoned parts
- An EAFB-provided crane used to:
  - Remove the top from the Boeing shipping container at the prep area
  - Lift the CM at the landing site
  - Lift the FHS and BHS at the landing site
  - Lift the CM at the preparation area
  - Lift the FHS and BHS into their shipping containers
  - Reinstall the top of shipping container at the end of processing in preparation for shipping the CM back to KSC
- Two EAFB-provided forklifts used to:
  - Unload a Boeing container at the preparation area containing equipment needed to prepare the CM for shipment back to KSC

    - Move the bottom of the shipping container from a Boeing contracted delivery low boy semi-truck to and EAFB provided flatbed for transport to the landing site
    - Lift the CM and the shipping container bottom off the flat bed at the preparation area
    - Load the FHS and BHS into
    - Lift the CM in the shipping container onto a Boeing contracted delivery low boy semi-truck for final shipment back to KSC
- An EAFB-provided truck and trailer to take the bottom part of the shipping container to the landing site and return with the CM to the preparation area
- An EAFB-provided truck and trailer to transport the FHS and BHS from the landing site to the preparation area
- All vehicles supporting the CM recovery would make one trip to the CM and return to base
- The 1-2 vehicles supporting jettisoned parts recovery would travel to/from the areas identified in the jettisoned parts landing map (example in Figure 2-4) to recovery the parts.

## 2.8 **Determination of Significance**

Determination of significance as used in NEPA requires consideration of both context and intensity of the Proposed Action as described in the CEQ regulations Section 1508.27. The significance of an action was analyzed relative to society as a whole (human, national), receptors, the affected region, the affected interests, the locality, and any other relevant aspects. In addition, the severity of impact was considered including:

- The degree to which the proposed action affects public health, safety, or the environment (or has the potential to do so)
- Unique characteristics of the geographic area (such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, endangered or threatened species/habitat, or ecologically critical areas)
- The degree to which the possible effects on the human environment are highly uncertain or involve new, unique or unknown risks
- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts
- Whether the action threatens ability to comply with applicable federal, state, or local law or requirements.

In addition, the FAA uses thresholds that serve as specific indicators of significant impact for some resource areas. FAA actions that would result in impacts at or above these thresholds require the preparation of an EIS, unless impacts can be reduced below threshold levels. Quantitative significance thresholds do not exist for all impact categories; however, the FAA has identified factors that should be considered in assessing the significance of impacts on the environmental impact category (FAA Order 1050.1F, Paragraph 4-3.3). Because the FAA plans to adopt this EA to support its environmental review of Boeing's license application, the FAA's significance thresholds are considered in the assessment of potential environmental consequences in this EA.

# 3.0 Affected Environments and Environmental Consequences

This section describes the affected environments and the potential environmental consequences of the proposed action by comparing these activities with the potentially affected environmental components for the EAFB landing site. To assess the potential for and significance of environmental impacts from the proposed activities, a list of activities was developed (Table 3-1) and the environmental setting was described, with emphasis on any special environmental sensitivities. Program activities were then compared with the potentially affected environmental components to determine the environmental impacts of the proposed landing and recovery operations.

The region of influence for all affected environments for this EA is the area within the boundaries of EAFB with the following exceptions:

For Department of Transportation Act, Section 4 (f), Biological Resources, Noise and Noise-Compatible Land Use, and Airspace, the region of influence also includes the area within the sonic boom footprint shown in Appendix C.

For Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks, the region of influence also includes the surrounding areas of California's Kern, Los Angeles, and San Bernardino Counties.

**Table 3-1: Resources Considered for Evaluation in this Environmental Assessment**

| **Resource Area** | **Analyzed in Detail in This EA** | **If Yes, EA Section Number**<br><br>**If No, Rationale for Dismissal** |
|---|---|---|
| Air Quality | Yes | 3.1 |
| Biological Resource | Yes | 3.2 |
| Climate | Yes | 3.3 |
| Department of Transportation Act, Sec 4(f) | Yes | 3.4 |
| Land Use and Airspace | Yes | 3.5 |
| Physical Resources | Yes | 3.6 |
| Cultural Resources | Yes | 3.7 |
| Noise, Noise Compatible Land Use, and Vibration) | Yes | 3.8 |
| Socioeconomics | Yes | 3.9 |
| Environmental Justice and Children's Health and Safety Risks | Yes | 3.10 |
| Visual Effects | Yes | 3.11 |
| Infrastructure and Utilities | Yes | 3.12 |
| Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention | Yes | 3.13 |
| Human Health and Safety | Yes | 3.14 |
| Farmland | No | No farmland is present in the area affected by the proposed action |
| Coastal Area | No | No coastal areas are present in the area affected by the proposed action |
| Mineral and Energy Resources | No | The proposed action would not result in the development of new facilities or result in consumption of natural resources other than the fuel used during the recovery operations. |

# 3.1 Air Quality

## 3.1.1 Affected Environments

Air quality at EAFB is regulated by the U.S. Environmental Protection Agency (U.S. EPA).

EAFB is located within the jurisdiction of three air districts: Eastern Kern Air Pollution Control District (EKAPCD), Mojave Desert Air Quality Management District (MDAQMD), and Antelope Valley Air Quality Management District (AVAQMD). (Figure 3-1).

Due to the location of the landing area, all proposed action activities would occur in the eastern portion of Kern County in EAFB, under the jurisdiction of the EKAPCD. As a result, maintaining air quality would be conducted in accordance with the regulatory requirements of the EKAPCD.

Air quality is determined on several factors including the type and amount of pollutants emitted into the atmosphere, the size of the air basin, and prevailing meteorological conditions. The significance of pollutant concentrations is determined by comparing ambient measured concentration levels to the National Ambient Air Quality Standards (NAAQS). These standards represent the maximum allowable atmospheric concentrations that may occur, while ensuring protection to public respiratory health and welfare under reasonable margins of safety.

Under the NAAQS, the U.S. EPA has developed numerical air emission concentration standards for seven criteria pollutants under provisions of the federal Clean Air Act of 1970 (CAA) (42 U.S.C. 7401–7671) and the 1990 Clean Air Act Amendments (Public Law 101-549). The criteria pollutants include ozone ($O_3$), particulate matter less than or equal to 10 microns/respirable particulate matter ($PM_{10}$), particulate matter less than or equal to 2.5 microns/fine particulate matter ($PM_{2.5}$), carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead.

The U.S. EPA tracks air quality on an ongoing basis and designate areas or basins as either attainment or nonattainment, based on the measured concentration of criteria pollutants. A maintenance area is defined as a geographic area of the United States and territories previously designated nonattainment pursuant the CAA Amendments of 1990 and subsequently re-designated in 40 CFR Part 81 to attainment, meeting the provisions of section 107(d)(3)(E) of the Act and has a maintenance plan approved under section 175A of the Act. An area may be designated as marginal, moderate, serious, severe, or extreme nonattainment depending upon the level of pollutant concentrations. Likewise, if standards are achieved for pollutants in a particular area, the area is designated in attainment. Areas designated as unclassified when standards have not been established, or when there is a lack of monitoring data for criteria pollutants. Unclassified areas are treated as attainment areas until proven otherwise.

The action will fall within the Eastern Kern County severe 8-hr Ozone Nonattainment Area within EKAPCD and does not fall within any other nonattainment or maintenance area.

Beginning in 2012, NEPA project reviews must consider greenhouse gas emissions (GHG) in addition to criteria pollutants during environmental assessments. GHG include air pollutants commonly associated with climate change, but not limited to carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

To ensure compliance with relevant federal air regulations each air quality control district enacts their own rules and regulations. Local air districts use Title V federal permit programs and stationary source new source review (NSR) permits, such as an authority to construct and permit to operate, as means of enforcing air quality rules and regulations. For EKAPCD, NSR is implemented under Rule 210.1, New and Modified NSR and Rule 210.1A Major New and Modified Stationary Source Review (MNSR). These rules establish project limits based on a significance level that may require emissions are mitigated thorough the use of control technology or other offsets. EKAPCD recommends using offset limits in these rules as guidance for establishing de minimis thresholds in project reviews, because these are more stringent than the NEPA de minimis thresholds.

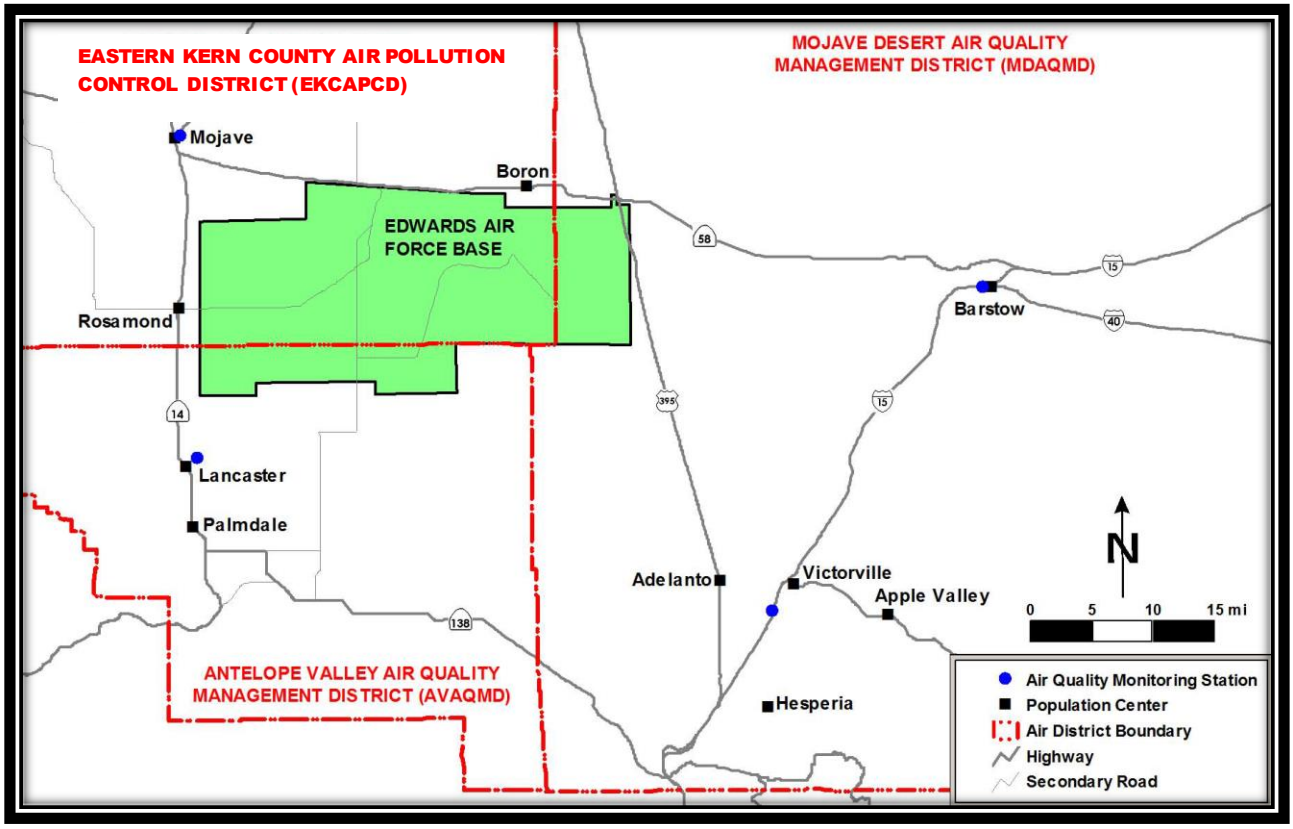


**Figure 3-1: EAFB Air District Boundaries**

### 3.1.2 Environmental Consequences

Impacts resulting from the proposed action would be considered significant if they cause levels of air pollution that cause an exceedance of permit limits or regional air quality standards. Impacts would also be significant if the action would cause pollutant concentrations to exceed one or more of the NAAQS or would increase the frequency or severity of any such existing violations (FAA Order 1050.1F).

The proposed action utilizes EAFB as a potential emergency landing site beginning with either the OFT-2 or CFT mission followed by regularly scheduled missions anticipated to take place 1-2 times/per year. Crew recovery activities would take place on the lake bed post landing and take 1-2 hours. The CM would then be covered with an environmental enclosure inflated by a portable generator for up to 3 days while the Boeing shipping container is transported to EAFB. Recovering the CM and jettisoned parts from the lake bed is a 1 day event and requires a crane and semi-truck. Preparing the CM for shipment takes up to 10 days and will take place either in an EAFB hangar, if one is available, or in a Boeing-provided tent. If a tent is required, it will be inflated by an EAFB-provided generator. The action takes place entirely within the EKAPCD with the exception of the travel necessary to move the Boeing shipping container and equipment to/from EAFB. EAFB recovery vehicles and portable generators would be the primary emission sources. No new stationary sources of emissions will be built or brought on base for the project.

The Starliner spacecraft lands under parachutes. Reentry of the Starliner would not generate GHG emissions. No propulsion jet firings take place below approximately 30,000 feet altitude. This is of primary importance to the FAA's action due to its analysis of emissions within 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.

During the landing and recovery operations air emissions would be generated from vehicle and portable generator combustion, man-made dust, and, should a failure occur, fluid release from the Starliner (hydrazine or ammonia) or recovery vehicles (diesel or gasoline).

Dust or soil particulate matter disturbance would occur at the landing site for the Starliner spacecraft, at the impact sites for the items jettisoned before landing, and from the recovery vehicles. However, only small quantities of dust would be generated during these short events. Recovery personnel would maintain speed limits on unpaved roads on base between 5 and 35 miles per hour (mph) according to the posted speed limit and use water trucks once or twice a day to keep soil damp on frequently traveled unpaved roads (more than 20 vehicle trips per day). The maximum speed limit on unpaved roads that do not employ dust control measures is 15 mph. Chemical/organic stabilizers and dust suppressants would not violate State Water Quality Control Board standards and be accepted by, EPA, and the local District. Cleanup of project-related dirt track out or bulk material spills on publicly maintained paved surfaces would be accomplished within 24 hours. Impacts to air quality from dust would be negligible.

The Proposed Action would require the use of portable generators to supply appropriate power at the landing site. These generators are included in the EAFB air permits and would be operated in accordance with the applicable regulations and operating restrictions. The Air Force registration for tactical support equipment (TSE) is shown in Appendix J. The list is a snapshot of the base TSE inventory. EAFB is allowed to add / remove TSE equipment throughout the year without modifying the permit as long as the items meet the following definition:

"Military tactical support equipment is owned by the U.S. Department of Defense and/or the U.S. military services and used in combat, combat support, combat service support, tactical or relief operations, or training for such operations. Examples include, but are not limited to, internal combustion engines, associated with portable generators, aircraft start carts, heaters, and lighting carts"

EAFB obtained concurrence with the EKAPCD Air Pollution Control Officer that the use of TSE equipment for Starliner recovery after an emergency landing at EAFB is within the definition of tactical support under relief operations.

Emission calculations were done using individual pollutant emission rate data from a combination of the *Air Emissions Guide for Air Force Mobile Sources Methods For Estimating Emissions Of Air Pollutants For Mobile Sources At United States Air Force Installations* (June 2020)and *AP-42: Compilation of Air Emissions Factors*, depending on pollutant, as shown in Appendix E. Air Force projects normally require the use of the Air Force Conformity Applicability Model (ACAM) for emissions calculations. However, after discussion with EAFB it was determined this model isn't suitable for calculating emissions for this project. Table 3-2 shows the total estimated emissions generated by Boeing and EAFB-provided vehicles for each landing at EAFB. Appendix E shows the detailed calculations for each emission source. Calculations include the Boeing-provided semi-truck used to transport the Starliner shipping container from KSC and return, a second semi-truck used to transport the recovery trailer from WMSR and return, 4 Boeing California rented vehicles for employees travelling to/from Lancaster, and a crane, generator, and two forklifts provided by EAFB. Other EAFB support vehicles and equipment provided from base assets are not included as the proposed use would be comparable to daily operations. The majority of the emissions will take place outside California as the semi-trucks bringing the CM recovery equipment travel from WSMR and return to either WSMR or KSC.

**Table 3-2: Air Emissions Calculation Table**

**Total Emissions per Landing (lbs.)**

| | Source | NOx | $SO_2$ | CO | ROG | PM | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ | $NH_3$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Non-California | Vehicle Emissions | 17.14 | 4.64 | 49.56 | 0.12 | NR | 1.44 | 1.32 | 14694 | 0.28 |
| | Fugitive Dust Emissions | | | | | 4.86 | 0.93 | 0.23 | | |
| | Total (lb) | 17.14 | 4.64 | 49.56 | 0.12 | 4.86 | 2.36 | 1.55 | 14694 | 0.28 |
| | Total (tons) | 0.01 | 0.002 | 0.02 | 0.0001 | 0.0024 | 0.001 | 0.001 | 7.35 | 0.0001 |
| California | Vehicle Emissions | 5.72 | 1.11 | 25.63 | 2.02 | NR | 0.68 | 0.46 | 5867 | 0.22 |
| | Fugitive Dust Emissions | | | | | 5.20 | 1.08 | 0.23 | | |
| | Equipment Emissions | 0.32 | 0.00 | 0.21 | 0.03 | 0.32 | 0.01 | 0.01 | 61.76 | 0.00 |
| | Total (lb) | 6.03 | 1.11 | 25.84 | 2.06 | 5.51 | 1.77 | 0.70 | 5929 | 0.22 |
| | Total (tons) | 0.003 | 0.001 | 0.01 | 0.001 | 0.003 | 0.001 | 0.0004 | 2.96 | 0.0001 |
| Total Project | | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.00 | 10.31 | 0.00 |

**NEPA and General Conformity Thresholds**

| | Emissions Summary (ton/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Location** | **CO** | **$NO_x$** | **PM** | **$PM_{10}$** | **$PM_{2.5}$** | **$SO_2$** | **VOC** | **$CO_2e$** |
| Project TPY | 0.01 | 0.003 | 0.003 | 0.001 | 0.0004 | 0.001 | 0.001 | 2.965 |
| NEPA Thresholds for EKAPCD | 100 | 50 | 70 | 70 | 100 | 100 | 25 | 25,000 |
| General Conformity De Minimis Thresholds | 100 | 100 | | 100 | 100 | 100 | 25 | |

*NOX-Nitrogen Oxides, SO2-Sulfur Oxides, CO-Carbon Monoxide, ROG-Reactive Organic Gases, PM-Particulate Matter, PM10-Paticulate Matter/≤10 microns, PM2.5-Paticulate Matter/≤2.5 microns, $CO_{2e}$-Carbon Dioxide, $NH_3$-Ammonia, VOC-Volatile Organic Compounds*

When the totals are doubled to take into account a maximum of two landings per year these estimated emissions are well below the de minimis levels set by the CAA regulations for all pollutants and GHG for the appropriate containment classification. (EPA, De Minimis Tables)

During these landings and subsequent recovery phase, hydrazine or ammonia (from the spacecraft) or fuel or coolant (from the vehicles or generators) may be released to the air should a failure occur that causes a leak. A typical Safety Data Sheet (SDS) for each of the hazardous materials are located in Appendix A. Note: the title page for the NASA Explosive Bolt Assembly sheet lists it as a Material Safety Data Sheet (MSDS) but the subsequent pages are labeled SDS.

Air Force personnel would conduct a hydrazine sniff check in protective gear to ensure the spacecraft is safe to approach. In the event of a fuel leak from the Starliner spacecraft, the actual hazard distances would depend on the amount of hydrazine released, meteorological conditions, and emergency response measures taken. A downwind plume of up to ¾ of a mile wide and 6+ miles long could result depending on wind conditions. A dispersion model of potential hydrazine releases has been performed to establish the worst-case hazard scenarios assuming 90 pounds of hydrazine remaining on the spacecraft following the landing is released in the atmosphere. Note the maximum remaining hydrazine for a typical ISS mission is 55 pounds (Details of the dispersion models are available in Appendix B). Standard Operating

Procedures (SOPs) are being developed, including having recovery personnel in personal protection equipment approach the spacecraft with sniffers to determine the presence of any free hydrazine. The procedures will document the distances at which it would be safe to establish perimeters around the spacecraft during the sniff tests. Establishment of and adherence to these SOPs would minimize potential hazards to recovery personnel in the unlikely event of an unplanned propellant release. The low likelihood of such an occurrence and the implementation of approved emergency response plans would limit the impact of such a release. In addition, the remote location of the site and the prevailing weather conditions provide the time and distance required to disperse the pollutants to non-hazardous levels before reaching inhabited areas. Boeing would be responsible for final cleanup and disposal of any hazardous waste.

The ammonia present on the spacecraft is contained in several heat pipes used in the cooling system. Release would only take place in the unlikely event of a weld failure or puncture of the heat pipe. The maximum amount of ammonia in the largest heat pipe is less than 12 grams.

In the event of a fuel leak from an EAFB-provided vehicle or generator, EAFB SOPs will be utilized to contain and clean up the spill.

Fire suppression, hazardous materials emergency response, and emergency medical teams would be on site during landing and recovery operations.

The proposed action does not include any new or modified stationary sources emissions.

Airspace closures associated with reentries would result in additional aircraft emissions primarily from aircraft being re-routed and subsequently expending additional fuel. However, emissions from aircraft being re-routed would occur above 3,000 feet (the mixing layer) where NAAQS would not be applicable; therefore, no impact to air quality would occur from aircraft re-routing from airspace closures.

With regards to potential departure delays, airspace-related impacts could increase up to a maximum of 2 times per year; however, only a negligible amount of emissions would be generated from any aircraft departure delays associated with reentries. Therefore, any air emissions increase from departure delays are not expected to result in an exceedance of a NAAQS for any criteria pollutant. It is likely that grounded aircraft would not have its engines idling during such a foreseeable delay, further minimizing increases in air emissions. Emissions from aircraft being re-routed would occur above 3,000 feet and thus would not affect ambient air quality. Therefore, airspace closures associated with reentries are not expected to result in significant air quality impacts.

In summary, the Proposed Action would not result in exceedance of any air quality standards or permit levels and therefore would not result in significant air quality impacts.

### 3.1.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in air quality impacts at the EAFB landing site or the surrounding area.

## 3.2 **Biological Resources**

### 3.2.1 **Affected Environment**

Biological resources include native and introduced plants that comprise various vegetative habitats, the animals that are found in such habitats and the natural environment that support wildlife populations. EAFB manages biological resources that are typical of the western Mojave Desert. The plant and animal species that characterize the desert community can occur in previously disturbed areas around the base, including areas surrounding existing structures and road shoulders.

EAFB manages non-federally listed species through the use of general conservation measures outlined in the *Integrated Natural Resources Management Plan for Edwards Air Force Base, California, Air Force Test Center* and any future revised INRMP.

Migratory birds are protected under the *Migratory Bird Treaty Act* (*MBTA*) (16 U.S.C. 703- 712) and Executive Order 13186, R*esponsibilities of Federal Agencies to Protect Migratory Birds* (11 January 20111). Migratory birds typically build their nest on roofs, on ledges above doors and building entrances and along eaves of occupied and abandoned buildings and other facilities and in nearby trees planned for removal during construction activities. Migratory birds, their active nests, eggs and young in the nest are protected under the *MBTA* from being harmed, removed or killed without a depredation permit from the USFWS.

The U.S. Fish and Wildlife Service (USFWS) website was consulted in August 2020 to complete an Information for Planning and Conservation (IPaC) search which provided a current list of potential threatened and endangered species (TES) and migratory birds that may occur at the proposed landing site and within the sonic boom footprint of the Starliner.

The U.S. Fish and Wildlife Service Biological Opinion (BO) for: Operations and Activities Edwards Air Force Base, California (8-8-14-F-14, dated March 11, 2014, see appendix B) addresses the effects on the federally threatened desert tortoise and its critical habitat and states that: "Overall, the operation of Edwards Air Force Base, as described in this biological opinion, including the development of solar energy facilities, is unlikely to adversely affect the recovery of the desert tortoise." The BO covers the proposed activity. The Biological Opinion notes that over a 16 year period only 5 desert tortoise mortalities occurred.

#### 3.2.1.1 Flora

There are 50 plant associations at EAFB, of which main plant communities are creosote bush (Larrea tridentata) scrub, saltbush (Atriplex spp.) scrub, Joshua tree (Yucca brevifolia), and mesquite (Prosopis spp.) (EAFB Integrated Resource Management Plan (INRMP) 2020). There are 19 sensitive plant species of interest, listed on the California Natural Diversity Database (shown in Figure 3-2 and listed in Appendix H). None of these species is present in the 4km radius area of the landing zone. Mohave Spineflower, Desert Cymopterus, Yellow Spinecape, Mojave Wooly Sunflower, Sagebrush Loeflingia, and Rosamond Eriastrum, as well as the Joshua Tree which is under consideration for addition to the database, are present in the jettisoned parts extension. There is no federal protection for these species at this time and there are no known Endangered Species Act (ESA)-listed plant species in the study area.

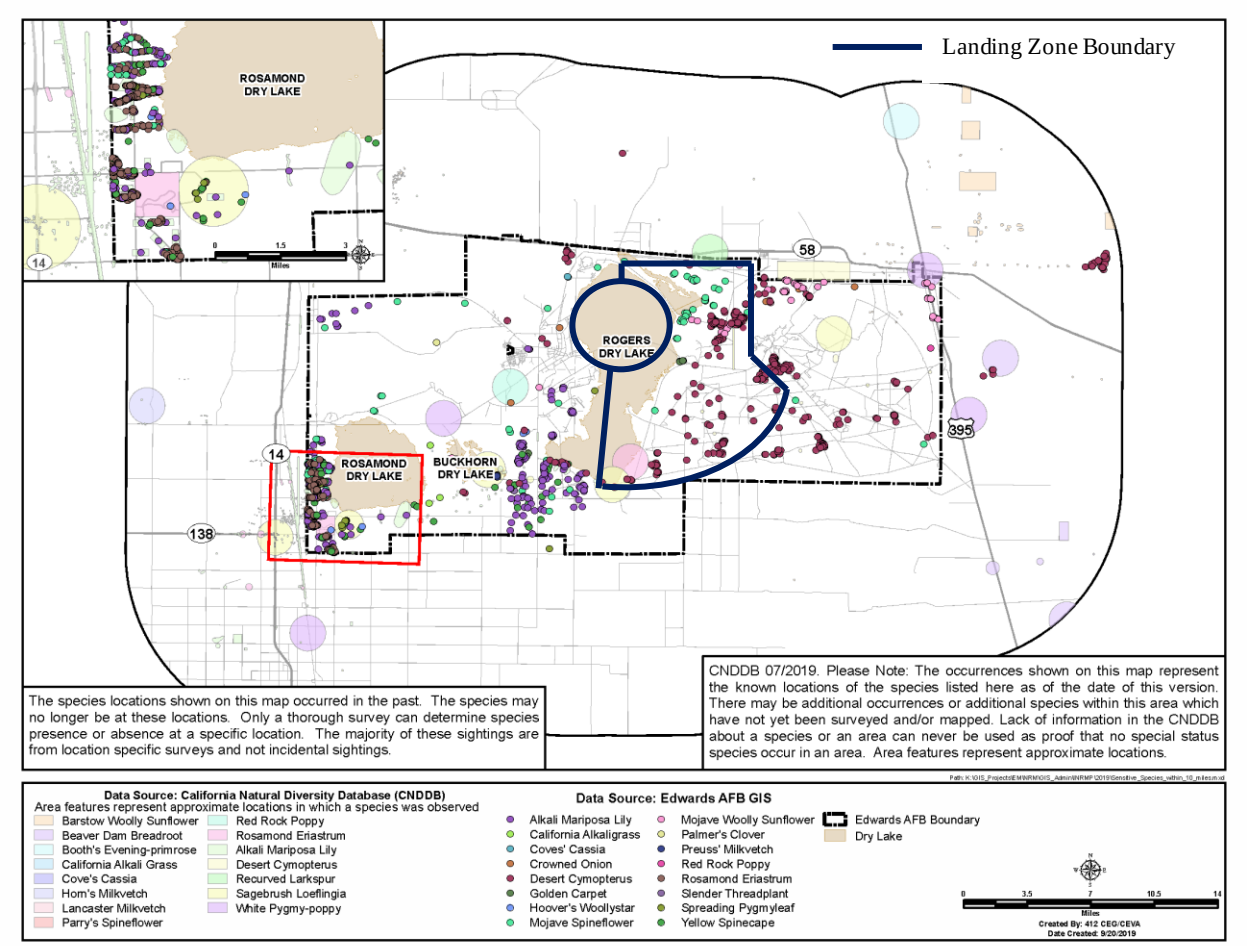


**Figure 3-2: EAFB Sensitive Plant Species**

### 3.2.1.2 Fauna

#### 3.2.1.2.1 Endangered Species

One federally threatened species, the desert tortoise (Gopherus agassizii), is of concern on EAFB. The desert tortoise is a permanent resident and has critical habitat within the landing zone. Desert tortoise densities vary throughout the base, with the highest densities mostly concentrated in the designated critical habitat comprising about 60,800 acres on base (Figure 3-3). Critical habitat designated by the USFWS is defined as "the specific area within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the ESA, on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection" (16 USC § 1532). Critical habitat is, in general, less disturbed and has higher levels of protection and more restrictions in its use.

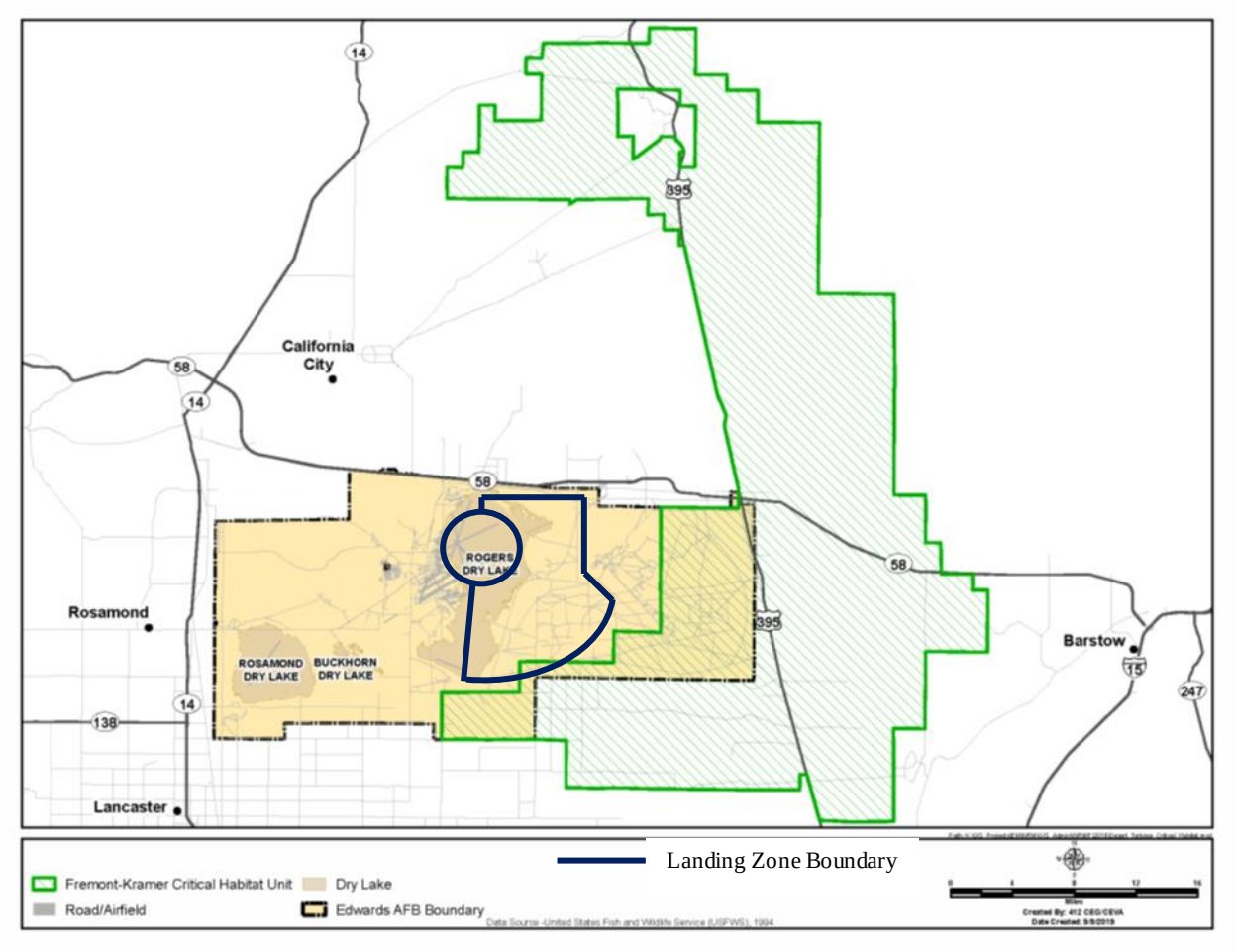


**Figure 3-3: Desert Tortoise Critical Habitat**

#### 3.2.1.2.2 Birds Protected Under the Migratory Bird Treaty Act

Per the USFWS IPaC website, the following migratory birds protected under the Migratory Bird Treaty Act could be present at EAFB during certain portions of the year:

- Allen's Hummingbird (Selasphorus sasin)
- Burrowing Owl (Athene cunicularia)
- Clark's Grebe (Aechmophorus clarkia)
- Costa's Hummingbird (Calypte costae)
- Golden Eagle (Aquila chrysaetos)
- Lawrence's Goldfinch (Carduelis lawrencei)
- Le Conte's Thrasher (toxostoma lecontei)
- Long-billed Curlew (Numenius americanus)
- Marbled Godwit (Limosa fedoa)
- Mountain Plover (Charadrius montanus)
- Rufous Hummingbird (selasphorus rufus)
- Whimbrel (Numenius phaeopus)
- Willet (Tringa semipalmata)

#### 3.2.1.2.3 Mohave Ground Squirrels

The Mohave ground squirrel is currently a threatened species under the California Endangered Species Act (CESA). On EAFB, the Mohave ground squirrel population distribution is widely scattered east, west and south of Rogers Dry Lake in creosote bush scrub and saltbush scrub habitat (including desert tortoise critical habitat on the Precision Impact Range Area southeast of the lake bed (Figure 3-4).

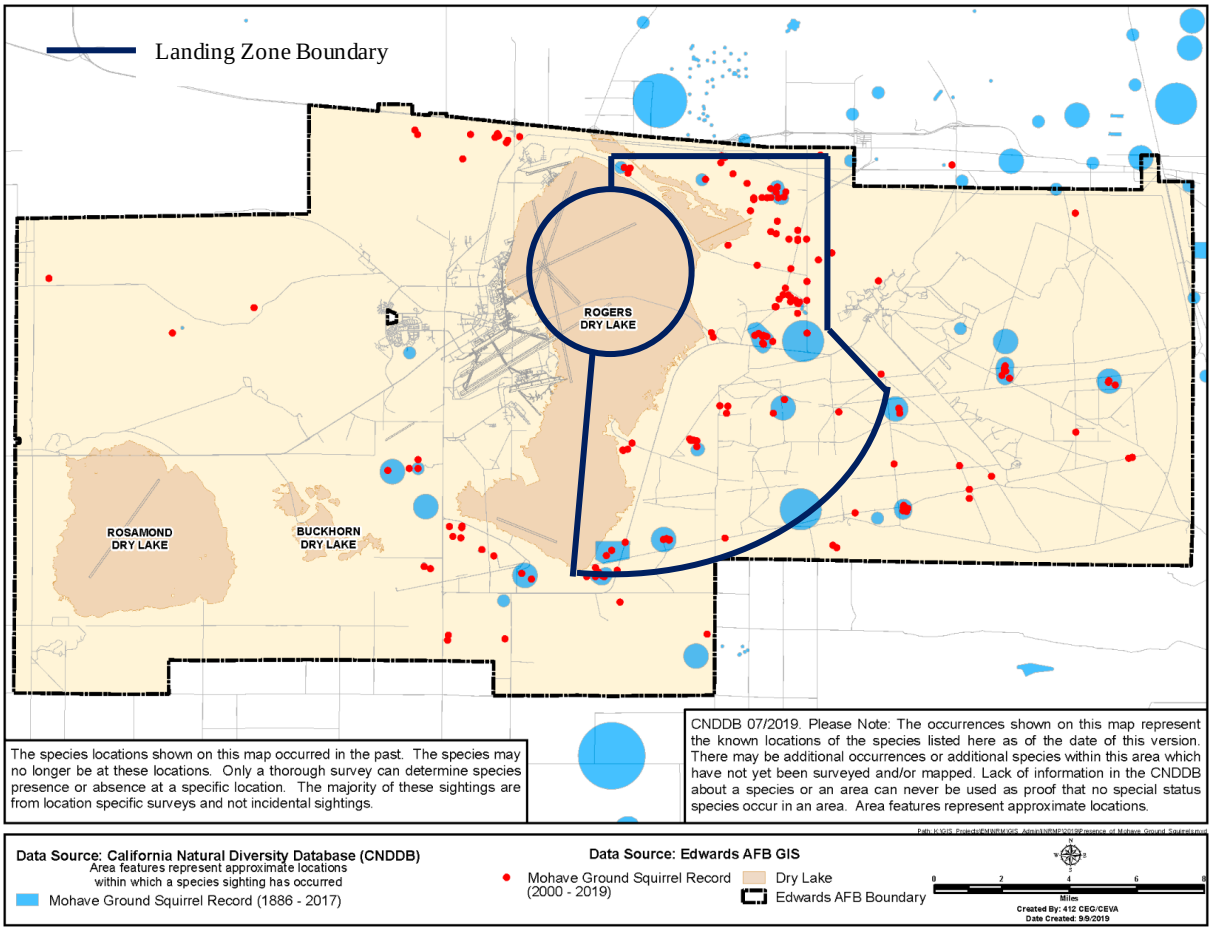


**Figure 3-4: Presence of Mohave Ground Squirrel**

#### 3.2.1.2.4 California Species of Concern

In addition to the federal and state listed species listed above there are 3 reptiles, 45 birds, 7 mammals, and 3 invertebrates listed as California species of concern that are present on EAFB (see Appendix H).

#### 3.2.1.2.5 Sonic Boom Footprint

Appendix H shows the federally listed species and whether there is critical habitat within the footprint of the sonic boom as shown in the USFWS IPaC system.

### 3.2.2 **Environmental Consequences**

Impacts resulting from the proposed action would be considered significant if:
1. The U.S. Fish and Wildlife Service determines that the action would be likely to jeopardize the continued existence of a federally listed threatened or endangered species (TES), or would result in the destruction or adverse modification of federally designated critical habitat (FAA Order 1050.1F)
2. The proposed action would cause substantial mortality or displacement of species
3. The proposed action would cause substantial damage to vegetation communities.

The environmental effects analyzed in the following sections were not significant.

#### 3.2.2.1 Flora

The interior of the lakebed, including the landing site, is entirely barren of vegetation. As shown on Figure 3-2, there are areas of Barstow Woolly Sunflower and Desert Cymopterus within the landing area of the pieces jettisoned from the Starliner during the landing sequence, however these are few in number and spread mostly on the outskirts of the landing zone where items will only travel in higher wind scenarios. Figure 3-7 shows the damage done to the ground from the mortar lids, sabots, and FHS door on the flight test that landed at WSMR in December2019. These are the parts that could travel to these areas depending on the winds on the day of landing. While individual plants could be damaged if hit by a jettisoned part the chances are small given the size of the landing zone. A larger area could be affected by gaining access to and recovering these pieces. Pickup trucks will be utilized for the location and recovery of jettisoned pieces. In all proposed activities, ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Off-road traffic would be restricted in accordance with EAFB regulations to minimize disturbance to vegetation. Recovery operators would be instructed to minimize disturbance of vegetation and avoid Joshua Trees during the recovery of the jettisoned pieces of the spacecraft. If necessary EAFB biologists would accompany the recovery members to ensure sensitive plants are avoided. If determined prudent by EAFB biologists, some smaller jettisoned parts could be left in the field to further minimize impacts to vegetation due to vehicle traffic. The mortar lids are aluminum and would not degrade. The FHS lids are graphite composite covered with Nomex felt and ceramic fiber insulation. While this material can degrade it would take many years. As a result, these would have no significant impacts to the environment if left in place.

Overall, there would be little near-term and no long-term significant impacts to site vegetation.

#### 3.2.2.2 Fauna

The Starliner landing and recovery activities have the potential to impact animal species, including the desert tortoise, bats, other non-ground dwelling birds and ground-nesting birds, primarily from vehicle traffic. The maximum number of landings at EAFB annually is two times. The probability of directly hitting fauna with the spacecraft or jettisoned pieces is inherently low. The activities would involve only limited aerial activity, consisting of the spacecraft and jettisoned pieces parachuting or falling to the ground. The largest part, the CM, travels around 18 mph once the main chutes deploy at 8000 ft. altitude. Other jettison parts travel faster (see appendix F) but all land within an 8-minute window. These would pose little threat of bird or bat collisions or mortality to ground animals.

Excess surface water runoff during the rainy season periodically accumulates on the lakebeds as standing water. During these conditions, migratory birds may use the lakebed as a resting stop. However, during these times the lakebed would be unsuitable for Starliner recovery so landing would be targeted to one of the alternate landing sites or the ocean.

Small mammals, ground-nesting birds, reptiles, and amphibians could be injured or killed by vehicles during landing and recovery operations. To minimize project-related mortality of wildlife, vehicles would keep to existing roadways whenever possible. Landing and recovery personnel would be instructed not to collect, harm or harass any wildlife species. Any active bird nests would be avoided.

The only TES animal that could be impacted within the landing zone is the desert tortoise. The southeast portion of the landing zone extension overlaps the desert tortoise critical habitat (see Figure 3-3). Tortoises could still be present in other parts of the landing zone. While it is unlikely any would be present on the lakebed itself, they could be present in the area of the landing zone to the east and south of the lakebed where some of the jettisoned parts could land. There are also areas within the jettisoned parts landing zone where Mohave Ground Squirrel have been sighted (see Figure 3-4). The main risks to either the tortoise or squirrel would be from the vehicles. If determined necessary by EAFB biologists, only the larger jettisoned parts (forward heat shield and drogue parachutes) would be recovered if they land off the lakebed. Based on the most recent Boeing analysis, the maximum distance these larger parts could travel from the center of the landing zone is approximately 5 km, which only overlaps the northwest part of the tortoise critical habitat, and only then if the winds are blowing in a southwesterly direction on the day of landing. As a result, the areas disturbed by the recovery of these jettisoned parts will be very small compared to the overall habitat available. Figure 3-6 shows the damage done to the ground from two of the jettisoned mortar lids that could travel farther into the tortoise habitat depending on the winds on the day of landing. A total of six parts could land into this area. While an individual animal could be injured or killed if hit by a jettisoned part the chances are small given the size of the landing zone. These smaller jettisoned parts could be left in the field to minimize habitat impacts from vehicle traffic. These are composed of aluminum or composite material, ranging in size up to 17 inches in diameter and weighing at most one pound, and will not have any adverse effects on the environment. The recovery operators would use existing roads to the extent possible to reach the jettisoned parts locations. Recovery personnel would be provided desert tortoise awareness training prior to accessing Edwards AFB or the project area. The operators would be instructed to be watchful for and avoid any tortoises or ground squirrels encountered during the recovery of the jettisoned pieces of the spacecraft. Desert tortoise authorized biologist would survey/flag any off-road vehicle access trails required to collect jettisoned parts. Only desert tortoise authorized biologists are allowed to handle desert tortoises. At night crew recovery activities in vegetated habitat would require the presence of a desert tortoise authorized biologist.

A larger area, and therefore more species, would be affected by the sonic boom. The footprints for the sonic boom are shown in Appendix C. The maximum sonic boom footprint is 0.5 psf, which is equivalent to something less than a clap to thunder, and would take place at most two times per year. Given this small amplitude, the sonic boom would have no effect to any ESA-listed species or critical habitat.

Noise from the sonic boom, vehicles, and general human activities would cause some disruption to wildlife found in the project areas. Many small mammals and reptiles would likely react to unexpected noise by retreating underground. Larger mammals and birds would likely temporarily vacate the area (Larkin 1996). Therefore, the localized and temporary nature of increased noise and activity would not have a significant long-term effect on fauna inhabiting the landing areas.

While individual mortality may occur, regional populations of species would not be affected. Landing activities would affect only a limited portion of the total available habitat within EAFB.

In summary, the Proposed Action would not result in any long-term impacts to the local flora and fauna, nor violations of the MBTA, and therefore would not result in significant biological impacts.

### 3.2.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in biological resource impacts at the EAFB landing site or the surrounding area.

## 3.3 **Climate**

### 3.3.1 **Affected Environment**

Located in the Antelope Valley region of the western Mojave Desert in Southern California, EAFB has an arid to semi-arid climate with abundant sunshine, relatively low humidity, modest rainfall, and relatively mild winters typical of low latitude arid areas. Rainfall through the year is light and insufficient for any growth except desert vegetation. Brief local summer thunderstorms also occur. The average annual rainfall at EAFB is around 15 cm (6 in). Temperatures at EAFB are generally warm in the summer and mild during the winter. High temperatures in the summer average in the mid-high 90's F. High temperatures in the winter average in the high 50's F. The lowest temperatures occur in December and January, when nighttime temperatures can drop below freezing.

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).

$$CO2e = (CO2 \times 1) + (CH4 \times 28) + (N2O \times 265)$$

In 2019, U.S. GHG emissions totaled an estimated 6,558 million MT of CO2e (USEPA 2021).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 (FAA Order 1050.1F).

The Starliner spacecraft lands under parachutes. Reentry of the Starliner would not generate GHG emissions. No propulsion jet firings take place below approximately 30,000 feet altitude. There would be exhaust from recovery vehicles and portable generators, including GHG, as well as some dust caused by the movement of the recovery vehicles during the landing and recovery operations (See Table 3-2). GHG emissions total less than 3 metric tons per year assuming two landings, well below EPA de minimus levels. Airspace closures associated with reentries would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. These emissions include CO2, which is a GHG. Based on Boeing's proposal, airspace-related impacts could increase up to a maximum of 2 times per year. The amount of time that affected aircraft spend being re-routed would be short-term. In addition, the number of aircraft that would be impacted per reentry would not be expected to produce additional emissions that would have a notable impact on climate. Therefore, the increases in GHGs caused by short-term airspace closures during reentries is not expected to result in significant climate-related impacts. Project emissions would not alter the global climate or climate at EAFB. In addition, climate change would not affect the proposed action or exacerbate any of the potential effects caused by the proposed action.

Thus, the proposed action is not expected to result in significant climate impacts.

### 3.3.2 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in climate impacts at the EAFB landing site or the surrounding area.

## 3.4 Department of Transportation Act, Section 4(f)

### 3.4.1 Affected Environment

Section 4(f) of the U.S. Department of Transportation Act of 1966 (now codified at 49 U.S.C. § 303) protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites listed or eligible for listing on the National Register of Historic Places. Section 4(f) provides that the Secretary of Transportation may approve a transportation program or project requiring the use of publicly owned land off 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 use of that land and the program or project includes all possible planning to minimize harm resulting from the use.

The proposed action will take place entirely within EAFB, with the exception of the sonic boom footprint. Part of the landing zone for the Starliner includes the National Landmark portion of Rogers Dry Lake Bed (see Figure 3-10). The sonic boom areas contain the following potential Section 4(f) properties (see Appendix C for the sonic boom footprints):

The sonic boom footprint for a southwest approach to EAFB covers parts of the Angeles and Los Padres National Forests as well as other park land southwest of EAFB. It also covers large portions of the cities of Los Angeles, Thousand Oaks, Palmdale, and Lancaster as well as other towns containing potential Section 4(f) properties along the path. Only EAFB and parts of Palmdale and Lancaster are within the max overpressure area created by the sonic boom.

The sonic boom footprint for a northwest approach to EAFB covers parts of the Sequoia National Forests as well as other state parks along a path northwest of Los Angeles to EAFB. It also covers large portions of Mohave, California City, and other towns containing potential Section 4(f) properties along the path. Only EAFB and California City are within the max overpressure area created by the sonic boom.

### 3.4.2 Environmental Consequences

Impacts 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 (FAA Order 1050.1F). Substantial impairment occurs when the activities, features, or attributes of the resource that contribute to its significance or enjoyment are substantially diminished.

For Section 4(f) purposes, a proposed action would "use" a property in one of two ways:

- Physical use: the action physically occupies and directly uses the Section 4(f) resource. An action's occupancy or direct control (via purchase) causes a change in the use of the Section 4(f) resource.
- Constructive use: the action indirectly uses a Section 4(f) resource by substantially impairing the resource's intended use, feature, or attributes.

The proposed action would not result in a use (physical or constructive) of any Section 4(f) property. While recovery operations could take place in the portion of Rogers Dry Lake Bed that is designated a National Historic Landmark (and thus is a Section 4(f) property), operations would be temporary, lasting only a few hours or days, and occur a maximum of two times per year. Recovery operations would not create any long-term physical impacts on the lake bed. Any damage to the lake bed would be repaired by EAFB. The DAF controls public access to Edwards Air Force Base, and manages the lake bed, and therefore the proposed action would not affect public access to the National Historic Landmark. The proposed action would not require closing any public roads that provide access to a Section 4(f) property. The sonic boom generated prior to landing would be 1-2 seconds in duration and, while possibly noticeable, would not cause any impacts or damage to any Section 4(f) properties due to the small magnitude of the overpressure (maximum of 0.5 pounds per square foot (psf), somewhat less than a clap

of thunder). Therefore, sonic booms generated during reentry would not result in a constructive use of any Section 4(f) property.

In conclusion, the proposed action would not result in a use of a Section 4(f) property. Therefore, the proposed action would not result in significant impacts on Section 4(f) properties

### 3.4.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in Section 4(f) impacts at the EAFB landing site or the surrounding area.

## 3.5 **Land Use and Airspace**

### 3.5.1 **Affected Environment**

Land may be used for a variety of activities including commercial, recreational, industrial, and military. Specialized land uses may include radio transmission areas, explosive ordnance ranges, and airfields. The *General Plan, Edwards Air Force Base* lays out the long-range development at EAFB. This plan establishes the goals, policies, plans, and anticipated actions regarding the physical, social, and economic environment.

The term airspace is described as the aboveground region used for transit of aerial vehicles. Airspace is a finite resource that can be defined spatially and temporally when describing its use for aviation purposes. At EAFB, the Edwards Air Traffic Control is delegated management and control (e.g. air traffic control and scheduling) of the airspace in the area described for the proposed action.

#### 3.5.1.1 Land Use Restrictions

DAF land use policies and guidance are only applicable to lands under DAF control. Policies established for airfields are similar to the criteria established by the FAA for development surrounding civilian airports. The EAFB Planning and Zoning Committee grants final siting approval for all construction related projects. Installations are also required to ensure that all structures and facilities conform to the airfield and airspace clearance criteria defined in United Facilities Code 3-260-01, *DOD Airfield and Heliport Planning and Design*. The instruction specifies criteria and standards for planning, developing, and siting airfield facilities, including support facilities.

#### 3.5.1.2 Airfield Operations

Flightline operations are carried out by the 412th Test Wing (TW) and 95 Air Base Wing (ABW). The 412 TW is the direct mission organization of the AFTC that is responsible for test/integration and evaluation of manned and unmanned aerial systems, subsystems, and components. The 95 ABW is the support unit on EAFB that is responsible for communications; civil engineering; transportation, including loading and unloading armament and supplies; fuel supply; security police; and fire protection.

The 412th Operations Group plans and conducts all flight test activities for the 412 TW. The 412th Operations Group also advises the 412 TW on air traffic control matters, and airfield and airspace management, including flight management.

Use of the EAFB airfield is limited to authorized personnel only, such as the DAF, other government organizations, and contractors. Airfields are used to develop, test, and fly aircraft. Authorized government and private vehicles operate on the roads, taxiways, and runways. Pedestrian traffic occurs on the airfield

with the heaviest concentration being in and around the hangars. The period of greatest use on the airfield occurs during weekdays.

### 3.5.2 **Environmental Consequences**

The FAA has not established a significance threshold, nor has it identified specific factors to consider, for land use. The determination that significant land use impacts exist is normally dependent on the significance of other impacts (FAA Order 1050.1F).

There is no new permanent construction as part of the planned action. The proposed action would utilize existing EAFB pad and road infrastructure with utilization of the lakebed and landing zone extension for landing and retrieving the various parts of the Starliner. The largest land areas impacted are around the CM and BHS, both of which are 15 feet in diameter, and the FHS, which is 9 feet in diameter. These require the most vehicle traffic to recovery. The CM and BHS would land within 4 km radius landing zone on the lake bed. The FHS would typically land within the lakebed, however a small number (less than 1%) of 3000 wind cases analyzed went outside the 4 km circle with two cases landing at approximately 5 km from the center of the lakebed in higher wind scenarios. The total footprint of all other jettisoned parts, minus the parachutes, is approximately 10 square feet. The spacecraft and all jettisoned hardware would be collected and removed from the landing site, unless a decision is made to leave the smaller jettisoned parts in the field to minimize impacts to cultural sites and animal habitat due to vehicle traffic. No impacts are anticipated to the historic part of the lakebed utilized as part of the proposed action. The only evidence of the proposed action will be tire tracks and depressions or holes caused by the impact of the various pieces of the Starliner.

The recovery convoy would consist of the vehicles and trailers needed to deliver the Boeing safing equipment, provide hatch access to egress the crew, pull an generator trailer and light carts, a fire truck and ambulance and, when the CM is recovered, a semi-truck and trailer and large crane for lifting operations. Figures 3-5, 3-6, and 3-7 show the impacts to the surface from the test flight that landed at WSMR in December 2019. Only small divots and depressions were visible at the landing locations of the various parts, the deepest being 2-3 inches under the BHS.

As part of the Boeing contract with the DAF, any damage caused to the lakebed during landing would be repaired if necessary using the EAFB repair process. Hazardous materials and hazardous wastes would be recovered immediately, transported, and disposed of by Boeing. Nonhazardous waste would be handled as solid waste or non-regulated waste. Waste disposal is addressed in section 3.13 of this EA.

The proposed action is compatible with existing land use designations at EAFB. There would be no long term affect to the land or change to the land use designations from the proposed action.

**Figure 3-5: Base Heat Shield and Forward Heat Shield Impacts**

**Figure 3-6: Mortar Lid, Sabot, and Forward Heat Shield Door Impacts**

**Figure 3-7: Crew Module Impacts**

Impacts on airspace and scheduling from the proposed action would be minimal. The proposed action would involve over flight of the base from the west to the EAFB landing site. Activities would fall inside the scope of normal activities within EAFB-controlled airspace. Close scheduling and coordination from Edwards Air Traffic Control would minimize any airspace conflicts with other concurrent operations being conducted at Edwards. All airspace re-entry operations would comply with the necessary notification requirements, including issuance of NOTAMs and NOTMARs. 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. 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. Landings would be infrequent (only when an emergency landing in needed and EAFB is the only land option), cause airspace closures of 1-2 hours, and scheduled as far in advance as possible given the emergency nature of the landings to minimize interruption to airspace.

For the above reasons, significant environmental impacts of the temporary closures of airspace are not anticipated.

In summary, the proposed action would not result in significant impacts related to land use or airspace.

### 3.5.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in land use or airspace impacts at the EAFB landing site or the surrounding area.

## 3.6 **Physical Resources**

### 3.6.1 **Affected Environment**

#### 3.6.1.1 Water Resources

The Proposed Action would not affect wetlands, or wild and scenic rivers, as none of these are located within the area affected by the Proposed Action. Therefore, these water resources are not considered further. This section focuses on floodplains, surface water, groundwater, and water quality.

Rogers lakebed is considered a floodplain due to seasonal flooding. The floodplain is outlined in blue in Figure 3-8. Executive Order 11988, *Floodplain Management*, requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

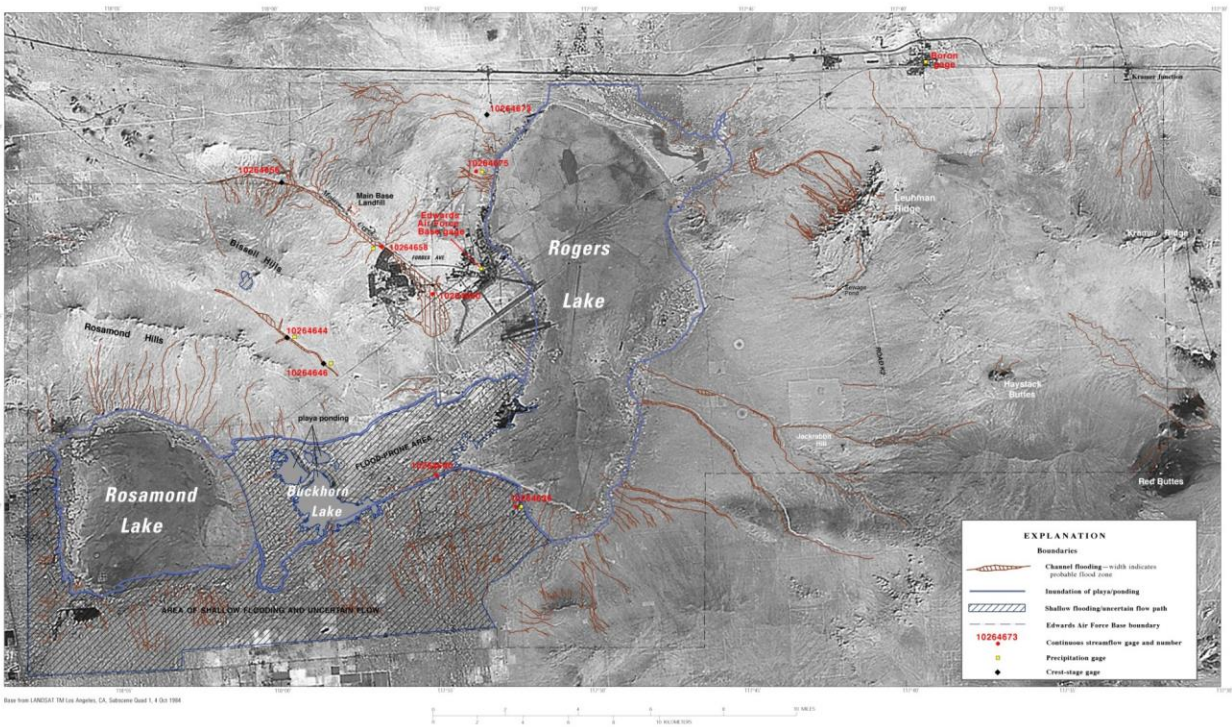


**Figure 3-8: EAFB Floodplain Boundaries**

Water resources describe the quality, quantity, source, and use of water at EAFB. This includes drinking (potable) water, wastewater, and storm water. Water quality is protected under the Clean Water Act 1972 (Federal Water Pollution Control Act), Safe Drinking Water Act 1974, and Code, Division 7, *Water Quality*. The sources of water on EAFB include groundwater, Antelope Valley-East Kern Water Agency water, treated wastewater (irrigation), and storm water. EAFB has various facilities dedicated to water resources. They include: six chlorination points for potable water, numerous potable and non-potable water storage tanks, two operating Waste Water Treatment Plants (WWTP) (Main Base and AFRL with associated evaporation ponds), and storm water retention ponds.

EAFB has been subdivided into six storm water management units (SMU): Main Base Flight line, Main Base Miscellaneous, South Base, NASA/Armstrong, AFRL, and North Base. These units are defined as nonphysical in that the boundaries reflect tenant lease areas and other organizational areas. In addition to the SMUs, eight storm water drainage areas (SWDA) have also been delineated in the *Storm Water Pollution Prevention Plan, Edwards Air Force Base, California*. These SWDAs include the Main Base Flight line South, Main Base Flight line Central, NASA/Main Base Flight line North, South Base, North Base, Piute Ponds, Small Arms Range, and Main Base Outlying Region. These SWDAs are delineated with respect to topographical features. The SWPPP describes each drainage area in detail including watershed association, area covered, containment structures and areas, and facility association. Industrial wastewater is liquid waste resulting from industrial processes: paint stripping, metal plating, maintenance and repair, aircraft and vehicle cleaning, power or heat plant operations, boiler and cooling water discharges, and oil and solvent recovery operations. Wastewater conveyed to the WWTP is required to meet specific pretreatment standards established to ensure that pollutants entering or passing through the WWTP will not have an adverse effect on the treatment process or contaminated sludge (Edwards AFB Instructions 32-601, Wastewater ).

#### 3.6.1.2 Geology and Soils

Geologic resources consist of naturally formed minerals, rocks, and unconsolidated sediments. Soil refers to the uppermost layers of surficial geologic deposits and is developed by the weathering of those deposits. Concerns associated with the geologic setting at EAFB include availability of borrow sites for fill material, projects located in the vicinity of geologic faults, land subsidence, and disturbances to Environmental Restoration Program sites and associated remediation equipment.

The U.S. Department of Agriculture prepared a soil survey of EAFB for the U.S. Army Corps of Engineers (1997). The report reveals that the erosion hazard rating for soils found in the area range from slight to severe for wind erosion and slight to moderate for water erosion. The soil types at EAFB and within the Starliner landing zone are shown in Figure 3-9.

Land subsidence features appear on the dry lakebeds in the form of surface cracking, fissures, solution cavities, and small surface depressions. The subsidence features are associated with surface water runoff after rain shower events and subsequent groundwater flow through the lakebed sediments. Erosion of the lakebed substratum occurs when groundwater flows through the sediments causing void spaces. When these void spaces collapse from the weight of the overburden, subsidence features appear at the surface. Subsidence features tend to increase in number and magnitude during storm water runoff and drainage onto the lakebed areas . Runways on the dry lakebed that are affected by subsidence features are shut down until surface repairs are made. During shutdown periods, the runways cannot be used for emergency landings or flight test operations.

The Mirage Valley Fault is a northwest trending fault that extends from South Base through Main Base. The fault is seismically dormant with no record of earthquake activity along its trace. Earthquakes have occurred along local faults in the vicinity of EAFB with magnitudes less than 4.4 on the Richter scale with no reported damage to structures. Near Bissell, approximately 2 miles northwest of the base, an earthquake of 4.6 to 6.5 on the Richter scale was recorded. The earthquakes were accompanied by ground motion with little or no ground displacement or structural damage to buildings (95 ABW, 2009b). Numerous minor faults are known, or suspected due to their trends, to be present within the boundaries of EAFB.

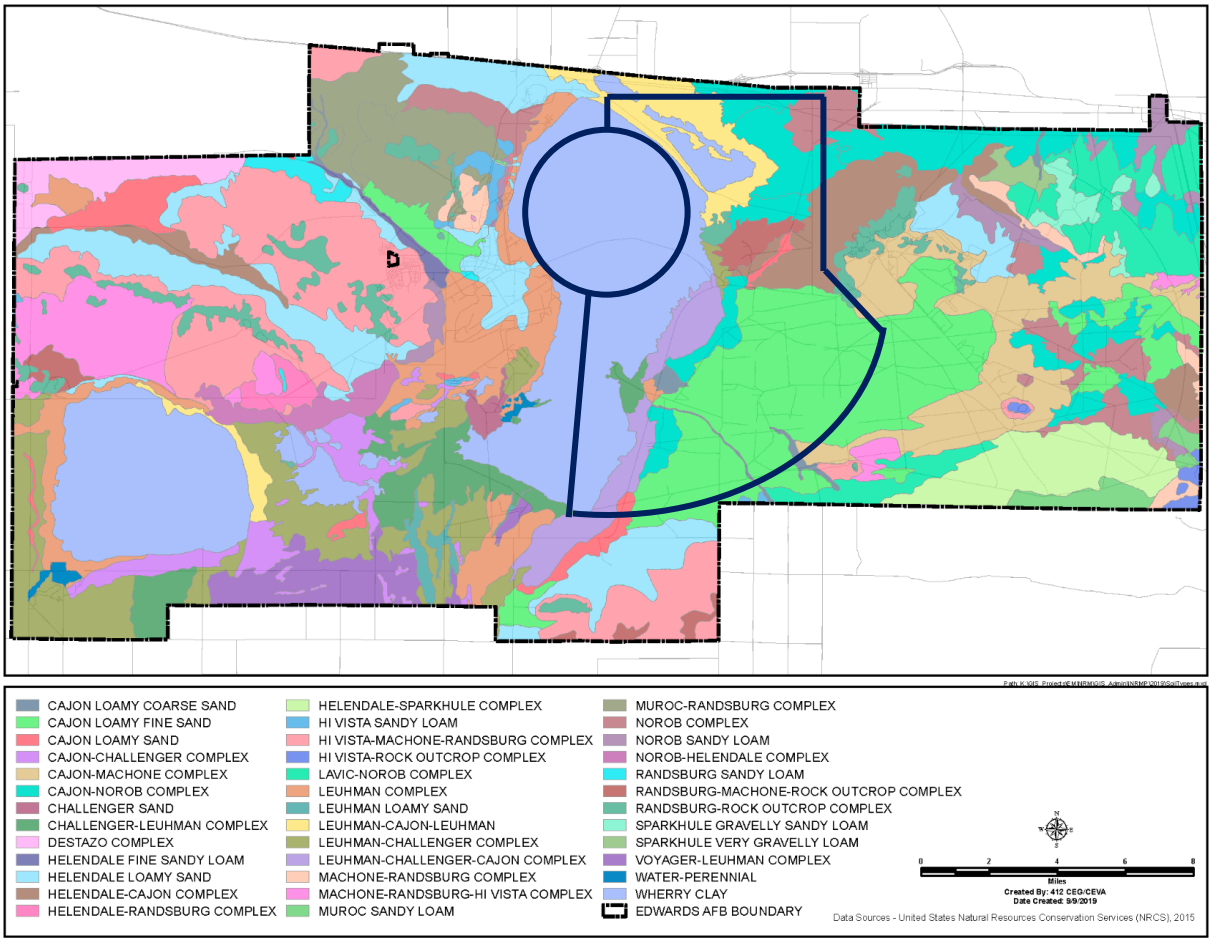


**Figure 3-9: EAFB Soil Types**

## 3.6.2 **Environmental Consequences**

### 3.6.2.1 Water Resources

Impacts to floodplains would be significant if the proposed action causes notable adverse impacts on natural and beneficial floodplain values as defined in defined in Paragraph 4.k of Department of Transportation (DOT) Order 5650.2, *Floodplain Management and Protection*. Impacts to surface waters would be significant if the proposed 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 to groundwater would be significant if the proposed 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. (FAA Order 1050.1F)

As documented in section 2, EAFB is the only landing site in a suitable location to allow a safe terrestrial return of the Starliner and crew should a failure of the Atlas V occur during the launch phase that prevents the Starliner from reaching the orbit of the ISS. This would cause the need for an early return to EAFB within the first three orbits of the Starliner. The only alternative is to land in the ocean, which increases the risk to the crewmembers as search and rescue forces would need to deploy to locate the CM. It could take up to 24 hours for search and rescue forces to arrive on scene and recover the crew from an ocean landing and several hours after recovery to transfer them to a Level 1 Trauma Center. A landing at EAFB allows transfer of the crew to a trauma center within two hours of landing. Therefore, there is no

practicable alternative to using EAFB as a landing site for the Starliner for this emergency case. For other emergency landings EAFB would only be targeted if the other landing sites are unavailable due to the ISS trajectory and bypassing EAFB would require a water landing which caused added risk to the crew for emergency landing scenarios. Landings of the Starliner at EAFB would not be planned for those times of the year when standing water is present on the lakebed. Should standing water be present when EAFB is needed for an emergency Starliner landing, the landing would be targeted to the ocean. Any damage to the lakebed caused by landings during the non-flooded months would be repaired to put the lakebed back to its original state; therefore, the floodplain would not be affected by the proposed action. Boeing notified the public via newspaper ads in January 2020 of the need for utilizing the flood plain for landing of the Starliner and requested comments. No comments were received.

No permanent water bodies (e.g. stream, creeks) occur within the landing area. Therefore, surface water would not be affected by any of the proposed activates. It is unlikely there would be quantities of groundwater of any significance. In the unlikely event of an accidental petroleum, oil, lubricant (POL) spill, contaminated soil would be cleaned using established site procedures. In the unlikely event of a hydrazine spill, Boeing would be responsible for cleanup, removal and disposal of all contaminated material. Groundwater would not be contaminated such that water quality standards would be exceeded, and no aquifers used for public water supply would be affected. Given the lack of water resources, it is unlikely that the proposed action would impact water resources.

All water needed for the recovery activities would be transported to the landing site by the landing recovery personnel. All wastewater generated by the recovery operations would be removed in accordance with applicable EAFB regulations.

In summary, the proposed action would not result in significant impacts on water resources.

#### 3.6.2.2 Geology and Soils

The landing and recovery activities could result in soil compaction or erosion and de-vegetation caused by the spacecraft and jettisoned hardware impacting the soil and accessing of the sites with the vehicles needed to recover the crew, CM, and jettisoned parts. The landing impacts are expected to be minor based on the impacts made at WSMR during the OFT mission as show in Figures 3-5, 3-6, and 3-7. On OFT, which had relatively light winds, all the jettisoned parts landing within approximately 150 meters of the CM. Higher winds would spread the parts out farther. Current Boeing analysis shows that the farthest any jettisoned part would carry based on historical winds is approximately 12 km from the center of the landing zone. Most of the soil disturbance will be caused by the vehicles driving from the EAFB flight line to the landing site and subsequent retrieval of the jettisoned parts. Any significant holes made in the surface would be repaired. EAFB equipment used for landing recovery activities would be inspected in accordance with established site procedures for POL leaks and, if necessary, appropriate containment would be placed underneath equipment when not in use. In the unlikely event of an accidental POL spill, contaminated soil would be cleaned using established site procedures.

Should surface cracking or fissures be present on the lakebed that would make landing and recovery of the Starliner hazardous, the landing would be waved off until the fissures are repaired or diverted to an alternate landing site.

Overall, the proposed action would not significantly affect the geology and soil in the area.

### 3.6.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in physical resource impacts at the EAFB landing site or the surrounding area.

# 3.7 Cultural Resources

## 3.7.1 Affected Environment

### 3.7.1.1 Cultural Resources

Cultural resources are defined in AFMAN 32-7003, Environmental Conservation , as historic properties (any prehistoric or historic district, site, building, structure, or object as defined by 36 CFR Part 800 included in, or eligible for inclusion in, the National Register of Historic Places, whether or not such eligibility has been formally determined), including artifacts, records, and material remains related to such a property or resource; cultural items as defined in Native American Graves Protection and Repatriation Act; American Indian, Eskimo, Aleut, or Native Hawaiian sacred sites as defined in EO 13007, *Indian Sacred Sites*; archaeological resources as defined in the *National Historic Preservation Act of 1966*; and, archaeological artifact collections and associated records as defined in 36 CFR Part 79, *Curation of Federally-Owned and Administered Archaeological Collections*..

Prehistoric period sites include villages, temporary camps, rock shelters, milling stations, lithic deposits, quarries, cremations, rock features, and rock art. Historic period archaeological sites include refuse deposits, rock cairns, railroad grades, roads and trails, abandoned mines and homesteads, rock alignments, wells, and military sites. There is one National Historic Landmark on EAFB, which is in the northern portion of Rogers Dry Lake (Figure 3-10).

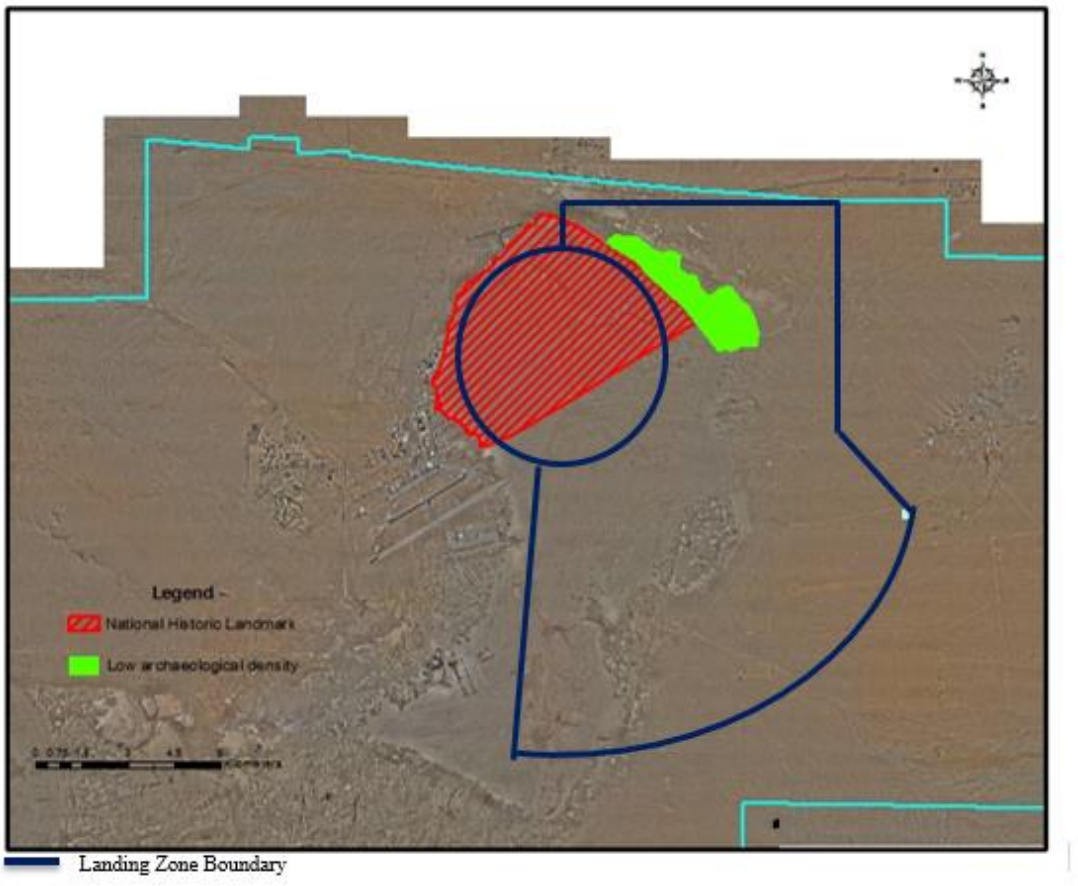


**Figure 3-10: National Historic Landmark on Rogers Dry Lake Bed**

#### 3.7.1.2 Prehistoric Archaeological Resources

A number of American Indian groups are known ethnographically to have used the Antelope Valley to hunt and gather food from areas surrounding prehistoric Lake Thompson (precursor to Rosamond and Rogers Dry Lakes) and groundwater springs that occurred in the region. The groups known to have inhabited the region included Kawaiisu, Tataviam, Kitanemuk, and Vanyume or Desert Serrano. Additional information on these groups can be found in the *Cultural Resources Overview and Management Plan of Edwards AFB, California, Volume 1, Overview of the Prehistoric Cultural Resources* (Earle et al., 1997).

Prehistoric period sites include villages, temporary camps, rock shelters, milling stations, lithic deposits, quarries, cremations, rock features, and rock art. These sites have been evaluated in ongoing site evaluations by the Environmental Management Cultural Resources group.

#### 3.7.1.3 Historic Resources

Historic land use in the Antelope Valley was limited to mineral exploration activities until the middle of the 19th century. During the late 19th and early 20th centuries, land use activities in the area of EAFB included precious metal exploration, development of railroad rights-of-way, ranching, and homesteading. Evaluation of historic sites on EAFB is ongoing and conducted by the Environmental Management Cultural Resources group.

Significant dates in the historic development of the EAFB area were:

a. 1909–The town of Muroc was founded and located east of the present-day air traffic control tower on the Main Base Flight line.

b. 1910–The Atchison, Topeka, and Santa Fe Railroad, between Mojave and Barstow, was constructed across the dry lakebed and passed through the town of Muroc.

c. 1928–The Muroc area was used for military exercises.

d. 1934–A bombing and gunnery range was established at Rogers Dry Lake adjacent to the Muroc area.

e. 1941–The Muroc Bombing and Gunnery Range headquarters was established on the west shore of Rogers Dry Lake (currently South Base).

f. 1942–Muroc Flight Test Base was established as a separate facility at the northern end of Rogers Dry Lake (currently North Base).

g. 1943–The bombing and gunnery range was renamed Muroc Army Air Field.

h. 1947–Muroc Army Air Field was combined with Muroc Flight Test Base and renamed Muroc AFB.

i. 1949–Muroc AFB was renamed Edwards AFB.

j. Mid-1950s–The majority of base operations was moved to new facilities that comprise the current Main Base.

#### 3.7.1.4 Review of Cultural Resources

Previous cultural surveys of the landing site, including both the 4km radius circle and the jettisoned parts landing zone extension, were reviewed and a new survey of approximately 1370 acres, within the inner 2 km radius of the 4k circle and along the shoreline of the lakebed was performed. The new survey also included an eligibility recommendation for seven known sites within the landing zone. No new cultural resources were found during the survey and none of the sites evaluated was recommended as eligible. There were an additional 41 sites identified outside the 4km radius landing zone of the CM but within the

jettisoned parts landing zone extension. Of these 31 are identified as eligible, 3 not eligible, and 6 undetermined.

Due to its size (several thousand sq. mi. for all footprints) and the small amplitude of the sonic boom generated by the Starliner during re-entry (max 0.5 psf, somewhat less than a clap of thunder), no review was done for all cultural resources within the sonic boom footprints show in Appendix C. In general, for well-maintained structures, the threshold for potential damage from sonic booms is 2 psf; below 2 psf, damage is unlikely (Haber and Nakaki 1989 ). Therefore, the sonic booms would not affect historic properties..

### 3.7.2 **Environmental Consequences**

Impacts resulting from the proposed action would be considered significant if they were to:

1. Adversely affect known cultural resources eligible for inclusion into the National Register of Historic Places (NRHP).
2. Damage or impact previously unknown and recorded cultural resources eligible for inclusion in the NRHP.
3. Cause substantial unauthorized artifact collection by recovery personnel.
4. Adversely affect known Traditional Cultural Properties on EAFB. These are eligible for inclusion in the National Register because of an association with cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community.

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 of the NHPA consultation process. However, an adverse effect finding does not automatically trigger preparation of an EIS (FAA Order 1050.1F).

A large portion of the Starliner landing zone would be within the NRHP portion of Rogers Dry Lake Bed. Based on previous Starliner testing, including the OFT mission landing impacts shown in Figures 3-5, 3-6, and 3-7, minimal damage is expected to the lakebed. However, should the lakebed be damaged by any of the pieces of the Starliner during landing, the damage would be repaired and the lakebed put back to its original state using EAFB internal repair processes. All pieces of the Starliner spacecraft would be recovered and removed, if found or unless a decision is made to leave some parts in place. It may not be possible to find and recover all of the mortar lids and sabots due to their small size should they land off the lakebed. Due to the materials used in the construction of these pieces, they do not pose any environmental impacts to the area.

No known eligible cultural resources are within the 4km radius landing zone of the CM. 31 eligible and 6 undetermined sites are within the jettisoned part extension. Over half of these are more than 8 km from the center of the landing zone where jettisoned parts would only travel in high wind cases. The chances of a part impacting one of these is inherently low given the small number of sites, the small number of parts and the overall size of the landing area combined with the fact the Starliner would only land at EAFB in an emergency situation. The chances of the Starliner or a jettisoned part landing on any unknown cultural site is also inherently low. EAFB personnel would determine if EAFB archeologists are required to be part of the recovery to provide guidance should a known cultural resource be impacted or a previously unknown resource encountered.

EAFB performed consultations of the action with the State Historic Preservation Officer (SHPO) and local tribes, in accordance with Section 106 of the NHPA. The SHPO concurred with the DAF finding of no adverse effects from the project to historic properties. A copy of the concurrence correspondence is included in Appendix G. Tribal consultation with the Tejon Indian Tribe, the San Manuel Band of Mission Indians, the Colorado River Indian Tribe, the Morongo Band of Mission Indians, and the Chemehuevi Indian Tribe resulted in comments received from the San Manuel Band of Mission Indians

expressing concerns over the culture history and the characterization of two sites. Boeing and the DAF-provided additional documentation on these sites and the possible impacts from a Starliner landing. The DAF received documentation confirming that the tribe's concerns were adequately addressed and that there are no remaining issues regarding site eligibility.

No historic properties will be affected by this action.

### 3.7.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in historical or cultural impacts at the EAFB landing site or the surrounding area.

## 3.8 **Noise and Noise-Compatible Land Use**

### 3.8.1 **Affected Environment**

Hazardous noise exposure occurs when workers are present in areas where ambient noise levels exceed 85 decibels. Title 29 CFR Section 1910.95, *Occupational Noise Exposure*, states that protection against the effects of noise exposure should be provided when the sound levels exceed those shown in the regulation. Figure 3-12 compares the relative noise of common sounds.

There are many flight operations at EAFB that generate noise. Aircraft operations and machinery/equipment including, but not limited to, skids, grinders, pneumatic hammers and drills, concrete saws, vibrating compactors, bulldozers, backhoes, graders, and cable plows are the primary sources of noise in flight line areas. Noise is also generated by general vehicle traffic on roads. Aircraft takeoffs and landing are the main noise generators on the Rogers Dry Lake Bed.

The sonic boom would extend past the boundaries of EAFB and potentially be noticeable in the areas shown in the footprints in Appendix C.

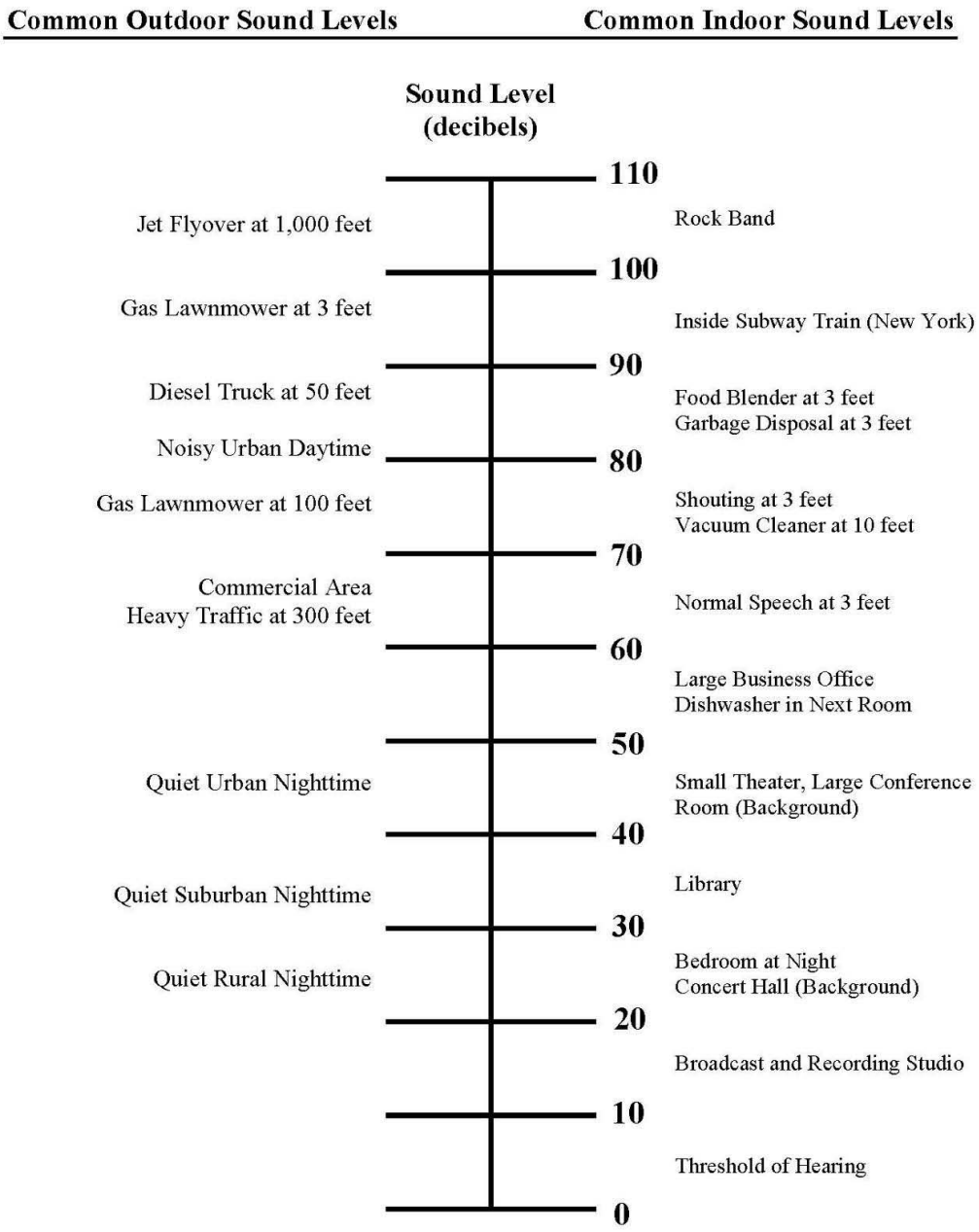


**Figure 3-11: Relative Noise Comparisons**

### 3.8.2 **Environmental Consequences**

A significant impact would occur if the proposed action would increase noise by day-night average sound level (DNL)[4] 1.5 decibels (dB) or more for a noise sensitive area[5] that is exposed to noise at or above the

[4] DNL is the 24-hour average sound level, in decibels, for the period from midnight to midnight, obtained after the addition of ten decibels to sound levels for the periods between midnight and 7 a.m., and between 10 p.m. and midnight, local time.

[5] A noise sensitive area is an area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, and parks,

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 (FAA Order 1050.1F).

Landing recovery vehicle traffic, portable generators, and recovery operations generate noise and vibrations. In addition, the Starliner spacecraft would generate a sonic boom during atmospheric reentry to the EAFB landing site. Sonic booms are measured in pounds per square foot (psf) of overpressure. This is the amount of the increase over the normal atmospheric pressure which surrounds us (2,116 psf/14.7 psi). At one psf overpressure, no damage to structures would be expected. Overpressures of 1 to 2 psf are produced by supersonic aircraft flying at normal operating altitudes. (NASA Armstrong). Booms in the 0.2 to 0.3 psf range could be heard by someone who is expecting it and listening for it, but usually would not be noticed. Booms of 0.5 psf are more likely to be noticed, and booms of 1.0 psf are certain to be noticed. The local public may be concerned about property damage. The most common sonic boom property damage is to fragile items like glass. The probability of a 1 psf boom breaking a typical residential window is somewhat less than one in a million (Hershey, 1974). Rare minor damage may occur with 2 to 5 psf overpressure. As overpressure increases, the likelihood of structural damage and stronger public reaction also increases. Tests, however, have shown that structures in good condition have been undamaged by overpressures of up to 11 psf. Sonic booms produced by aircraft flying supersonic at altitudes of less than 100 feet, creating between 20 and 144 psf overpressure, have been experienced by humans without injury. (Armstrong 2014).

Appendix C contains details of the dispersion of the sonic boom. As shown, the maximum sonic boom overpressure caused by the Starliner spacecraft is 0.5 psf and will take place at most 2 times per year. This equates to a DNL of 24 dB, well below the FAA threshold of 65 dB. Therefore, the sonic booms generated during reentry would not result in significant noise impacts.

Due to the short timeframe of the activities, no long-term high levels of noise are generated. Any loud noise or vibration generated during landing and recovery activity would be one time and very short in duration, and are not be expected to significantly affect the local people or wildlife.

Airspace closures associated with reentry could result in temporarily grounded aircraft at affected airports and re-routing of en-route flights on established alternate flight paths. The FAA has rarely, if ever, received reportable departure delays associated with reentries. Aircraft could be temporarily grounded if airspace above or around an airport is closed. Ground delays are also used under some circumstances to avoid airborne reroutes. If aircraft were grounded, noise levels at an airport could temporarily increase as the planes sit idle. Also, depending on the altitude at which aircraft approach an airport, there could be temporarily increases in noise levels in communities around an airports. However, aircraft would travel on existing en-routes and flight paths that are used on a daily basis to account for weather and other temporary restrictions. Re-routing associated with reentry-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 individual airports 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 launches are not expected to result in significant noise impacts.

The proposed action would be consistent with current land use and below the significance noise threshold listed above so would not result in any significant noise impacts.

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recreational areas, areas with wilderness characteristics, wildlife and waterfowl refuges, and cultural and historical sites.

### 3.8.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in noise impacts at the EAFB landing site or the surrounding area.

## 3.9 **Socioeconomics**

### 3.9.1 **Affected Environment**

Socioeconomic resources are the economic, demographic, and social assets of a community. Key elements include fiscal growth, employment, housing, construction materials, and retail services. The economic impact region for EAFB is the area located within 75 miles of Main Base, and includes portions of Los Angeles, Kern, and San Bernardino Counties. The majority of socioeconomic impacts from base activities would be expected to occur within the Antelope Valley area.

### 3.9.2 **Environmental Consequences**

The FAA has not established a significance threshold for socioeconomics. Factors to consider when assessing the significance of potential socioeconomic impacts include whether the action would have the potential to:

- Induce substantial economic growth in an area, either directly or indirectly (e.g., through establishing projects in an undeveloped area);
- Disrupt or divide the physical arrangement of an established community;
- Cause extensive relocation when sufficient replacement housing is unavailable;
- Cause extensive relocation of community businesses that would cause severe economic hardship for affected communities;
- Disrupt local traffic patterns and substantially reduce the levels of service of roads serving an airport and its surrounding communities; or
- Produce a substantial change in the community tax base. (FAA Order 1050.1F)

No significant impact to employment, population, and economic activity is expected from the proposed action. The current level of socioeconomic activity would not significantly change or be adversely affected. Personnel working in support of the proposed activities would include military, civil servants, and contractors. Proposed activities would provide very small socioeconomic benefits for the counties around EAFB due to the small number of NASA personnel who would travel to the landing site to retrieve the astronauts and the 5-10 Boeing personnel who would travel to and spend up to two weeks in the area for the recovery of the CM.

The proposed action would not result in an increase in population or employment levels in the area nor impact community or emergency services in the surrounding region. Therefore the proposed action would not significantly impact socio-economic activity.

Purely social and economic effects are not required to be analyzed under NEPA. Even if NEPA recognizes socioeconomic impacts from re-routing aircraft due to reentries, such impacts would be similar to re-routing aircraft for other reasons (e.g., weather issues, runway closures, wildfires, military exercises, and presidential flights). 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 cancelations, and missed connections. Alternatively, restricting or preventing a reentry event would have socioeconomic impacts on Boeing. 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 launches are temporary and the FAA's previous analyses related to the National Airspace System (NAS) have concluded minor or minimal impacts on the NAS from reentries, the FAA does not expect airspace closures from Boeing's proposal

would result in significant socioeconomic impacts. Furthermore, local air traffic controls would coordinate with airports and aircraft operators to minimize the effect of the reentry operations on airport traffic flows as well as traffic flows in en-route airspace.

### 3.9.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in socioeconomic impacts at the EAFB landing site or the surrounding communities.

## 3.10 **Environmental Justice and Children's Environmental Health and Safety Risks**

### 3.10.1 **Affected Environment**

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires that federal agencies identify and address, as appropriate, disproportionately high and adverse human health, or environmental effects of their activities on minority populations and low-income populations. The general purposes of the EO are to: 1) focus the attention of federal Agencies on the human health and environmental conditions in minority and low-income communities with the goal of achieving environmental justice; 2) foster nondiscrimination in federal programs that substantially affect human health or the environment; and 3) give minority and low-income communities greater opportunities for public participation in, and access to, public information on matters relating to human health and the environment (EPA 2011).

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* requires federal agencies to identify and assess environmental health and safety risks that may disproportionately affect children.

Based on the information from the U.S. Census Bureau (USCB), minority and low-income populations exist within the three counties surrounding EAFB (Los Angeles, Kern, and San Bernardino). Statistics for minority populations in the region of influence indicate an average of 49 percent Hispanic of any race with a combined average of 23 percent minority population for "other" minority groups. The population in poverty within the region of influence averages 19 percent. The general population of minority and low-income population in the state of California average 38.6 percent Hispanic of any race, 23 percent population of "other" minority groups, and 16 percent in poverty (USCB 2014). The proposed landing site is remote and not near towns or schools. Since the percentages of low income and minority populations in the ROI is higher than the state of California, which is the Community of Comparison, there would be a potential for disproportionate impacts to occur if communities in the ROI would be adversely impacted by the Proposed Action.

The closest playground and schools to the EAFB landing site are the Irving L. Branch Elementary and Desert Jr/Sr High School, located approximately 5 miles southwest of the landing site in the main base housing area, and North Edwards High School, located approximately 5 miles north of the landing site.

### 3.10.2 **Environmental Consequences**

The FAA has not established a significance threshold for environmental justice. Factors to consider when assessing the significance of potential environmental justice impacts include whether the Proposed Action would have the potential to lead to a disproportionately high and adverse impact to an environmental justice population (i.e., a low-income or minority population) due to significant impacts in other environmental impact categories or impacts on the physical or natural environment that affect an environmental justice population in a way that the FAA determines is unique to the environmental justice population and significant to that population (FAA Order 1050.1F).

The FAA has not established a significance threshold for children's environmental health and safety risks. The factor to consider is whether the action would have the potential to lead to a disproportionate health and safety risk to children (FAA Order 1050.1F).

The proposed action would not have a significant impact on EAFB air quality, noise, soils and other environments as identified above. Direct impacts are not anticipated to extend outside the boundaries of EAFB to the surrounding communities, with the exception of the sonic boom which is very short term in nature, low in magnitude, and would occur only when an emergency landing is necessary at EAFB, which would occur a maximum of two times annually. Surrounding communities would not be adversely impacted by the presence of recovery personnel temporarily relocated to support landing and recovery. Therefore, under the proposed action, there would be no impact on, nor a potential for, disproportionately high and adverse effects on minority or low-income populations or children. The DAF controls public access to EAFB and therefore no member of the public would be present around the landing site during landing operations.

In summary, the proposed action would not result in impacts related to environmental justice and children's environmental health and safety risks.

### 3.10.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in impacts to minority or low-income populations or children at the EAFB landing site or the surrounding communities.

## 3.11 **Visual Effects**

### 3.11.1 **Affected Environment**

EAFB has considerable aesthetic and visual resources within its boundaries and merging into surrounding areas. Scenic desert landscapes with rugged topography are typical. However, most of the EAFB landscape is not readily viewable by the general public due to access restrictions. There are no federal statutory or regulatory requirements for classifying and assessing light emissions and visual impacts. Light emissions at EAFB are generated from permanent buildings, flight line operations, and military housing located just outside the landing site. There are no permanent light sources within the landing site on the Rogers Dry Lake Bed.

### 3.11.2 **Environmental Consequences**

The FAA has not established a significance threshold for visual effects. Factors to consider when assessing the significance of potential visual effects include the degree to which the action would have the potential to:

- Create annoyance or interfere with normal activities from light emissions;
- Affect the visual character of the area due to the light emissions, including the importance, uniqueness, and aesthetic value of the affected visual resources.
- Affect the nature of the visual character of the area, including the importance, uniqueness, and aesthetic value of the affected visual resources;
- Contrast with the visual resources and/or visual character in the study area; and
- Block or obstruct the views of visual resources, including whether these resources would still be viewable from other locations. (FAA Order 1050.1F)

The proposed action would have a slight impact on light emissions at the landing site for those instances where the Starliner spacecraft lands after sunset or late enough in the day that the crew recovery operations would extend past sunset. For these instances, portable lighting would be required around the landing site until recovery operations are complete. CM recovery from the lakebed would always take place during daylight hours. The planned action would have no long-term impacts on the visual

environment as the LRT removes all parts of the spacecraft from the landing site with the possible exception of any mortar lids and mortar sabots not found. There are no visually or light-sensitive receptors in the project's region of influence.

Therefore, the proposed action would not result in significant visual impacts.

### 3.11.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in visual impacts at the EAFB landing site or the surrounding area..

## 3.12 **Infrastructure and Utilities**

### 3.12.1 **Affected Environment**

Infrastructure refers to the physical components that are used to deliver utilities to the point of use. Elements of the base infrastructure system include water, wastewater, electricity, natural gas, liquid fuel pipelines, communication lines (e.g., telephone and computer), and transportation systems (e.g., streets and railroads) that run in a network throughout the base. The infrastructure that could potentially be affected from the proposed action includes portable physical structures (e.g. tents), site use, electricity, utilities, waste disposal and treatment, transportation and roads, and communications. The capacity and current demands of the following infrastructure elements at EAFB were examined to determine infrastructure constraints.

#### 3.12.1.1 Structures and Utilities

Several permanent buildings and runways exist on site at EAFB, however no permanent buildings exist at the landing site. There are several Environmental Restoration Program (ERP) wells located within the 4km landing zone for the CM. Existing base utilities include electrical power, telephone service, and water for drinking and sanitation purposes. None of these is available at the landing site itself. Public services, including civil and military police, fire protection, and emergency medical treatment services, are operated and /or supervised by the DAF. Most of the personnel providing these services are based at the Main Base.

#### 3.12.1.2 Transportation and Roads

Primary access to EAFB from the adjacent roadways is by way of three gates, each in operation 24 hours per day, 7 days per week. The West Gate is accessed via Rosamond Boulevard, which provides primary access to EAFB from the west and north. The north gate is accessed via North Lancaster Boulevard off of Highway 58, which also provides access from the north. The south gate is accessed via Lancaster Boulevard/120th Street East, which provides access from the south. Internal circulation on base is by way of paved and unpaved primary, secondary, and tertiary roads. Two rail spurs, one at EAFB Station and the other at Boron Station, connect to Main Base and the AFRL, respectively. The spurs connect the two railroads adjacent to the base.

### 3.12.2 **Environmental Consequences**

Impacts resulting from the proposed action would be considered significant if they were to increase demand on public infrastructure or services that would negatively affect the quality of service for persons living in the region. The proposed action, which occurs entirely within EAFB boundaries, would not significantly impact public infrastructure or increase the burden on infrastructure. Infrastructure requirements for the landing and recovery activities would not exceed EAFB's existing infrastructure resources.

All power and water, as well as sanitation capability in the form of portable toilets if needed, would be brought to the site by the EAFB recovery team and removed at the end of the recovery operations. All equipment needed the recovery of the crew post landing would be mustered just outside the 4km landing

zone, either on the lake bed or in a parking area just off the lake bed. A generator would be left at the CM to provide power until the Boeing recovery team arrives. After removal of the CM from the lakebed the Boeing team would utilize an EAFB or NASA hangar, if available, or set up a tent in a parking lot for up to 10 days to perform that activities needed to process the CM for shipment.

There is potential impact to the ERP wells should the CM or one of jettisoned parts land on one. Given these wells are on the outer 1km of the 4km landing CM landing zone the chances of contact are low. Should any be damaged, Boeing would be responsible to repair and/or re-establish ERP equipment and infrastructure by an accredited ERP subcontractor within the time frame agreed upon with the EAFB ERP Manager. Water and septic system use would have a minor increase under the proposed action during the period when 5-10 Boeing personnel are present post landing to process the CM for shipment. All existing facilities are considered sufficient to handle an increase in demands for services under the proposed action. No major changes to the demands for public services (e.g., fire protection, solid waste disposal) are anticipated under the proposed action.

Proposed activities would have little to no impact on the permanent and electrical sources at EAFB. Cellular phones or radios, required for personnel supporting the landing recovery activities, would see increased use, but the increased use of this communication would not significantly impact communication resources. Power at the recovery site would be provided by a portable generator so would not affect the EAFB power capabilities. Generators would be inspected to ensure proper working order and compliance with applicable permitting requirements, safety, air quality, and spill containment.

Increased vehicle traffic at EAFB will result from the proposed action but would not be considered significant and will be short term in nature (approximately 10 days). The existing roads and parking areas would be used and are considered adequate to handle the demands under the proposed action. The transportation of waste or hazardous materials would comply with EAFB procedures and applicable regulations. Only approved or existing routes would be used.

Depending on the winds, the Starliner landing may require the closure of roads within the landing zone extension for approximately an hour to ensure no jettisoned part strikes a vehicle. This will include the only road access to and from the AFRL. The proposed activity would not significantly affect transportation since periodic roadblocks impede vehicular traffic only when needed for an emergency landing and are temporary.

The proposed action would have no significant impact to infrastructures or utilities.

### 3.12.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in infrastructure, transportation, or communications impacts.

## 3.13 **Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention**

### 3.13.1 **Affected Environment**

In general, hazardous materials include substances that may present substantial danger to public health or the environment when released because of their quantity, concentration, or physical, chemical or biological characteristics. Hazardous wastes are regulated by the *Resource Conservation and Recovery Act (RCRA) of 1976* (42 U.S.C. 6901–6991). Hazardous Wastes are any waste or combination of wastes that either exhibit one or more hazardous characteristics including ignitibility, corrosivity, toxicity, or reactivity. Solid wastes are essentially those wastes that are not hazardous. If hazardous materials or wastes are handled improperly or accidentally released, they can present a threat to the health of humans, wildlife, and soil and water systems.

Hazardous wastes that require proper handling could be generated as a result of landing and recovery activities. AFMAN 32-7002, Environmental Compliance and Pollution Prevention, , provides guidelines for the generation, storage, transportation, and disposal of hazardous waste. The California Environmental Protection Agency enforces hazardous waste laws documented in Title 22 California Code of Regulations (CCR) Division 4.5, *Environmental Health Standards for the Management of Hazardous Waste*, and California Health and Safety Code Division 20, Chapter 6.5, *Hazardous Waste Control*.

Guidelines used by Edwards AFB include the *Edwards Air Force Base Hazardous Waste Management Plan*, (HWMP) which was prepared IAW AFMAN32-7002, *Environmental Compliance and Pollution Prevention* . The HWMP establishes procedures to achieve compliance with applicable federal, state, and local regulations for hazardous waste management. Specifically, it contains requirements for hazardous waste characterization, training, accumulation, turn-in and disposal, inspections, permits, and record keeping.

The transportation of hazardous waste is governed by RCRA. The transportation of hazardous materials in commerce is governed by Department of Transportation regulations that specify procedures for transporting these materials on public roads (49 CFR 100–199; 40 CFR 260–299; and 22 CCR Division 4.5, Chapter 13).

EAFB operates a nonhazardous municipal solid waste landfill within the Main Base area for DAF-generated solid waste. All nonhazardous waste from privatized housing is hauled to off Base landfills. Nonhazardous waste from contractor projects that are not regular ongoing activities is generally hauled off Base as well, but disposal in the EAFB operated landfill may be considered on a case-by-case basis. The base actively participates in a solid waste recycling program. Recycling is the use, reclamation, and reuse of a material. AFMAN 32-7002, Environmental Compliance and Pollution Prevention requires the base to recycle and states, “Each installation will strive to recycle as much of the solid waste stream as possible. As a minimum, each qualified recycling program will recycle metals, plastic, glass, used oil, lead acid batteries, tires, high quality copier paper, cardboard, and newspaper.” A contractor operates the recycling program under contract with EAFB, with program oversight provided by Civil Engineering and Environmental Management.

Normal operations on EAFB result in the use of hazardous materials and generation of hazardous waste.

### 3.13.2 **Environmental Consequences**

The FAA has not established a significance threshold for hazardous materials, solid waste, and 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. (FAA Order 1050.1F)

The proposed action would require the use of H4N2 hydrazine, ordnance, Galden (a perfluoropolyether heat transfer fluid), coolant and ammonia within the CM and fuel in ground vehicles and equipment. Solid waste and potentially biohazard material would also be generated.

Unless a failure occurs that would allow a release, all hazardous material would remain in the spacecraft for transport back to the Boeing facility at the Kennedy Space Center in Florida and therefore have no impact to EAFB or its surrounding areas. Under the proposed action, removal of all waste, hardware, debris, and other hazardous or potentially hazardous material would be the responsibility of Boeing.

Following a nominal landing, the only live ordnance devices would be in the NASA Docking System (NDS) Emergency Undock System (unless it was fired due to an emergency undocking from the ISS) and the Airbag Vent Cord Cable Cutters (AVCCC) in the landing airbag water drains and center airbag (which are only fired in a water landing). These are in a safe configuration for landing and would require multiple failures to inadvertently fire. The majority of Starliner ordnance devices are Class 1 Division 1.4 per the Department of Transportation CFR 49, Part 173.50 (see definitions below). SureSep Expanding Tube Assemblies (XTAs), used to separate the Starliner from the launch vehicle during ascent, are division 1.1 and the drogue parachute mortars, fired as part of the parachute deploy sequence during landing, are division 1.2. All these division 1.1 and 1.2 ordnance would be expended prior to landing. The NDS ordnance is initiated via NASA standard detonators (NASA standard initiator + detonating booster assembly). The remainder of the ordnance devices, with the exception of the AVCC's, are initiated via smart initiators. The AVCC has a built-in initiator. All ordnance devices receive command signals from ordnance controllers within the Starliner Command and Data Handling system. All ordnance is developed per MIL-HDBK-83578, Criteria for Explosive Systems and Devices used on Space Vehicles.

The maximum explosive remaining unexploded in any ordnance after a nominal landing is just over half a gram. The total unexploded ordnance remaining on the vehicle after a nominal landing is approximately 30 grams.

*"Division 1.1 consists of explosives that have a mass explosion hazard. A mass explosion is one which affects almost the entire load instantaneously.*
*Division 1.2 consists of explosives that have a projection hazard but not a mass explosion hazard.*
*Division 1.4 consists of explosives that present a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package."*

Emergency response planning would be incorporated into the landing and recovery operations requirements in order to minimize any impacts due to an unplanned release of hazardous materials. Should a leak occur entry to the landing site would be restricted to approved emergency hazardous materials response personnel until the area is determined to be safe.

Nonhazardous waste would be handled as solid waste or non-regulated waste. All solid waste generated at EAFB is collected and disposed of in the EAFB operated landfill. The only petroleum, oil, and lubricants used during the landing and recovery operations would be contained in support equipment, generators, cranes, and vehicles.

The Edwards Spill Prevention, Control, and Countermeasures Plan would be followed for both pollution prevention and in the unlikely event of accidental spills. Health and safety risks would be minimized by following established EAFB procedures.

Biomedical hazardous waste could be generated by the crew during their time in the CM for landing and/or from any local medical evaluations needed post landing prior to moving the crew to a local hospital. Any waste generated would be left in the CM for removal by the Boeing team or removed by the medical staff supporting the crew post landing.

In summary, the proposed action would not result in significant impacts related to hazardous materials, hazardous waste, solid waste, and pollution prevention.

### 3.13.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in hazardous or solid waste being generated at the EAFB landing site.

## 3.14 **Human Health and Safety**

### 3.14.1 **Affected Environment**

Health and safety on Edwards AFB are regulated by AFMAN 91-203, Air Force Occupational Safety, Fire and Health Standards, federal OSHA and California OSHA. The health of military and civilian DoD personnel at Edwards AFB is supervised by Bioenvironmental Engineering Services and the Safety Department. Contractors are responsible for their own health and safety. The total accident spectrum encompasses not only injury to personnel, but also damage or destruction of property or products. For worker safety, the boundary of the immediate work area, job trailers, staging areas and ingress/egress routes defines the region(s) of influence. A contractor's attention to occupational health and safety rules and regulations will help avoid potential environmental issues and/or cross contamination in areas adjacent to the region(s) of influence.
Environmental conditions existing at Edwards AFB can present a physical/health hazard to personnel such as unexploded ordnance (UXO), heat stress, venomous snakes and spiders, hantavirus from deer mice (*Peromyscus maniculatus*) and valley fever spores. Only rare instances of valley fever have been diagnosed at Edwards AFB.

### 3.14.2 **Environmental Consequences**

As a safety precaution, recovery personnel would remain outside the landing zone until after the landing of the spacecraft and all jettisoned pieces. Upon landing, the landing team would reposition to a location approximately 500 feet upwind of the Starliner. After confirmation from the astronauts that the Starliner systems have been safed, a safety assessment team in protective gear would perform the initial safety assessment. If hazardous conditions are detected the safety assessment team would determine the source of the hazard and mitigate the hazard, if possible. If unable to mitigate the hazard, the EAFB Fire Crash Rescue team would assist in mitigating the hazard and to perform toxic spill or contamination cleanup. Once the area around the CM is deemed safe, recovery personnel would reposition around the spacecraft and commence recovery operations. Proper personal protective equipment would be used, as needed, by personnel working on the project and applicable EAFB safety procedures would be followed.

Boeing personnel would be required to receive UXO training before being allowed entry onto EAFB, including instruction not to disturb potential UXO items. All potential UXO and unfamiliar objects would be reported to EAFB personnel.

There is some risk to recovery personnel from venomous snake and spider bites, but these typically occur only when the species is disturbed, harassed or provoked; although the Mojave "green" rattlesnake has been known to strike without provocation. Recovery personnel would be instructed not to harass venomous spiders and snakes. In addition, Hantavirus training would be provided to recovery personnel. Personnel would be trained prior to arrival at the EAFB.

Any public viewers of a landing would be kept outside of EAFB and would not be affected by the landing. All areas located on EAFB and inside of the EAFB landing zone would be cleared and all access to the area on the day of landing is controlled by EAFB Flight Safety. NASA and EAFB Public Affairs and other DAF officials would provide the necessary guidance and assist Public Affairs in providing landing information to the public.

Overall, the proposed action would have no significant impact on human health and safety.

### 3.14.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at EAFB. Therefore, the No Action Alternative would not result in impacts on human health and safety at the EAFB landing site or the surrounding area.

# 4.0 Mitigation Measures

This section summarizes applicable mitigation and minimization measures that have been incorporated into the Proposed Action and would be adhered to during Starliner landing and recovery operations at EAFB. Further, these measures will be incorporated as conditions on the license the FAA issues to Boeing.

- Normal dust suppression methods would be employed as necessary. Vehicles and generators would be inspected to ensure proper working order and compliance with applicable permitting and requirements. The site safety plan would be designed to minimize environmental impacts and health hazards in the unlikely event of an accidental fuel or hazardous material leak. Hazardous materials-related response plans and standard safety operating plans would be developed before beginning the proposed action.
- The following measures follow the terms and conditions for the U.S. Fish and Wildlife Service Biological Opinion for: Operations and Activities Edwards Air Force Base, California (8-8-14-F-14) regarding the effects on the federally threatened desert tortoise and its critical habitat.
    - All project personnel working in the area shall attend desert tortoise awareness training prior to commencing field work or visiting the work site. Contact the EAFB Environmental Management Office for training requirements.
    - At no time would LRT personnel or visitors touch, move, harass, harm or kill any desert tortoise. LRT personnel and visitors would immediately report all desert tortoise sightings to the EAFB Environmental Management Office and immediately cease work, if required, in that specific area until an authorized biologist assumes protection of the tortoise.
    - Vehicles will generally remain on previously established roads and within staging areas and follow flagged off road routes that have been surveyed or cleared of desert tortoises. When driving off road, operators will minimize disturbance to vegetation and not exceed 10 miles per hour. Speed limits on existing dirt roads within the landing zone shall be less than 20 mph.
    - If a desert tortoise burrow is encountered within the landing zone, the burrow shall be avoided. LRT personnel would immediately report the burrow sighting to the EAB Environmental Management Office and immediately cease work, if required, in that specific area until an authorized biologist assumes protection of the tortoise.
    - All LRT personnel working in open areas shall inspect under all vehicles and equipment for desert tortoises and other wildlife species prior to operation. If a tortoise is present, the vehicle shall not be moved. The EAFB Environmental Management Office shall be notified and immediately cease work, if required, in that specific area until an authorized biologist assumes protection of the tortoise.
    - Should the EAFB Environmental Management Office recommend it, the LRT would only recover the large jettisoned parts, leaving the smaller parts in the field to minimize vehicle traffic damage to desert tortoise habitat.
    - Parking and staging areas will be restricted to previously disturbed areas as much as possible.
    - At night crew recovery activities in vegetated habitat will require the presence of a desert tortoise authorized biologist. All other recovery activities will take place during daylight hours.
    - All trash and food items will be disposed of in common raven-proof containers, and
    - regularly removed from project sites to reduce attraction of common ravens.
- The LRT would contact the Environmental Management Office if an active bird nest (i.e., nest with eggs, unfledged birds or adult birds observed in the nest), or a burrowing owl burrow is found within the landing zone and cannot be avoided.

- If any additional species of interest are found following the completion of this EA, the Environmental Management Office would be consulted to determine if additional mitigation or agency consultation is necessary to prevent impact to the listed species' populations.
- Any damage to the historic lakebed would be repaired by EAFB using their internal processes. There is currently no plan to close any public highways during the landing activities and the sonic boom overpressure is minimal, therefore no mitigation measures are needed for these.
- Close scheduling and coordination from Edwards Air Traffic Control would minimize any airspace or scheduling conflicts with other aviation operations being conducted at the EAFB landing. Any large holes or craters caused to the lakebed during landing would be filled in by EAFB if necessary.
- In all proposed activities ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Equipment used would be inspected frequently for petroleum, oil, and lubricant leaks and, if needed, appropriate containment would be placed underneath equipment when not in use. Any damage to the lakebed that occurs during landing and recovery operations will be repaired so as not to affect the floodplain.
- In the event that a previously unknown resource is located around the CM landing location, all activity would cease after the crew is removed from the Starliner and EAFB Environmental Management would be notified. In the event that a known or previously unknown resource is impacted by a jettisoned part or by access for its retrieval, all activity would cease and EAFB Environmental Management would be notified. In the event that any project activities are required outside the proposed areas in this EA, all landing activities would cease after the crew is removed, the site would be evaluated per section 106 of the NHPA and an area of 100 yard on both sides of a straight line back to the landing zone would be surveyed and evaluated before the CM is recovered.
- Recovery efforts may be required to be monitored, and impact disturbance due to falling debris on a site may require a damage assessment. EAFB Environmental Management may also require NRHP testing if a site with undetermined NRHP status is damaged.
- For the safety of workers, proper protective equipment including hearing protection would be utilized if needed (Reference: 29 CFR 1910.95, Occupational Safety and Health Administration (OSHA) standard for Noise Exposure) for those working close to noise sources that could be hazardous.
- When nighttime operations are required the lighting needs would be assessed to ensure the level of lighting is commensurate with safely performing the proposed action.
- The spacecraft and all jettisoned hardware would be collected, if found, and removed from the landing site. It may not be possible to find and recover all of the mortar lids and doors due to their small size should they land outside the lakebed. Hazardous materials and hazardous wastes would be recovered, and disposed of by Boeing. Nonhazardous waste would be handled as solid waste or non-regulated waste and disposed of accordingly. To ensure pollution protection all equipment used for landing and recovery activities would be inspected in accordance with established site procedures for POL leaks and, if necessary, appropriate containment would be placed underneath equipment when not in use. In the unlikely event of an accidental POL spill, contaminated soil would be cleaned using established site procedures.
- All personnel working on the test project would have the required UXO, wildlife, cultural, and necessary training. Process and plans would be in place to eliminate or mitigate anticipated potential safety and health risks.
- Any public viewers would be kept outside the landing zone. NASA and EAFB Public Affairs would also provide ways to inform the public of the landing and related activity.

# 5.0 Irretrievable and Irreversible Commitment of Resources and Cumulative Impacts

## 5.1 Irretrievable and Irreversible Commitment of Resources

The proposed landing and recovery of the Starliner spacecraft would cause no losses to natural, cultural, or human resources. Some irreversible and irretrievable commitment to resources would be expected from the use of recovery vehicles, fuel, energy, and labor. The landing and recovery activities at the EAFB landing site would not commit natural resources in unacceptable quantities nor cause resources to become inaccessible for other uses.

## 5.2 Cumulative Impacts

This EA also considers the effects of cumulative impacts as required in 40 CFR §1508.7 and concurrent actions as required in 40 CFR §1508.25(1). A cumulative impact, as defined by the CEQ, is the "…impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future action regardless of which agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

A list of past, present, and reasonably foreseeable future actions at EAFB and the surrounding area that could result in cumulative impacts with the implementation of this Proposed Action are shown in Table 5-1. Since the Proposed Action would occur in an area central to EAFB property, there would be no potential for cumulative impacts from actions occurring outside of EAFB. Therefore, any such action was not included for consideration in this cumulative impacts analysis. However, non-DAF actions that are occurring or would occur on EAFB were included for analysis.

**Table 5-1 Past, Present, and Reasonably Foreseeable Future Actions**

| Action # | Action | Description |
|---|---|---|
| 1 | Construct Module Support Facility<br>(near future) | Construction of new ~20,000 SF facility east of Building 130A to support the expansion of the 419th Special Instrumentation group. |
| 2 | Construct Temporary Storage Facility<br>(expected to begin Dec 21/Jan 22) | Construction of a temporary storage facility to accommodate storage needs for site support for B-21 assets near Buildings 1860 & 1858. |
| 3 | Construct Modular Facility<br>(near future) | Construction of new modular facility near buildings 1022A and 1020, including pavement, fencing, and utilities. |
| 4 | Construct Refueling Truck Maintenance Facility<br>(near future) | Construction of ~960 SF building for refueling truck maintenance near Building 3511 parking areas. |
| 5 | Construct Hangar, New Egress Facility, and Demolish 1400, 1407, 1410, 1412 and 1425<br>(expected to begin in Calendar Year 22) | New construction and demolition projects near Ramp 1 to support the Flightline Strategic Plan, B-52 Re-engine Program and Combined Task Force expansions. |

| | | |
|---|---|---|
| 6 | Munitions Complex Expansion (ongoing) | Construction of up to ~20,000 SF of munitions storage igloos and drive-thru igloos, as well as the necessary utilities, infrastructure, and security features in the footprint of Buildings 639 and 647, which would be demolished. |
| 7 | Joint Simulator Environment (ongoing) | Construction of new ~98,000 SF facility and supporting infrastructure to house the Joint Simulation Environment and Electronic Warfare Groups. |
| 8 | Construct Muroc School (ongoing) | Renovation of the existing school complex at Edwards to create a TK-12 campus and improve campus infrastructure and athletic facilities. |
| 9 | Aratina Transmission Line (near future) | Construction of a transmission line to connect the Aratina Solar Farm to the statewide electrical grid. |
| 10 | BLM/SCE-Ivanpah (expected to begin in Calendar Year 22) | Replacement and modification of existing sub transmission facilities supporting the Southern California Edison 115kV transmission line, a portion of which runs through Edwards AFB. |
| 11 | Edwards Solar Array Construction (ongoing) | Lease of ~4,000 acres of undeveloped, non-excess real property for construction, operation, and maintenance of a solar photovoltaic facility for up to 40 years. |

Descriptions of potential cumulative impacts for each resource area analyzed within this EA are presented in the following sections. This analysis considers potential impacts from outside projects based on the best available information for these proposals. Future actions would be evaluated under separate NEPA documentation, if required, by the appropriate federal agency.

### 5.2.1 **Air Quality**

No significant impacts to regional air quality or GHGs would result from implementation of the Proposed Action. Construction activities associated with the projects identified in Table 5-1 would result in some impacts on regional air quality. However, with the use of standard and required best management practices for all activities, potential impacts would be mitigated. Further, construction activities would occur at different times and different locations on base. Since the Proposed Action would occur on rare occasions and only when necessary, cumulative air quality impacts resulting from this Proposed Action in conjunction with the other identified actions would be short-term and would not be significant.

### 5.2.2 **Biological Resources**

The Proposed Action analyzed in this EA would not result in significant impacts to local flora, fauna, or overall biological resources. While the construction activities associated with the projects identified in Table 5-1 could impact biological resources, those activities would not occur in the same area where the Proposed Action would take place. Further, the Proposed Action would be implemented on rare occasions and only when necessary. Therefore, cumulative impacts to biological resources as a result of this Proposed Action and the other projects listed in Table 5-1 would not be significant.

### 5.2.3 **Climate**

This Proposed Action would not result in significant climate impacts. GHG emissions could result from the construction activities associated with the projects identified in Table 4-1; however, each proposed action has been or will be analyzed and ensure that potential impacts would not be significant and/or

would be mitigated. Since the Proposed Action would be implemented on rare occasions, and only when necessary, cumulative impacts to climate would not be significant.

### 5.2.4 Department of Transportation Act, Section 4(f)

No Department of Transportation Act Section 4(f) property would be used in implementing the Proposed Action analyzed in this EA. Since there would be no impacts to Section 4(f) under this Proposed Action, there would be no potential for cumulative impacts to this resource.

### 5.2.5 Land Use and Airspace

The Proposed Action analyzed in this EA would not result in significant impacts to Land Use or Airspace. The other projects identified in Table 5-1 would not disrupt existing land uses or impact other neighboring landowners; as stated above, all projects listed occur on-base. Therefore, cumulative impacts to Land Use would not be significant. The projects identified in Table 5-1 would not require the use of Airspace, so there would be no potential for cumulative impacts to this resource.

### 5.2.6 Physical Resources

There would be no significant impacts to water resources or geology and soils under this Proposed Action. Potential impacts to these resources resulting from the projects identified in Table 5-1 would be geographically and temporally separated, and would employ standard best management practices as required. Since the Proposed Action would occur on rare occasions, and only when necessary, cumulative impacts to water resources and/or geology and soils would not be significant.

### 5.2.7 Cultural Resources

The Proposed Action analyzed within this EA would not impact archaeological resources, architectural resources, or traditional cultural properties at EAFB. Since the Proposed Action does not include construction, any impacts to archaeological resources, architectural resources, or traditional cultural properties resulting from construction activities associated with the other projects identified in Table 5-1 would not be cumulative to this Proposed Action. Therefore, no cumulative impacts to cultural resources would result from the implementation of the Proposed Action in conjunction with other projects identified.

### 5.2.8 Noise and Noise-Compatible Land Use

The Proposed Action analyzed within this EA would be consistent with current land use and would not result in significant noise impacts. Potential noise impacts resulting from the projects identified in Table 5-1 would only occur as a result of construction activities. As the Proposed Action would occur on rare occasions, and only when necessary, cumulative impacts to noise and noise-compatible land use would not be significant.

### 5.2.9 Socioeconomics

The Proposed Action analyzed within this EA, which would only occur on rare occasions and only when necessary, would result in short-term, minor impacts to socioeconomic resources within the ROI when access to the surrounding airspaces would be restricted. However, this restriction would be temporary and local air traffic would be re-routed during the restriction. The need for construction supplies and workers to complete the other projects identified in Table 5-1 would result in minor, short-term, beneficial impacts to socioeconomic resources in the area. For all projects, these impacts would cease once construction and operational phases were complete. Therefore, there would be no long-term cumulative impacts to socioeconomic resources resulting from the Proposed Action in conjunction with other identified actions.

### 5.2.10 Environmental Justice and Children's Environmental Health and Safety Risks

There would be no significant impacts to Environmental Justice or Children's Environmental Health and Safety resulting from this Proposed Action. Along with the other projects identified in Table 5-1, potential impacts would not be expected to extend beyond the boundaries of EAFB. As such, cumulative impacts to Environmental Justice and Children's Environmental Health and Safety Risks would not be significant.

### 5.2.11 Visual Effects

The Proposed Action analyzed in this EA would not result in significant visual impacts. Construction activities associated with the projects outlined in Table 5-1 would result in visual changes; however, these changes would only occur within EAFB boundaries. Construction activities would occur at different times and different locations on base. Since the Proposed Action would occur on rare occasions, and only when necessary, there would be no long-term cumulative visual impacts resulting from this Proposed Action in conjunction with the other identified actions.

### 5.2.12 Infrastructure and Utilities

There would be no significant impacts to structures, utilities, transportation, and/or roads resulting from the Proposed Action analyzed in this EA. Construction activities associated with the projects outlined in Table 5-1 could impact these resources; however, those activities would occur at different times and different locations on base. The Proposed Action would occur on rare occasions, and only when necessary. There would be no long-term cumulative impacts to infrastructure and utilities.

### 5.2.13 Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention

The Proposed Action would not result in significant impacts related to hazardous materials, hazardous waste, solid waste, and pollution prevention. Hazardous materials could be used during the construction activities associated with the projects identified in Table 5-1, and hazardous and/or solid waste could be generated as well. However, all projects would abide by EAFB hazardous materials and waste and solid waste management plans. The Proposed Action would occur on rare occasions, and only when necessary. Therefore, there would be no cumulative impacts to hazardous materials, hazardous waste, solid waste, or pollution prevention.

### 5.2.14 Human Health and Safety

The Proposed Action analyzed within this EA would not result in significant impacts to health and human safety. Standard and required safety procedures would be followed during all construction activities associated with the projects identified in Table 5-1. Construction activities would occur at different times and different locations on base, and the Proposed Action would occur on rare occasions, and only when necessary. Therefore, there would be no cumulative impacts to health and human safety.

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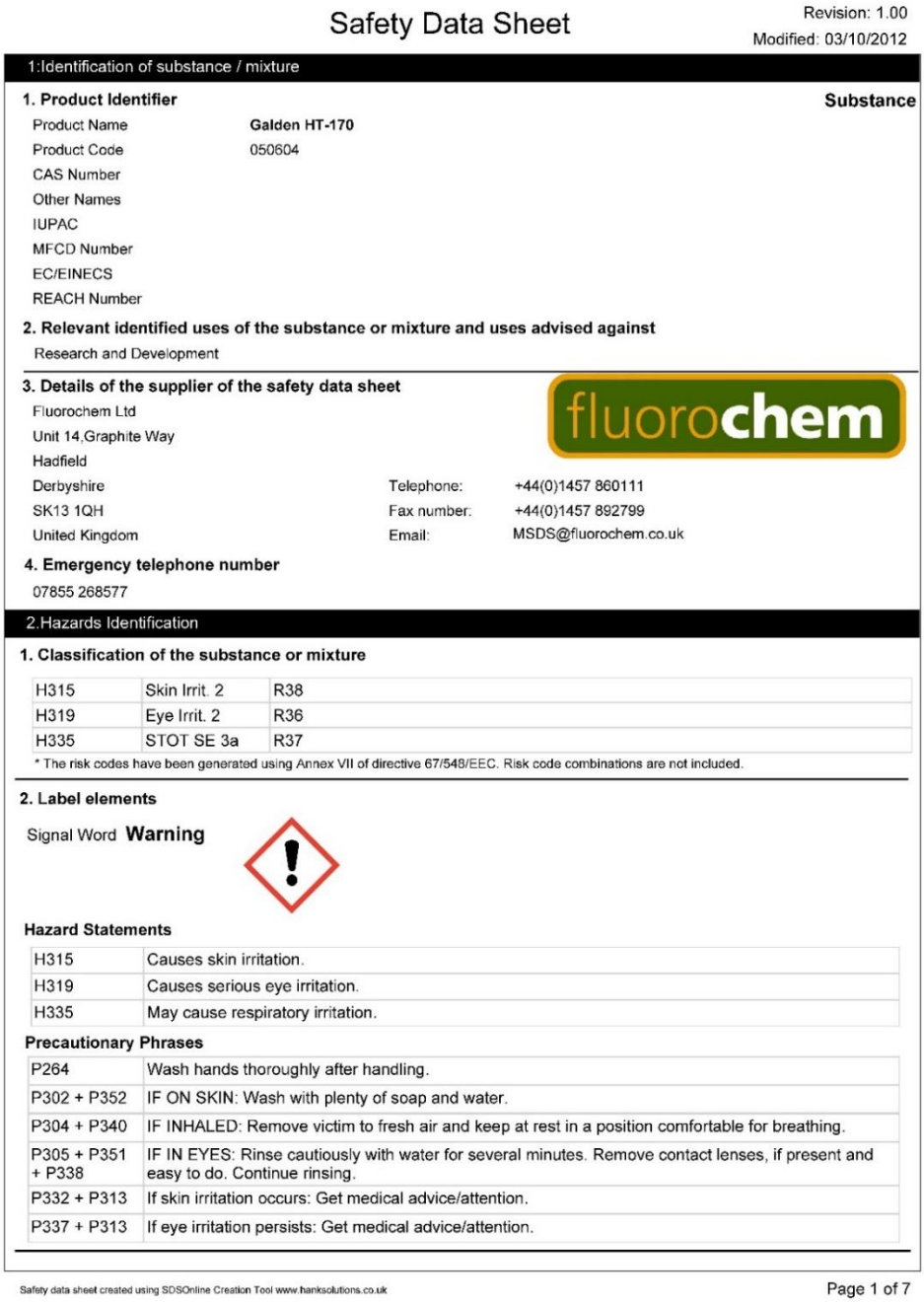
# 7.0 Appendices

# Appendix A – Typical Safety Data Sheets

- Perfluoropolyether Heat Transfer Fluid



Safety Data Sheet

Revision: 1.00
Modified: 03/10/2012

**1:Identification of substance / mixture**

**1. Product Identifier** **Substance**

| | |
|---|---|
| Product Name | **Galden HT-170** |
| Product Code | 050604 |
| CAS Number | |
| Other Names | |
| IUPAC | |
| MFCD Number | |
| EC/EINECS | |
| REACH Number | |

**2. Relevant identified uses of the substance or mixture and uses advised against**

Research and Development

**3. Details of the supplier of the safety data sheet**

Fluorochem Ltd
Unit 14,Graphite Way
Hadfield
Derbyshire
SK13 1QH
United Kingdom

Telephone: +44(0)1457 860111
Fax number: +44(0)1457 892799
Email: MSDS@fluorochem.co.uk

**4. Emergency telephone number**

07855 268577

**2.Hazards Identification**

**1. Classification of the substance or mixture**

| | | |
|---|---|---|
| H315 | Skin Irrit. 2 | R38 |
| H319 | Eye Irrit. 2 | R36 |
| H335 | STOT SE 3a | R37 |

* The risk codes have been generated using Annex VII of directive 67/548/EEC. Risk code combinations are not included.

**2. Label elements**

Signal Word **Warning**

**Hazard Statements**

| | |
|---|---|
| H315 | Causes skin irritation. |
| H319 | Causes serious eye irritation. |
| H335 | May cause respiratory irritation. |

**Precautionary Phrases**

| | |
|---|---|
| P264 | Wash hands thoroughly after handling. |
| P302 + P352 | IF ON SKIN: Wash with plenty of soap and water. |
| P304 + P340 | IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. |
| P305 + P351 + P338 | IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. |
| P332 + P313 | If skin irritation occurs: Get medical advice/attention. |
| P337 + P313 | If eye irritation persists: Get medical advice/attention. |

Safety data sheet created using SDSOnline Creation Tool www.hanksolutions.co.uk

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# Safety Data Sheet

Revision: 1.00
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**3. Other Hazards**

Additional precautionary phrases are located throughout the safety data sheet

## 3.Composition / Information on Ingredients

**1. Substances**

Galden HT-170 **Assay:**100% CAS Number :

**2. Mixtures**

Not Relevant

## 4.First Aid Measures

**1.Description of first aid measures**

*Skin Contact* IF ON SKIN: Wash with plenty of soap and water.
If skin irritation occurs: Get medical advice/ attention.

*Eye Contact* If eye irritation persists: Get medical advice/attention.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

*Ingestion* Wash out mouth with water.

*Inhalation* IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.

**2.Most important symptoms and effects**

No symptoms.

**3.Indication of any immediate medical attention**

Call a POISON CENTER or doctor/physician if you feel unwell.
No additional measures required

## 5.Firefighting measures

**1.Extinguishing Media**

*Suitable* Carbon dioxide.
Dry chemical powder.
Water.

*Unsuitable* Do not use water with a full water jet

**2.Special Hazards arising from the substance or mixture**

In combustion toxic fumes may form.

**3.Advice for Fire Fighters**

Wear protective clothing to prevent contact with skin and eyes.
Wear self-contained breathing apparatus.

## 6.Accidental Release Measures

**1.Personnal Precautions**

Refer to section 8 of SDS for personal protection details.

**2.Environmental Precautions**

Do not discharge into drains or rivers.

**3.Methods & Materials**

Mix with sand or vermiculite.
Transfer to a suitable container.

## 7.Handling and Storage

**1.Personnal Precautions**

| | |
|---|---|
| *Safe Handling* | Handle in fume hood.<br>Wash hands immediately after contamination.<br>Wash handsoughly after handling. |
| *Protection against explosions and fires* | Take off contaminated clothing and wash before reuse.<br>normal measures for preventive fire protection |

**2.Conditions for safe storage, including any incompatibilities**

| | |
|---|---|
| *Managing Storage Risks* | Keep container tightly closed.<br>Store in cool, well ventilated area. |
| *Storage Controls* | No special requirements |
| *Maintaining Integrity* | Keep in tightly closed container in cool area away from direct sunlight or heat sources. |
| *Other advice* | Store in a well-ventilated place. Keep container tightly closed. |

**3.Specific End Uses**

The end use(s) have not been fully determined. The substance is supplied for Research and Development purposes by professionals only.

## 8.Exposure Controls/Personal Protection

**1. Control Parameters**

No Data Available

**2.Exposure Controls**

| | |
|---|---|
| *General protective and hydgiene measures* | Wear protective gloves/protective clothing/eye protection/face protection. .<br>The standard precautionary measures should be adhered to when handling<br>Wash hands during breaks and at the end of handling the material<br>Immediately remove any contaminated clothing |
| *Engineering measures* | Use only outdoors or in a well-ventilated area.<br>Ensure there is sufficient ventilation of the area. |
| *Eye / Face Protection* | Safety Glasses. |
| *Hand protection* | Protective gloves. |
| *Respiratory protection* | Avoid breathing dust/fume/gas/mist/vapours/spray..<br>Respiratory protection not required. |
| *Skin protection* | Protective clothing. |
| *Other personal protection advice* | no data |

# Safety Data Sheet

Revision: 1.00
Modified: 03/10/2012

## 9.Physical and Chemical Properties

### 1. Physical and Chemical Properties

| | |
|---|---|
| Appearance | Clear colourless liquid |
| Odour | Odourless |
| Odour threshold | Not Applicable |
| PH | Not Applicable |
| Melting point / Freezing point | Not Applicable |
| Initial boiling point and boiling range | 170°C |
| Flash point | Not Applicable |
| Evaporation rate | Not Applicable |
| Flammability(solid,gas) | Not Applicable |
| Upper/lower flammability or explosive limits | Not Applicable |
| Vapour pressure | <1 torr. |
| Vapour density | Not Applicable |
| Relative density | 1.7-1.9 |
| Solubility(ies): | Insoluble in water |
| Partition coefficient: n-octanol/water | Not Applicable |
| Auto-ignition temperature | Not Applicable |
| Decomposition temperature | Not Applicable |
| Viscosity | Not Applicable |
| Explosive properties | Not Applicable |
| Oxidising properties | Not Applicable |

### 2.Other Information

No additional information available

## 10.Stability and Reactivity

### 1.Reactivity

no unusual reactivity

### 2.Stability

Stable under normal conditions.

### 3.Possibility of Hazardous Reactions

no hazardous reactions known

### 4.Conditions to Avoid

Flames.
Heat.
Sparks

### 5.Incompatible Materials

Strong oxidizing agents.
Alkali metals and halogenated compounds
Strong or non-aqueous alkali and Lewis acids above 100°C.

### 6.Hazardous Decomposition Products

In combustion emits toxic fumes.
In combustion emits toxic fumes of hydrogen fluoride.

# Safety Data Sheet

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## 11.Toxicology information

### 1.Information

| | |
|---|---|
| *Acute Toxicity* | Intraperitoneal LD50 (Rat) >25 g/kg<br>Oral LD50 (Rat) >2 g/kg<br>Dermal LD50 (Rat) >25.65g/kg |
| *Skin corrosion/irritation* | irritant for skin and mucous membranes |
| *Serious eye Damage/irratation* | irritant effect |
| *Respiratory or skin sensitisation* | No sensitizing effect known |
| *Germ Cell mutagenicity* | not known |
| *Carcinogenicity* | not known |
| *Reproductive toxicity* | not known |
| *STOT-single exposure* | not known |
| *STOT-repeated exposure* | not known |
| *Aspiration hazard* | not known |

### 2.Additional

To the best of our knowledge the acute and chronic toxicity of this substance is not fully known.
No classification data on carcinogenic properties of this material is available from the EPA, IARC,NTP,OSHA or ACGIH

## 12.Ecological Information

### 1.Toxicity

not known

### 2.Persistance and degradability

not known

### 3.Bio-Accumulative Potential

not known

### 4.Mobility and Soil

not known

### 5.Results of PBT & vPvB assessment

not known

### 6.Other adverse effects

not known

## 13.Disposal Considerations

### 1.Waste Treatment Methods

*Disposal Operations*

Consult state, local or national regulations for proper disposal.
Hand over to authorised disposal company as hazardous waste.

*Disposal of Packaging* Disposal must be made according to official regulations.

## 14. Transport Information

**Air (ICAO)**

Not classified as hazardous for transport

**Road (ADR)**

Not classified as hazardous for transport

**Sea (IMDG)**

Not classified as hazardous for transport

## 15.Safety, health and environmental regulations

**1.Safety, health and environmental regulations:**

product is not subject to any additional regulations or provisions

**2. Safety Assessment**

No Chemical Safety Assessment

## 16.Other Information

**1.Other Information:**

ADR: Accord Europeen sur le transport des merchandises Dangereuses par Route(European Agreement concerning the International Carriage of Dangerous Goods by road)
RID:Reglement International concernant le transport des merchandises dangereuses par chemin de fer (Regulations concerning the International transport of Dangerous Goods by Rail)
IMDG: International Maritime Code for Dangerous Goods
IATA: International Air Transport Association
IATA-DGR: Dangerous Goods Regulations by the International Air Transport Association
ICAO:International Civil Aviation Organization
ICAO-TI: Technical Instructions by the ICAO
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
CAS:Chemical Abstracts Service

**2. Associated risk phrases according to european directive 67/548/EEC**

| | |
|---|---|
| R36 | Irritating to eyes. |
| R37 | Irritating to respiratory system. |
| R38 | Irritating to skin. |

**3. Disclaimer**

# Safety Data Sheet

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The product listed is for research and development purposes only and not for human or animal use. As such, in most cases, the toxicological, ecological and physicochemical properties have not been fully determined and the product should be treated with respect and always handled under suitable conditions by appropriately qualified personnel. The responsible party shall use this datasheet only in conjunction with other sources of information gathered by them, and should make an independent judgement of suitability, to ensure proper use and protect the health and safety of employees. This information is furnished without warranty and any use of the product not in conformance with this material safety data sheet, or in combination with any other product or process, is the responsibility of the user.

- Propellants

SDS#74287 Rev 03-03-2015

**SIGMA-ALDRICH** sigma-aldrich.com

**SAFETY DATA SHEET**

Version 4.7
Revision Date 03/03/2015
Print Date 03/25/2015

**1. PRODUCT AND COMPANY IDENTIFICATION**

**1.1 Product identifiers**

Product name : Hydrazine

Product Number : 215155
Brand : Sigma-Aldrich
Index-No. : 007-008-00-3

CAS-No. : 302-01-2

**1.2 Relevant identified uses of the substance or mixture and uses advised against**

Identified uses : Laboratory chemicals, Manufacture of substances

**1.3 Details of the supplier of the safety data sheet**

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

**1.4 Emergency telephone number**

Emergency Phone # : (314) 776-6555

**2. HAZARDS IDENTIFICATION**

**2.1 Classification of the substance or mixture**

**GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)**
Flammable liquids (Category 3), H226
Acute toxicity, Oral (Category 3), H301
Acute toxicity, Inhalation (Category 2), H330
Acute toxicity, Dermal (Category 3), H311
Skin corrosion (Category 1B), H314
Serious eye damage (Category 1), H318
Skin sensitisation (Category 1), H317
Carcinogenicity (Category 1B), H350
Acute aquatic toxicity (Category 1), H400
Chronic aquatic toxicity (Category 1), H410

For the full text of the H-Statements mentioned in this Section, see Section 16.

**2.2 GHS Label elements, including precautionary statements**

Pictogram

Signal word Danger

Hazard statement(s)
H226 Flammable liquid and vapour.
H301 + H311 Toxic if swallowed or in contact with skin
H314 Causes severe skin burns and eye damage.
H317 May cause an allergic skin reaction.
H318 Causes serious eye damage.

| | |
|---|---|
| H330 | Fatal if inhaled. |
| H350 | May cause cancer. |
| H410 | Very toxic to aquatic life with long lasting effects. |
| Precautionary statement(s) | |
| P201 | Obtain special instructions before use. |
| P202 | Do not handle until all safety precautions have been read and understood. |
| P210 | Keep away from heat/sparks/open flames/hot surfaces. - No smoking. |
| P233 | Keep container tightly closed. |
| P240 | Ground/bond container and receiving equipment. |
| P241 | Use explosion-proof electrical/ ventilating/ lighting/ equipment. |
| P242 | Use only non-sparking tools. |
| P243 | Take precautionary measures against static discharge. |
| P260 | Do not breathe dust/ fume/ gas/ mist/ vapours/ spray. |
| P264 | Wash skin thoroughly after handling. |
| P270 | Do not eat, drink or smoke when using this product. |
| P271 | Use only outdoors or in a well-ventilated area. |
| P272 | Contaminated work clothing should not be allowed out of the workplace. |
| P273 | Avoid release to the environment. |
| P280 | Wear protective gloves/ protective clothing/ eye protection/ face protection. |
| P281 | Use personal protective equipment as required. |
| P284 | Wear respiratory protection. |
| P301 + P310 + P330 | IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician. Rinse mouth. |
| P301 + P330 + P331 | IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. |
| P303 + P361 + P353 | IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower. |
| P304 + P340 + P310 | IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/ physician. |
| P305 + P351 + P338 + P310 | IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/ physician. |
| P308 + P313 | IF exposed or concerned: Get medical advice/ attention. |
| P333 + P313 | If skin irritation or rash occurs: Get medical advice/ attention. |
| P363 | Wash contaminated clothing before reuse. |
| P370 + P378 | In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction. |
| P391 | Collect spillage. |
| P403 + P233 | Store in a well-ventilated place. Keep container tightly closed. |
| P403 + P235 | Store in a well-ventilated place. Keep cool. |
| P405 | Store locked up. |
| P501 | Dispose of contents/ container to an approved waste disposal plant. |

**2.3 Hazards not otherwise classified (HNOC) or not covered by GHS** - none

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

**3.1 Substances**

| | | |
|---|---|---|
| Formula | : | $H_4N_2$ |
| Molecular weight | : | 32.05 g/mol |
| CAS-No. | : | 302-01-2 |
| EC-No. | : | 206-114-9 |
| Index-No. | : | 007-008-00-3 |

**Hazardous components**

| Component | Classification | Concentration |
|---|---|---|

| | | |
|---|---|---|
| **Hydrazine** Included in the Candidate List of Substances of Very High Concern (SVHC) according to Regulation (EC) No. 1907/2006 (REACH) | | |
| | Flam. Liq. 3; Acute Tox. 3; Acute Tox. 2; Acute Tox. 3; Skin Corr. 1B; Eye Dam. 1; Skin Sens. 1; Carc. 1B; Aquatic Acute 1; Aquatic Chronic 1; H226, H301 + H311, H314, H317, H318, H330, H350, H410 | <= 100 % |

For the full text of the H-Statements mentioned in this Section, see Section 16.

## 4. FIRST AID MEASURES

### 4.1 Description of first aid measures

**General advice**
Move out of dangerous area.Consult a physician. Show this safety data sheet to the doctor in attendance.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

**In case of eye contact**
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.Continue rinsing eyes during transport to hospital.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

### 4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

### 4.3 Indication of any immediate medical attention and special treatment needed
No data available

## 5. FIREFIGHTING MEASURES

### 5.1 Extinguishing media

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

### 5.2 Special hazards arising from the substance or mixture
Nitrogen oxides (NOx)

### 5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

### 5.4 Further information
Use water spray to cool unopened containers.

## 6. ACCIDENTAL RELEASE MEASURES

### 6.1 Personal precautions, protective equipment and emergency procedures
Wear respiratory protection. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

### 6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

**6.3 Methods and materials for containment and cleaning up**
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

**6.4 Reference to other sections**
For disposal see section 13.

## 7. HANDLING AND STORAGE

**7.1 Precautions for safe handling**
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

**7.2 Conditions for safe storage, including any incompatibilities**
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Storage class (TRGS 510): Flammable liquids

**7.3 Specific end use(s)**
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**8.1 Control parameters**

**Components with workplace control parameters**

| Component | CAS-No. | Value | Control parameters | Basis |
|---|---|---|---|---|
| Hydrazine | 302-01-2 | TWA | 0.010000 ppm | USA. ACGIH Threshold Limit Values (TLV) |
| | Remarks | Upper Respiratory Tract cancer<br>Confirmed animal carcinogen with unknown relevance to humans<br>Danger of cutaneous absorption | | |
| | | TWA | 0.01 ppm | USA. ACGIH Threshold Limit Values (TLV) |
| | | Upper Respiratory Tract cancer<br>Confirmed animal carcinogen with unknown relevance to humans<br>Danger of cutaneous absorption | | |
| | | TWA | 1.000000 ppm<br>1.300000 mg/m3 | USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants |
| | | Skin designation<br>The value in mg/m3 is approximate. | | |
| | | C | 0.030000 ppm<br>0.040000 mg/m3 | USA. NIOSH Recommended Exposure Limits |
| | | Potential Occupational Carcinogen<br>See Appendix A<br>2 hour ceiling value | | |

**8.2 Exposure controls**

**Appropriate engineering controls**
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

**Personal protective equipment**

**Eye/face protection**
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 30 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Body Protection**
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory protection**
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Control of environmental exposure**
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

### 9.1 Information on basic physical and chemical properties

| | | |
|---|---|---|
| a) | Appearance | Form: liquid, clear<br>Colour: colourless |
| b) | Odour | Ammonia odor |
| c) | Odour Threshold | No data available |
| d) | pH | No data available |
| e) | Melting point/freezing point | 1.4 °C (34.5 °F) |
| f) | Initial boiling point and boiling range | 113.5 °C (236.3 °F) at 1,013 hPa (760 mmHg) |
| g) | Flash point | 52 °C (126 °F) - closed cup |
| h) | Evaporation rate | No data available |
| i) | Flammability (solid, gas) | No data available |
| j) | Upper/lower flammability or explosive limits | Upper explosion limit: 99.99 %(V)<br>Lower explosion limit: 4.7 %(V) |
| k) | Vapour pressure | 13 hPa (10 mmHg) at 30.70 °C (87.26 °F) |
| l) | Vapour density | 1.11 - (Air = 1.0) |

| | | |
|---|---|---|
| m) | Relative density | No data available |
| n) | Water solubility | completely miscible |
| o) | Partition coefficient: n-octanol/water | log Pow: -0.16 |
| p) | Auto-ignition temperature | No data available |
| q) | Decomposition temperature | No data available |
| r) | Viscosity | No data available |
| s) | Explosive properties | No data available |
| t) | Oxidizing properties | No data available |

**9.2 Other safety information**

| | |
|---|---|
| Dissociation constant | 6.05 |
| Relative vapour density | 1.11 - (Air = 1.0) |

## 10. STABILITY AND REACTIVITY

**10.1 Reactivity**
No data available

**10.2 Chemical stability**
Stable under recommended storage conditions.

**10.3 Possibility of hazardous reactions**
No data available

**10.4 Conditions to avoid**
Heat, flames and sparks.

**10.5 Incompatible materials**
Oxidizing agents, Oxygen, Copper, Zinc, Organic materials

**10.6 Hazardous decomposition products**
Other decomposition products - No data available
In the event of fire: see section 5

## 11. TOXICOLOGICAL INFORMATION

**11.1 Information on toxicological effects**

**Acute toxicity**
LD50 Oral - Rat - female - 108 - 141 mg/kg
(OECD Test Guideline 401)

LC50 Inhalation - Rat - male - 4 h - 0.759 mg/l

Dermal: No data available

No data available

**Skin corrosion/irritation**
Skin - Rabbit
Result: Corrosive - 4 h

**Serious eye damage/eye irritation**
No data available

**Respiratory or skin sensitisation**
No data available

**Germ cell mutagenicity**
No data available

**Carcinogenicity**

This is or contains a component that has been reported to be carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification.

Possible human carcinogen

| | |
|---|---|
| IARC: | 2B - Group 2B: Possibly carcinogenic to humans (Hydrazine) |
| NTP: | Reasonably anticipated to be a human carcinogenThe reference note has been added by TD based on the background information of the NTP. (Hydrazine) |
| OSHA: | No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA. |

**Reproductive toxicity**
No data available

No data available

**Specific target organ toxicity - single exposure**
No data available

**Specific target organ toxicity - repeated exposure**
No data available

**Aspiration hazard**
No data available

**Additional Information**

Repeated dose toxicity - Mouse - female - Inhalation
RTECS: MU7175000

spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea, Vomiting

Liver - Irregularities - Based on Human Evidence
Liver - Irregularities - Based on Human Evidence

## 12. ECOLOGICAL INFORMATION

**12.1 Toxicity**

| | |
|---|---|
| Toxicity to daphnia and other aquatic invertebrates | semi-static test EC50 - Daphnia pulex (Water flea) - 0.17 mg/l - 48 h |
| Toxicity to algae | static test EC50 - Desmodesmus subspicatus (Scenedesmus subspicatus) - 0.017 mg/l - 72 h<br>(Directive 67/548/EEC, Annex V, C.3.) |
| Toxicity to bacteria | Respiration inhibition EC50 - Sludge Treatment - 5.5 mg/l - 3 h<br>(OECD Test Guideline 209) |

**12.2 Persistence and degradability**

| | |
|---|---|
| Biodegradability | Biotic/Aerobic - Exposure time 20 d<br>Result: 28 % - Not readily biodegradable. |

**12.3 Bioaccumulative potential**
No data available

**12.4 Mobility in soil**
No data available

**12.5 Results of PBT and vPvB assessment**
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

**12.6 Other adverse effects**

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Very toxic to aquatic life with long lasting effects.

## 13. DISPOSAL CONSIDERATIONS

**13.1 Waste treatment methods**

**Product**

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

**Contaminated packaging**

Dispose of as unused product.

## 14. TRANSPORT INFORMATION

**DOT (US)**

UN number: 2029 Class: 8 (3, 6.1) Packing group: I
Proper shipping name: Hydrazine, anhydrous
Reportable Quantity (RQ): 1 lbs

Poison Inhalation Hazard: No

**IMDG**

UN number: 2029 Class: 8 (3, 6.1) Packing group: I EMS-No: F-E, S-C
Proper shipping name: HYDRAZINE, ANHYDROUS
Marine pollutant: yes

**IATA**

UN number: 2029 Class: 8 (3, 6.1) Packing group: I
Proper shipping name: Hydrazine, anhydrous
IATA Passenger: Not permitted for transport

## 15. REGULATORY INFORMATION

**SARA 302 Components**

The following components are subject to reporting levels established by SARA Title III, Section 302:

| | CAS-No. | Revision Date |
|---|---|---|
| Hydrazine | 302-01-2 | 2007-07-01 |

**SARA 313 Components**

The following components are subject to reporting levels established by SARA Title III, Section 313:

| | CAS-No. | Revision Date |
|---|---|---|
| Hydrazine | 302-01-2 | 2007-07-01 |

**SARA 311/312 Hazards**

Fire Hazard, Acute Health Hazard, Chronic Health Hazard

**Massachusetts Right To Know Components**

| | CAS-No. | Revision Date |
|---|---|---|
| Hydrazine | 302-01-2 | 2007-07-01 |

**Pennsylvania Right To Know Components**

| | CAS-No. | Revision Date |
|---|---|---|
| Hydrazine | 302-01-2 | 2007-07-01 |

**New Jersey Right To Know Components**

| | CAS-No. | Revision Date |
|---|---|---|
| Hydrazine | 302-01-2 | 2007-07-01 |

**California Prop. 65 Components**

| | | |
|---|---|---|
| WARNING! This product contains a chemical known to the State of California to cause cancer. | CAS-No. | Revision Date |
| Hydrazine | 302-01-2 | 2007-09-28 |

SDS#74287 Rev 03-03-2015

## 16. OTHER INFORMATION

**Full text of H-Statements referred to under sections 2 and 3.**

| | |
|---|---|
| Acute Tox. | Acute toxicity |
| Aquatic Acute | Acute aquatic toxicity |
| Aquatic Chronic | Chronic aquatic toxicity |
| Carc. | Carcinogenicity |
| Eye Dam. | Serious eye damage |
| Flam. Liq. | Flammable liquids |
| H226 | Flammable liquid and vapour. |
| H301 | Toxic if swallowed. |
| H301 + H311 | Toxic if swallowed or in contact with skin |
| H311 | Toxic in contact with skin. |
| H314 | Causes severe skin burns and eye damage. |
| H317 | May cause an allergic skin reaction. |
| H318 | Causes serious eye damage. |
| H330 | Fatal if inhaled. |
| H350 | May cause cancer. |
| H400 | Very toxic to aquatic life. |

**HMIS Rating**

| | |
|---|---|
| Health hazard: | 4 |
| Chronic Health Hazard: | * |
| Flammability: | 4 |
| Physical Hazard | 0 |

**NFPA Rating**

| | |
|---|---|
| Health hazard: | 4 |
| Fire Hazard: | 4 |
| Reactivity Hazard: | 3 |
| Health hazard: | 4 |
| Fire Hazard: | 2 |
| Reactivity Hazard: | 0 |

**Further information**


The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

**Preparation Information**

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.7 Revision Date: 03/03/2015 Print Date: 03/25/2015

- Lithium Ion Battery

# Product Information Sheet

**Panasonic Batteries**
Panasonic Industrial Company
A Division of Panasonic Corporation of North America
5201 Tollview Drive, 1F-3
Rolling Meadows, IL 60008
Toll Free: 877-726-2228
Fax: 847-468-5750
e-mail: oembatteries@us.panasonic.com
Internet: www.panasonic.com/industrial/batteries-oem

**Product: Lithium-ion Batteries (Li-ion)**
**Applicable models/sizes: All Cylindrical and Prismatic Lithium-ion batteries**

**Revision: – January 1, 2013**

**The batteries referenced herein are exempt articles and are not subject to the OSHA Hazard Communication Standard requirement. This sheet is provided as a service to our customers.**

## MSDS

Material Safety Data Sheets (MSDS) are a sub-requirement of the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard, 29 CFR Subpart 1910.1200. This Hazard Communication Standard does not apply to various subcategories including anything defined by OSHA as an "article". OSHA has defined "article" as a manufactured item other than a fluid or particle; (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which under normal conditions of use does not release more than very small quantities, e.g. minute or trace amounts of a hazardous chemical, and does not pose a physical hazard or health risk to employees.

*Because all of our batteries are defined as "articles", they are exempt from the requirements of the Hazard Communication Standard, hence a MSDS is not required.*

**The following components are found in a Panasonic Lithium Ion battery:**

**Nickel Manganese Cobalt Type**

| Component | Material | Formula |
|---|---|---|
| Positive Electrode | Lithium Nickel Manganese Cobalt Oxide | $LiNMnCoO_2$ |
| Negative Electrode | Graphite | C |
| Electrolyte | Ethylene Carbonate – Solvent | $C_3H_4O_3$ |
| | Diethyl Carbonate – Solvent | $C_5H_{10}O_3$ |
| | Lithium Hexaflurophosphate – Salt | $LiPF_6$ |

**Cobalt Type**

| Component | Material | Formula |
|---|---|---|
| Positive Electrode | Lithium Cobalt Oxide | $LiCoO_2$ |
| Negative Electrode | Graphite | C |
| Electrolyte | Ethylene Carbonate – Solvent | $C_3H_4O_3$ |
| | Diethyl Carbonate – Solvent | $C_5H_{10}O_3$ |
| | Lithium Hexaflurophosphate – Salt | $LiPF_6$ |

**Nickel Cobalt Aluminum Type**

| Component | Material | Formula |
|---|---|---|
| Positive Electrode | Lithium Cobalt Nickel Aluminum Oxide | $LiCoNiAlO_2$ |
| Negative Electrode | Graphite | C |
| Electrolyte | Ethylene Carbonate – Solvent | $C_3H_4O_3$ |
| | Diethyl Carbonate – Solvent | $C_5H_{10}O_3$ |
| | Lithium Hexaflurophosphate – Salt | $LiPF_6$ |


**DISPOSAL**

All Panasonic Lithium ion batteries are classified by the federal government as non-hazardous waste and are safe for disposal in the normal municipal waste stream. These batteries, however, do contain recyclable materials. Panasonic is a Licensee of the Call2Recycle Battery Recycling Program. If you build our cells into a battery pack, please call 1-800-8-BATTERY or go to the Call2Recycle website at www.call2recycle.org for additional information on how your branded product can also participate in the program.

**TRANSPORTATION**

All Panasonic lithium ion batteries are not subject to the other requirements of the US Department of Transportation (DOT) Subchapter C, Hazardous Materials Regulations if shipped in compliance with 49 CFR 173.185 and Special Provision 188.

Effective January 1, 2013 all Panasonic lithium ion batteries can be shipped by air in accordance with International Civil Aviation Organization (ICAO) 2013-2014 edition, Section II or Section 1B or International Air Transport Association (IATA), 54th edition, Section II or 1B, Packing Instructions (PI) 965 (Batteries), PI 966 (Batteries, packed with equipment) and PI 967 (Batteries, contained in equipment) as appropriate.

Currently all Panasonic lithium ion batteries are regulated by the International Maritime Organization (IMO), 2010 edition, 35$^{th}$ amendment, under Special Provisions 188 and 230.

All Panasonic lithium ion cells are tested and comply with the UN Model Regulations, Manual of Test and Criteria, Part III, subsection 38.3.

If you build any of our lithium ion cells into a battery pack, you must also assure that they are tested in accordance with the UN Model Regulations, Manual of Test and Criteria. Part III, subsection 38.3, 5$^{th}$ revised edition, Amendment 1.

If you plan on transporting any untested prototype battery packs contact your Panasonic Sales Representative for regulatory information.

**FIRST AID**

If you get electrolyte in your eyes, flush with water for 15 minutes without rubbing and immediately contact a physician. If you get electrolyte on your skin wash the area immediately with soap and water. If irritation continues, contact a physician. If the battery is ingested, call the National Capital Poison Center (NCPC) at 202-625-3333 (Collect) or your local poison center immediately.

**GENERAL RECOMMENDATIONS**

CAUTION: Risk of fire, explosion and burns. Do not short-circuit, crush, incinerate or disassemble battery.

**FIRE SAFETY**

In case of fire, you can use dry chemical, alcohol resistant foam or carbon dioxide fire extinguishers. Cooling the exterior of the batteries will help prevent rupturing. Burning of these batteries will generate toxic fumes. Fire fighters should use self-contained breathing apparatus. Detailed information on fighting a lithium ion battery fire can be found in Guide 147 (Lithium Ion Batteries) of the US DOT Emergency Response Guide.

- Pyro Materials



# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
**MSDS No :** MSDSD10735/1
**Date Revised :** 12/16/2020
**Revision No :** 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly
**PRODUCT DESCRIPTION:** Detonator Booster Assembly/Electro-Explosive Initiator (EEI) Assembly
**PRODUCT CODE:** See Section Comments for Applicable Part Numbers

**MANUFACTURER**

Ensign-Bickford Aerospace & Defense Company
640 Hopmeadow St
P O Box 429
Simsbury, CT 06070-0429
**Emergency Phone:** (860) 843-2289

**24 HR. EMERGENCY TELEPHONE NUMBERS**

CHEMTREC 800-424-9300
EBA&D (860) 843-2276

**COMMENTS:** This MSDS covers the following part numbers:
D10523-2; D10523-3; D10724-501; D10724-502 (NERT); D10724-503; D10724-504; D10724-505; D10735-3; D10735-4; D10735-5; D10735-6; D10759-1; D10759-99 (INERT); D10783-1; D10783-1-CR10676; D10783-99 (INERT); D10917-01; D10917-02; D10917-03; D10917-04; D10917-05; D10917-06; D10917-07; D10917-08; D10917-09; D11237-501; D11237-502; D11237-503; D11237-504; D11237-601 (INERT); D11237-602 (INERT); D11237-603 (INERT); D11237-604 (INERT); D11237-901; D11237-902; D11237-903; D11237-904; D11481-0001; D11481-0501; D11481-0503; D11481-0505; D11481-0507; D11481-0509; D11481-0511; D11481-0513; D11481-0515; D11481-99-DVL (INERT); D11573-1; D11573-1A; D11573-2; D11573-2A; D11573-3; D11573-3A; D11573-4; D11573-4A; D11573-5T; D11603-1; D11603-99 (INERT); D11603-99A (INERT); D11603-1A; D11772-501; D11772-502; D11827-1; D11962-1; D12061-1, D12061-1-DVL1, D12107-1

## 2. HAZARDS IDENTIFICATION

**GHS CLASSIFICATIONS**

**Physical:**

Explosives, Division 1.4

**GHS LABEL**

Exploding bomb

**SIGNAL WORD:** WARNING

**HAZARD STATEMENTS**

H201: Explosive; mass explosion hazard.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
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**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

## PRECAUTIONARY STATEMENT(S)

**Prevention:**

P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P250: Do not subject to grinding / shock / friction.
P370+P380: In case of fire: Evacuate area.
P372: Explosion risk.
P373: DO NOT fight fire when fire reaches explosives.

**Storage:**

P401: Store in accordance with local / state / regional / national / international regulations.

**Disposal:**

P501: Dispose of contents/container to local / state / regional / national / international regulations.

## EMERGENCY OVERVIEW

**PHYSICAL APPEARANCE:** The product is an ordnance device consisting of a pyrotechnic cartridge and a high explosive output. Device is contained within a stainless steel housing.

**IMMEDIATE CONCERNS:** May detonate if exposed to friction, impact, or heat. Do not fight fires involving explosives. Isolate the area. Evacuate personnel to a safe place.

## POTENTIAL HEALTH EFFECTS

**EYES:** Not a normal route of exposure as hazardous ingredients are sealed within the product. Prolonged or repeated contact with post-function gases and particulates may result in eye irritation with discomfort, tearing, and blurring of vision.

**SKIN:** Not a normal route of exposure as hazardous ingredients are sealed within the product. Prolonged or repeated exposure to post-function residues and core materials may cause skin irritation.

**INGESTION:** Normal use, storage, and disposal will not result in ingestion of hazardous ingredients.

**INHALATION:** Not a normal route of entry in the solid state. Prolonged exposure to post-function residues may cause nasal or respiratory irritation.

## 3. COMPOSITION / INFORMATION ON INGREDIENTS

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
**MSDS No :** MSDSD10735/1
**Date Revised :** 12/16/2020
**Revision No :** 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

| Chemical Name | Wt.% | CAS |
|---|---|---|
| Lead Azide | < 1 | 13424-46-9 |
| Hexanitrostilbene; HNS | < 1 | 20062-22-0 |
| Zirconium | < 1 | 7440-67-7 |
| Potassium Perchlorate | < 1 | 7778-74-7 |
| Stainless Steel | ~ 99 | |

## 4. FIRST AID MEASURES

**EYES:** Flush using running water for at least 15 minutes. If irritation persists, seek medical attention.

**SKIN:** Wash exposed area with soap and water. If irritation persists, seek medical attention.

**INGESTION:** Give large quantities of water. Induce vomiting in a conscious victim. Seek medical attention.

**INHALATION:** Remove victim to fresh air. If not breathing, administer rescue breathing. Seek medical attention.

## 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Extinguish fire using water, inert powder, or gas, but only if it can be applied remotely.

**HAZARDOUS COMBUSTION PRODUCTS:** Hazardous gases of carbon dioxide, carbon monoxide, nitrogen oxides, and oxides of various metals present in the product such as aluminum and lead particulates may be released when the detonator burns or detonates.

**EXPLOSION HAZARDS:** May detonate if exposed to shock, heat, impact, sparks, static, or friction.

## 6. ACCIDENTAL RELEASE MEASURES

**GENERAL PROCEDURES:** Review Fire and Explosive Hazards and Safety Precautions before proceeding with cleanup. Only qualified personnel should perform any cleanup and disposal of material. Isolate the spill area removing all sources of ignition from the location. Remove all explosives that were not involved in the spill from the spill area. Intact product may be safely collected for disposal. If the product is ruptured, moisten spilled core material with a water spray and collect using non-sparking tools or paper wipes. Carefully collect the spilled material and place in a (Velostat) electrically conductive bag. If safe to do so, separate material that is not contaminated from contaminated material.

**SPECIAL PROTECTIVE EQUIPMENT:** Perform the treatment of lead azide using ceric ammonium nitrate only in a well-ventilated area. If the available ventilation does not provide sufficient protection, wear a self-contained breathing apparatus (SCBA) or other supplied-air respiratory protection with tight-fitting eye protection to protect against the hydrazoic acid generated by the reaction of lead azide with ceric ammonium nitrate.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
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**Date Revised :** 12/16/2020
**Revision No :** 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Store in accordance with federal, state, and local regulations.

**HANDLING:** Only properly qualified and authorized personnel should handle and use explosive products covered by this MSDS. The DBA/EEI has a protective cap on the output end and a Faraday cap on the input end. These protective caps should remain on the unit at all times until they need to be removed for installation or test.

**STORAGE:** Store in a cool, dry place. Store away from sparks and other ignition sources. Store in accordance with federal, state, and local regulations. Avoid friction, impact, static, heat, and shock.

**ELECTROSTATIC ACCUMULATION HAZARD:** Avoid sources of electrostatic discharge (ESD).

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**EXPOSURE GUIDELINES**

| OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200) | | | | | |
|---|---|---|---|---|---|
| | | EXPOSURE LIMITS | | | |
| | | OSHA PEL | | ACGIH TLV | |
| **Chemical Name** | | **ppm** | **mg/m³** | **ppm** | **mg/m³** |
| Lead Azide | **TWA** | [1] | mg/m³ [1] | [1] | mg/m³ [1] |
| Hexanitrostilbene; HNS | **TWA** | | | | mg/m³ |
| Zirconium | **TWA** | | 5 mg/m³ | [2] | 5 mg/m³ [2] |
| | **STEL** | | | | 10 |
| Potassium Perchlorate | **TWA** | [3] | mg/m³ [3] | [4] | mg/m³ [4] |

**Footnotes:**
**1**. as Pb
**2**. STEL, 10 mg/m³
**3**. mg/m³ (total), 5 mg/m³ (resp) for nuisance dusts
**4**. mg/m³ (total) for PNOC containing no asbestos and <1% crystalline silica

**ENGINEERING CONTROLS:** Product is intended for indoor and outdoor use. Provide ventilation for indoor use. Provide ventilation for repetitive indoor testing. Provide local exhaust and mechanical ventilation as needed so as not to exceed the PEL.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Safety glasses are recommended for normal operations and functional testing. Splash-resistant goggles are required during spill cleanup procedures.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
**MSDS No :** MSDSD10735/1
**Date Revised :** 12/16/2020
**Revision No :** 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

**SKIN:** Protective gloves are not required for normal use and handling of detonators as received from the manufacturer. Protective gloves should be worn when handling post-detonation residues, the contents of damaged detonators, and any chemicals used to chemically decompose lead azide. Rubber gloves are recommended.

**RESPIRATORY:** Wear a dual cartridge negative respirator with high efficiency dust, mist, and fume cartridges if exposure is found to be between 0.05 and 0.5 mg(Pb)/m³ air. Wear a powered air purifying respirator or other higher form of respiratory protection if exposure levels exceed 0.5 mg/m³ or Chromium exposure levels are between 0.01 and 0.1 mg/m3.

**OTHER USE PRECAUTIONS:** Lead azide is to be handled only by qualified and authorized personnel. Use conductive shoes and flooring to protect against static discharge. Low levels of static can cause lead azide to detonate.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| Chemical Name | Melting Point (°C) | Boiling Point (°C) | Solubility in Water | Specific Gravity |
|---|---|---|---|---|
| Lead Azide | 320 Deflagration Point | Not Applicable | Slightly soluble in Cold Water | 4.8 |
| Hexanitrostilbene; HNS | 318 Decomposes | Not Applicable | Practically insoluble | 1.74 |
| Zirconium | 1852 | 3577 | Insoluble | 6.51 |
| Potassium Perchlorate | | | 1.5 g in 100 g Water | 2.52 |

**PHYSICAL STATE:** Solid Product

**ODOR:** No appreciable odor.

**APPEARANCE:** Explosive ordnance device consisting of a pyrotechnic delay and high explosive output. Device is contained within a steel housing coupled with an output adapter.

**AUTOIGNITION TEMPERATURE:** Lead Azide: 275°C (527°F) minimum temperature for ignition in 5 seconds for dextrinated lead azide. HNS: 326°C (618°F).

**VAPOR PRESSURE:** Not Applicable

## 10. STABILITY AND REACTIVITY

**HAZARDOUS POLYMERIZATION:** Will not occur.

**STABILITY:** Stable under normal conditions, but improper handling can result in accidental detonation.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
**MSDS No :** MSDSD10735/1
**Date Revised :** 12/16/2020
**Revision No :** 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

**CONDITIONS TO AVOID:** Friction, impact, static, heat, and shock.

**HAZARDOUS DECOMPOSITION PRODUCTS:** The function of this device may evolve oxides of carbon (Co and CO2) and Nitrogen (NOx); also H2, Cl, and K2O. Airborne particulates, including the metals listed in Section II, may also be released.

**INCOMPATIBLE MATERIALS:** Incompatiable with acids, alkalis, hydrogen peroxide and strong oxidizers.

## 11. TOXICOLOGICAL INFORMATION

**CARCINOGENICITY**

| Chemical Name | NTP Status | IARC Status | OSHA Status | Other | General Toxicity |
|---|---|---|---|---|---|
| Lead Azide | Not Listed | Not listed by NTP or OSHA; IARC, Group 2B: Possibly carcinogenic to humans. | Not Listed | | A deadly poison. May be fatal, if swallowed. May cause anemia, kidney damage. |
| Hexanitrostilbene; HNS | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | | No Data. |
| Zirconium | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | Not Listed | Non-toxic. |
| Potassium Perchlorate | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | | No Data. |

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA:** No data available.

**ECOTOXICOLOGICAL INFORMATION:** No data available.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

Date Prepared : 02/06/2007
MSDS No : MSDSD10735/1
Date Revised : 12/16/2020
Revision No : 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Any waste unfunctioned device is classified as a hazardous waste with the characteristic of reactivity. Any such waste should be handled, treated, and stored in accordance with local, state, and federal regulations. Recommended treatment method for waste unfunctioned devices is remote function (detonation). Any treatment or disposal must be performed by qualified personnel.

**RCRA/EPA WASTE INFORMATION:** Waste Booster Assemblies: EPA Hazardous Waste Number D003.

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME:** See Other Shipping Information below

**OTHER SHIPPING INFORMATION:**

Use the following Proper Shipping Information and EX Numbers for the Part Numbers Indicated:

**PN D10523-2, -3, D10724-501, -503, -504, -505, D10735-3, -4, -6, D10759-1, D10783-1, D11481-0001, -0501, -0503, -0505, -0507, -0509, -0511, -0513, and -0515, D11573-1, D11573-1A, D11573-2, D11573-2A, D11573-3, D11573-3A, D11573-4, D11573-4A, D11573-5T, D11603-1, D11603-1A, D11827-1, D11962-1, D12061-1, D12061-1-DVL1, D12107-1**

EX2019062064
Proper Shipping Name: Detonators, Electric
Class: 1.4S
UN0456

**PN D10735-5, D10917-01 thru -09, D11237-501 thru -504, D11237-901 thru -904, D11772-501, -502**

EX2019062065
Proper Shipping Name: Detonators, Non-Electric
Class: 1.4S
UN0455

**PN D10724-502, D10759-99, D10783-99, D11237-601 thru -604, D11481-99-DVL, D11603-99, -99A**

These parts are inert Proper Shipping Name, Hazard Class, UN/NA are not applicable

**D10783-1-CR10676**

DOT-SP 8451
Proper Shipping Name: Articles, Explosive, N.O.S
Class: 1.4E
UN0471

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 02/06/2007
**MSDS No :** MSDSD10735/1
**Date Revised :** 12/16/2020
**Revision No :** 23

**Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**

## 15. REGULATORY INFORMATION

**UNITED STATES**

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**TITLE III NOTES:** This product contains lead,which is subject to the reporting requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986, and 40 CFR Part 372.

## 16. OTHER INFORMATION

**APPROVED BY:** Ensign-Bickford Aerospace & Defense Company

**PREPARED BY:** Ensign-Bickford Aerospace & Defense Company **Date Revised:** 12/16/2020

**REVISION SUMMARY:** This SDS replaces the 10/19/2020 SDS.

**MANUFACTURER DISCLAIMER:** The information described in this Safety Data Sheet cannot possibly cover every application of the product or variation of conditions under which the product is used. The recommendations are based on the manufacturer's experiences and research. They are believed to be accurate, but no warranties are made, expressed, or implied. The information is offered as typical and not as a product specification. The recommended handling procedures are believed to be generally applicable, however, each user should review these recommendations in the context of the specific intended use.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 03/22/2006
**MSDS No :** MSDSD10448/1
**Date Revised :** 11/17/2020
**Revision No :** 27

**Flexible Confined Detonating Cord Assembly (FCDCA)**

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Flexible Confined Detonating Cord Assembly (FCDCA)
**PRODUCT DESCRIPTION:** Flexible Confined Detonating Cord Assembly (FCDCA)
**PRODUCT CODE:** See Section Comments
**ALTERNATE TRADE NAME(S):** Flexible Confined Detonating Cord Assembly (FCDCA), ODS Free, Explosive Transfer Line (ETL), Explosive Transfer Assembly (ETA), End Tip Assembly, Donorless FCDCA, Flexible Test Lead

**MANUFACTURER**

Ensign-Bickford Aerospace & Defense Company
640 Hopmeadow St
P O Box 429
Simsbury, CT 06070-0429
**Emergency Phone:** (860) 843-2289

**24 HR. EMERGENCY TELEPHONE NUMBERS**

CHEMTREC 800-424-9300
EBA&D (860) 843-2276

**COMMENTS:** This SDS covers the following base part numbers and all of their configurations: D10071; D10163; D10311; D10344; D10402; D10422; D10430; D10448; D10449; D10466; D10469; D10505; D10575; D10576; D10593; D10596; D10614; D10618; D10647; D10719; D10730; D10758; D10772; D10782; D10898; D10900; D10960; D11103; D11151; D11254; D11311; D11314; D11318; D11379; D11501; D11510; D11589; D11594; D11621; D11653; D11808, D11864; D11963; D12045; D12073; D12101; D12106; D12116; D12245; D12249; D12250; D12359; D12369; 13506479

For all base part numbers the -99 configurations are INERT materials.

## 2. HAZARDS IDENTIFICATION

**GHS CLASSIFICATIONS**

**Physical:**

Explosives, Division 1.4

**GHS LABEL**

Exploding bomb

**SIGNAL WORD:** DANGER

**HAZARD STATEMENTS**

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 03/22/2006
**MSDS No :** MSDSD10448/1
**Date Revised :** 11/17/2020
**Revision No :** 27

**Flexible Confined Detonating Cord Assembly (FCDCA)**

H203: Explosive; fire, blast or projection hazard.

**PRECAUTIONARY STATEMENT(S)**

**Prevention:**

P202: Do not handle until all safety precautions have been read and understood.
P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P250: Do not subject to grinding / shock / friction.
P370+P380: In case of fire: Evacuate area.
P373: DO NOT fight fire when fire reaches explosives.
P401: Store in accordance with local / state / regional / national / international regulations.
P501: Dispose of contents/container to local / state / regional / national / international regulations.

**EMERGENCY OVERVIEW**

**PHYSICAL APPEARANCE:** Flexible Confined Detonating Cord Assemblies are HNS filled linear products, encased in a textile/wire overbraid, with end fittings containing HNS and threaded nuts. Insulated FCDCA units have a Silicone Elastomer covering (orange) atop the wire overbraid.

**POTENTIAL HEALTH EFFECTS**

**EYES:** Normal use, storage, and disposal will not result in eye contact with hazardous ingredients. Exposure to HNS core material or prolonged or repeated contact with post-function gases and particulate can cause irritation of the eyes and mucous membranes.

**SKIN:** Normal use, storage, and disposal will not result in eye contact with hazardous ingredients. Exposure to HNS core material or prolonged or repeated contact with post-function gases and particulate can cause irritation of the skin.

**INGESTION:** Direct ingestion of core materials is unlikely as they are contained within the product jacketing. Core materials are toxic by ingestion. Prolonged or repeated exposure to core materials or post function residues should be avoided.

**INHALATION:** Normal use, storage, and disposal will not result in inhalation of hazardous ingredients. Exposure to HNS core material or prolonged or repeated contact with post-function gases and particulate can cause irritation of nasal, throat, and respiratory tract.

## 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | Wt. % | CAS |
|---|---|---|
| Hexanitrostilbene; HNS | - | 20062-22-0 |
| Aluminum | - | 7429-90-5 |
| Silicone Elastomer | - | 68988-89-6 |

**COMMENTS:** Some configurations of the FCDCA are insulated, the Silicone Elastomer is only applilcable

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 03/22/2006
**MSDS No :** MSDSD10448/1
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**Revision No :** 27

**Flexible Confined Detonating Cord Assembly (FCDCA)**

to insulated FCDCA units.

## 4. FIRST AID MEASURES

**EYES:** Flush using running water for at least 15 minutes. If irritation persists, seek medical attention.

**SKIN:** Wash exposed area with soap and water. If irritation persists, seek medical attention.

**INGESTION:** Give large quantities of water. Induce vomiting in a conscious victim. Seek medical attention.

**INHALATION:** Remove victim to fresh air. If not breathing, administer rescue breathing. Seek medical attention.

## 5. FIRE FIGHTING MEASURES

**EXPLOSION HAZARDS:** Explosive material is stable but can detonate if exposed to high temperatures, shock, or impact. Unit is fully confined if end caps are in place.

**FIRE FIGHTING PROCEDURES:** DO NOT FIGHT FIRES INVOLVING EXPLOSIVES, PRODUCT MAY EXPLODE. ISOLATE THE AREA, EVACUATE PERSONNEL TO A SAFE PLACE AND ALLOW TO BURN OR FIGHT FIRE REMOTELY.

## 6. ACCIDENTAL RELEASE MEASURES

**GENERAL PROCEDURES:** Intact product may be safely collected for disposal. If product has ruptured or spilled, explosive material should be wetted with a water spray and collected using non-sparking tools or paper wipes. All residue, including contaminated clean up materials, should be stored in an area designed for storage of reactive wastes until disposal.

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Transportation and storage must be in accordance with applicable regulations. Store away from sparks or other sources of ignition, with end caps installed. Avoid heat sources, shock and impact.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 03/22/2006
**MSDS No :** MSDSD10448/1
**Date Revised :** 11/17/2020
**Revision No :** 27

**Flexible Confined Detonating Cord Assembly (FCDCA)**

**EXPOSURE GUIDELINES**

| OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200) | | | | | |
|---|---|---|---|---|---|
| | | EXPOSURE LIMITS | | | |
| | | OSHA PEL | | ACGIH TLV | |
| **Chemical Name** | | **ppm** | **mg/m³** | **ppm** | **mg/m³** |
| Hexanitrostilbene; HNS | **TWA** | | | | mg/m³ |
| Aluminum | **TWA** | [1] | 15T 5R mg/m³ [1] | | 1 mg/m³ |
| **Footnotes:** 1. total dust, 5 mg/m³ (respirable fraction) | | | | | |

**ENGINEERING CONTROLS:** Provide mechanical ventilation where repeated testing will be performed indoors or in areas with limited natural ventilation. Consult local, state, and federal regulations concerning whether emission controls are needed.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Safety glasses or goggles are recommended for handling, testing, or cleanup.

**SKIN:** Protective gloves of latex or other impermeable materials should be worn to prevent contact with spilled explosive powder.

**RESPIRATORY:** Under normal surface use, no respiratory protection is required. Any extended testing of the product indoors may require respiratory protection.

**OTHER USE PRECAUTIONS:** Protective end caps provided with item confine explosive output of the end tips and should remain in place until item is installed.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| Chemical Name | Melting Point (°C) | Boiling Point (°C) | Solubility in Water | Specific Gravity |
|---|---|---|---|---|
| Hexanitrostilbene; HNS | 318 Decomposes | Not Applicable | Practically insoluble | 1.74 |
| Aluminum | 660 | 2327 | Insoluble | 2.7 |
| Silicone Elastomer | | Not Applicable | Negligible (<0.1%) | 1.03 |

**PHYSICAL STATE:** Solid Product

**ODOR:** Odorless

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 03/22/2006
**MSDS No :** MSDSD10448/1
**Date Revised :** 11/17/2020
**Revision No :** 27

**Flexible Confined Detonating Cord Assembly (FCDCA)**

**AUTOIGNITION TEMPERATURE:** to 326°C (618°F)

**MELTING POINT:** to 316°C (601°F) HNS

**SOLUBILITY IN WATER:** Insoluble

## 10. STABILITY AND REACTIVITY

**REACTIVITY:** Yes - this product contains one or more explosive compounds.

**HAZARDOUS POLYMERIZATION:** No

**STABILITY:** Stable under normal conditions, but improper handling can result in accidental detonation.

**CONDITIONS TO AVOID:** High temperatures, shock and impact,

**HAZARDOUS DECOMPOSITION PRODUCTS:** Upon decomposition or detonation, HNS produces oxides of nitrogen (NOx), carbon monoxcide and carbon dioxide.

**INCOMPATIBLE MATERIALS:** Strong oxidizers and alkaline materials may degrade this product.

## 11. TOXICOLOGICAL INFORMATION

**CARCINOGENICITY**

| Chemical Name | NTP Status | IARC Status | OSHA Status | General Toxicity |
|---|---|---|---|---|
| Hexanitrostilbene; HNS | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | No Data. |
| Aluminum | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | No Data. Inhalation of finely divided powder may cause pulmonary fibrosis. |

**COMMENTS:** See Section 3.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA:** No data available.

**ECOTOXICOLOGICAL INFORMATION:** No data available.

# SAFETY DATA SHEET

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 03/22/2006
**MSDS No :** MSDSD10448/1
**Date Revised :** 11/17/2020
**Revision No :** 27

**Flexible Confined Detonating Cord Assembly (FCDCA)**

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Dispose of toxic substances and hazardous materials in accordance with local, state, and federal regulations.

**RCRA/EPA WASTE INFORMATION:** Waste Explosive Products covered by this SDS: EPA Hazardous Waste Number D003.

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME:** FUZES, DETONATING

**PRIMARY HAZARD CLASS/DIVISION:** 1.4D

**SECONDARY HAZARD CLASS/DIVISION:** EX2006090083

**UN/NA NUMBER:** UN0410

**PACKING GROUP:** II

## 15. REGULATORY INFORMATION

**UNITED STATES**

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**TITLE III NOTES:** This product does not contain any constituents that are subject to the reporting requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986, and 40 CFR Part 372.

## 16. OTHER INFORMATION

**APPROVED BY:** Ensign-Bickford Aerospace & Defense Company

**PREPARED BY:** Ensign Bickford Aerospace & Defense Company **Date Revised:** 11/17/2020

**REVISION SUMMARY:** This SDS replaces the 09/23/2020 SDS.

**MANUFACTURER DISCLAIMER:** The information described in this Safety Data Sheet cannot possibly cover every application of the product or variation of conditions under which the product is used. The recommendations are based on the manufacturer's experiences and research. They are believed to be accurate, but no warranties are made, expressed, or implied. The information is offered as typical and not as a product specification. The recommended handling procedures are believed to be generally applicable, however, each user should review these recommendations in the context of the specific intended use.

**MSDS for the NASA Explosive Bolt Assembly**

**Part SEG26152302-XXX**

**Explosive Classification 1.4D**

HEXANITROSTILBENE, SEG26152302-XXX
EURENCO BOFORS AB
JSC MSDS # 44678

EURENCO

EURENCO Bofors

**SAFETY DATA SHEET** 1 (5)

| Issued by, department, telephone | Date of revision | Edition number | This edition replace |
|---|---|---|---|
| Birgitta Pettersson, XQ, 83535 | 2008-02-22 | 6 | 2004-09-02 ed. 5 |

Product denomination
Hexanitrostilbene, NSE812

## 1 PRODUCT IDENTIFICATION AND NAME OF THE COMPANY

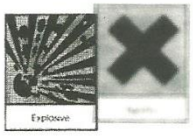
| | |
|---|---|
| Product name | Hexanitrostilbene, NSE812 |
| Application | Explosive |
| Manufacturer | EURENCO Bofors AB<br>SE-691 86 KARLSKOGA<br>Tel: 0586-83050 Int. +46-568-83050<br>Fax: 0586-83310 Int. +46-586-83310 |
| Emergency telephone number | 0586-832 00, ERC +46-0(8)-33 70 43 |

## 2 COMPOSITION/IDENTITY INFORMATION

| Hazardous Components | CAS-no | EINECS-no | % | Danger code | Risk phrases |
|---|---|---|---|---|---|
| 2,2,4,4,6,6-Hexanitrostilbene | 20062-22-0 | 243-494-5 | 97,5-100 | E, Xn | 2-20/21/22 |
| Hexanitrobibenzyl (HNBB) | 5180-53-0 | - | <2,5 | - | - |

## 3 HAZARD IDENTIFICATION

Health hazard: Risk of explosion by shock, fire or other sources of ignition
Harmful by inhalation, in contact with skin and if swallowed.




## 4 FIRST AID MEASURES

JSC MSDS # 44678

| | |
|---|---|
| Inhalation | Fresh air, rest and warmth. Rinse nose, mouth and throat with water. Call for a doctor if troubles remain. |
| Skin contact | Wash with soap and water. Call for a doctor if troubles remain. |
| Eye contact | Rinse carefully with water. Call for a doctor if troubles remain. |
| Ingestion | Rinse the mouth with water. Call for a doctor if troubles remain. |

## 5 FIRE FIGHTING MEASURES

| | |
|---|---|
| Suitable extinguishing media | Water sprinkler. |
| Extinguishing media not to be used | Powdered extinguishing medium. |
| Dangerous breaking down-product / gases | Nitrous fume. |
| Special protective equipment for fire-fighters | Evacuate the area, fire can be transformed into detonation, don't attempt to extinguish. |

## 6 ACCIDENTAL RELEASED MEASURES

| | |
|---|---|
| Ordinary measure | Sweep up and put into marked container. |
| Protective equipment for clearance personal | Protective equipment in case of directs contact, such as protective gloves and clothes. |

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**SAFETY DATA SHEET** 2 (5)

| Issued by, department, telephone | Date of revision | Edition number | This edition replace |
|---|---|---|---|
| Birgitta Pettersson, XQ, 83535 | 2008-02-22 | 6 | 2004-09-02 ed. 5 |

Product denomination
Hexanitrostilbene, NSE812

| | |
|---|---|
| Environmental precautions | Prevent the product from reaching the sewage system. Not acute toxic into the water environment. |
| Collection- and clearance method | Sweep up and put into marked container. |
| Unsuitable clearance method and absorb solvent | There are no indicated. |
| Method for taking care of waste | Burned at approved place. Note! That explosive can detonate. |

## 7 HANDLING AND STORAGE

| | |
|---|---|
| Ventilation with handling | Well ventilated area if there is some contact with the product. |
| Equipment with handling | The equipment shall suit to the explosive sensitivity. |
| Recommended temperature with handling | Normal room temperature. |
| Equipment witch not will be used with handling | Equipment which cause static electricity. |
| Requirement for storage and packing | To be stored in tight closing containers and only in places approved for explosives. |
| Unsuitable handling and storage method | Handling and storage only according to valid code of laws and instruction. |
| Other rules and instruction | Permission fore storage shall bee allowed the police. Keep in a way that ensures complete safety according handling and import of explosive products. |

## 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

| | |
|---|---|
| Hygienic limits | Swedish limit is missing. |
| Method of measurement | Measuring of dust can be done according (Swedish) Arbetsmiljöverkets Method series, no M1010. Sampling of total dust and resperabelt dust |
| Biological limits | Swedish limit is missing. |
| Specific measure for reducing exposure | Workplace and working methods shall be worked out so that directly contact with the product contact will be prevented. |
| Breathing protection | By danger of inhalation of dust, use breathing protection with dustfilter P2. |
| Gloves | Rubber gloves when it will become risk fore directly contact. |
| Eye protection | Protective glasses if there is some risk that the product can irritate the eyes. |
| Protective cloth and shoes | Flame protection treated clothes and safety boots when working with the product. |

## 9 PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| Physical form | Crystalline powder |
| Colour | Yellow |
| Odour | Odourless |
| Explosion properties | Explosive |

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**SAFETY DATA SHEET** 3 (5)

| Issued by, department, telephone | Date of revision | Edition number | This edition replace |
|---|---|---|---|
| Birgitta Pettersson, XQ, 83535 | 2008-02-22 | 6 | 2004-09-02 ed. 5 |

Product denomination
Hexanitrostilbene, NSE812

| | |
|---|---|
| Decomposition point | 315 °C |
| Solubility in water | <0,8 weight-% with 20 °C |
| Solubility in other solvents | Soluble in Dimethylformaide (DMF), Methylpyrrilidone (NMP) |
| Partition coefficient n-oktanol/water | Log Pow = 2,18 |
| Density (kg/m$^3$) | ~300 |
| Melting point | 315 °C |
| Autoignition temperature | 315 °C |
| Ignitability, gas igniter pistol | No ignition |
| Friction Sensitivity, BAM Friction | Low sensitive |
| Fall Hammer Impact Test | Very sensitive |
| Ignitability, Electrostatic Sensitivity Test | Low sensitive |

## 10 STABILITY AND REACTIVITY

| | |
|---|---|
| Conditions which could affect the product stability | Impact, friction, fire, heating or electrostatic discharge. |
| Material to avoid | Alkaline substances and strong acids. |
| Hazardous conversion- and or decomposition products | Nitrous fume. |

## 11 TOXICOLOGICAL INFORMATION

| | |
|---|---|
| Inhalation | Can irritate the mucous membranes of the respiratory. |
| Ingestion | Irritation the mucous membranes of the respiratory. |
| Skin | Risk of irritation by longer and repeated exposure. |
| System effects with handling | Have not been detectable. |
| Eye | Dust may irritate. |
| Allergy cause properties | No |
| Cancer/mutation/unborn child damage/reproduction | As the product has shown biologic activity in Ames test a risk on health (mutagen potential) must be considered. Avoid exposure of the product so far as possible even if the acute toxicity is low. |
| Delayed health effects | No |
| $LD_{50}$ oral art | >5000 mg/kg Ames test: Positive |

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**SAFETY DATA SHEET** 4 (5)

| Issued by, department, telephone | Date of revision | Edition number | This edition replace |
|---|---|---|---|
| Birgitta Pettersson, XQ, 83535 | 2008-02-22 | 6 | 2004-09-02 ed. 5 |

Product denomination
Hexanitrostilbene, NSE812

## 12 ECOLOGICAL INFORMATION

| | |
|---|---|
| Toxicity to aquatic organisms | >50 mg/l, $EC_{50}$ |
| Toxicity to soil organisms | With our knowledge about the product today, we can't see that the product should be toxic too the soil organism. |
| Toxicity to micro-organisms | Not tested. |
| Mobility and allocation in the environmental | Not tested. |
| The input products degradable into the environmental | Not tested. |
| The input products degradable into the sewage | The product is sparingly soluble $BOD_7$ 0.00 g/g, COD 0.22 g/g, $BOD_7$/COD 0.00 |
| Bioaccumulative | Log Pow = 2.18 |
| Data for the judge | Environment data, laboratory test |

## 13 DISPOSAL CONSIDERATION

| | |
|---|---|
| Take care off rest product | Handling as explosive waste, Not! explosion risk. |
| Take care off contaminated packaging | Container handling as dangerous goods. |
| Risks with waste handling | Rest of product can explode when combustion. |
| EWC-code | 160403: Discard explosive. |
| Dangerous waste | Yes |

## 14 TRANSPORT INFORMATION

| | |
|---|---|
| FN/UN number | 0392 |
| Class ADR/RID, IMDG, IATA | 1.1D |
| Proper shipping name | Hexanitrostilbene |
| Packing group | II |
| Marine Pollutant | No |
| EMS number | F-B, S-Y |
| EX-number (DOT/USA) | EX-9702031 |
| Other | CE-marking: PvTT 157/06 |

EURENCO Bofors

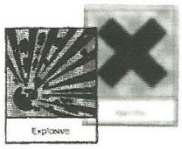
**SAFETY DATA SHEET** 5 (5)

| Issued by, department, telephone | Date of revision | Edition number | This edition replace |
|---|---|---|---|
| Birgitta Pettersson, XQ, 83535 | 2008-02-22 | 6 | 2004-09-02 ed. 5 |

Product denomination
Hexanitrostilbene, NSE812

## 15 REGULATORY INFORMATION

Dangerous symbols with dangerous code: E, Explosive; Xn, Harmful




| | |
|---|---|
| Risk phrases | R2, Risk of explosion by chock, friction, fire or other sources of ignition.<br>R20/21/22, Harmful by inhalation, in contact with skin and if swallowed. |
| Safety phrases | S16, Keep away from sources of ignition – No smoking.<br>S35, This material and its container must be disposed of in a safe way. |
| Product name | Hexanitrostilbene |
| Other regulations | Explosive legislation. |
| Limitation/restriction | Permit required for handling and storage. |
| Permission for transfer and handling | The law about flammable substance and explosive product. (Sweden)<br>Ordinance about flammable substance and explosive product. (Sweden)<br>Flammables and Explosives Department instruction about Permit regarding transfer of explosives. |
| Input product in EINICS | Yes exept Hexanitrobibenzyl |
| Other legislation | Safety adviser for dangerous goods.<br>Law about transport of dangerous goods.<br>Law and ordinance about manufacturing and sell of war material. |

## 16 OTHER INFORMATION

| | |
|---|---|
| R-phrase from point 2 | R2, Risk of explosion by chock, friction, fire or other sources of ignition.<br>R20/21/22, Harmful by inhalation, in contact with skin and if swallowed. |
| Training for handling | Yes. |
| References | CAMBREX KARLSKOGA AB environment data<br>SAAB Bofors technical rapport. |
| Other | This safety data sheet is a revised edition according the new chemical rules. The informant in this SDS is based at our existing knowledge and is based too describe the product from safety point of view. |

# SAFETY DATA SHEET

**CR 22686**

Ensign-Bickford Aerospace & Defense

**Date Prepared :** 07/26/2012
**MSDS No :** MSDSD11260/1
**Date Revised :** 07/05/2016
**Revision No :** 3

**Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly**

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly
**PRODUCT DESCRIPTION:** Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly
**PRODUCT CODE:** D11260-502, D11260-902, D11260-904, D11599-0001

**MANUFACTURER**

Ensign-Bickford Aerospace & Defense Company
640 Hopmeadow St
P O Box 429
Simsbury, CT 06070-0429
**Emergency Phone:** (860) 843-2289

**24 HR. EMERGENCY TELEPHONE NUMBERS**

CHEMTREC 800-424-9300
EBA&D (860) 843-2276

## 2. HAZARDS IDENTIFICATION

**GHS CLASSIFICATIONS**

**Physical:**

Explosives, Division 1.4

**GHS LABEL**

Exploding bomb

**SIGNAL WORD:** DANGER

**HAZARD STATEMENTS**

H203: Explosive; fire, blast or projection hazard.

**PRECAUTIONARY STATEMENT(S)**

**Prevention:**

P202: Do not handle until all safety precautions have been read and understood.
P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P250: Do not subject to grinding / shock / friction.
P370+P372+P380+P373: In case of fire: Explosion risk. Evacuate area. DO NOT fight fire when fire reaches explosives.
P401: Store in accordance with local / state / regional / national / international regulations.

# SAFETY DATA SHEET

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P501: Dispose of contents/container to local / state / regional / national / international regulations.

**EMERGENCY OVERVIEW**

**PHYSICAL APPEARANCE:** The Pressure Cartridge Assembly (PCA) consists of a machined stainless steel / Inconel housing.

**IMMEDIATE CONCERNS:** May detonate if exposed to friction, impact, static, heat, or shock. Do not fight fires involving explosives. Isolate the area. Evacuate personnel to a safe place. Explosive detonation can occur.

**POTENTIAL HEALTH EFFECTS**

**EYES:** Not a normal route of exposure as hazardous ingredients are sealed within the product. Prolonged or repeated contact with post-function gases and particulates may result in eye irritation with discomfort, tearing, and blurring of vision.

**SKIN:** Not a normal route of exposure as hazardous ingredients are sealed within the product. Prolonged or repeated exposure to post-function residues and core materials may cause skin irritation.

**INGESTION:** Normal use, storage, and disposal will not result in ingestion of hazardous ingredients.

**INHALATION:** Not a normal route of exposure as hazardous ingredients are sealed within the product. Prolonged or repeated exposure to post-function residues and core materials may cause respiratory tract irritation.

## 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | Wt.% | CAS |
|---|---|---|
| Titanium Hydride (tih2) | < 1 | 7704-98-5 |
| Potassium Perchlorate | < 1 | 7778-74-7 |
| Zirconium | < 1 | 7440-67-7 |
| Nitrocellulose | < 1 | 9004-70-0 |
| Nitroglycerin | < 1 | 55-63-0 |

## 4. FIRST AID MEASURES

**EYES:** Flush using running water for at least 15 minutes. If irritation persists, seek medical attention.

**SKIN:** Wash exposed area with soap and water. If irritation persists, seek medical attention.

**INGESTION:** Seek medical attention.

**INHALATION:** Remove victim to fresh air. If not breathing, administer rescue breathing. Seek medical attention.

## 5. FIRE FIGHTING MEASURES

# SAFETY DATA SHEET

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**EXTINGUISHING MEDIA:** DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Isolate the affected area and evacuate all personnel to a distant safe area. Extinguish fire using a water deluge, only if it can be applied remotely.

**HAZARDOUS COMBUSTION PRODUCTS:** Nitrogen oxides are released when the product is burned.

**EXPLOSION HAZARDS:** May detonate if exposed to shock, heat, impact, sparks, static, or friction.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Hazardous gases of carbon dioxide, carbon monoxide, and nitrogen oxide are released when the product is heated to decomposition.

## 6. ACCIDENTAL RELEASE MEASURES

**GENERAL PROCEDURES:** Review Fire and Explosive Hazards and Safety Precautions before proceeding with cleanup. Only qualified personnel should perform any cleanup and disposal of material. Isolate the spill area removing all sources of ignition from the location. Remove all explosives that were not involved in the spill from the spill area. Carefully collect the spilled material and place in a (Velostat) electrically conductive bag. Contamination of this material with sand, grit, or dirt will render the material more sensitive to detonation. If safe to do so, separate material that is not contaminated from contaminated material.

**SPECIAL PROTECTIVE EQUIPMENT:** Use appropriate Personal Protective Equipment during cleanup. See Section 8.

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Store in accordance with federal, state, and local regulations.

**HANDLING:** Only properly qualified and authorized personnel should handle and use explosive products covered by this MSDS. The PCA/NSI has a protective cap on the output end and a Faraday cap on the input end. These protective caps should remain on the unit at all times until they need to be removed for installation or test.

**STORAGE:** Store in accordance with federal, state, and local regulations. Avoid friction, impact, static, heat, and shock. Store in a cool, dry place. Store away from sparks and other ignition sources.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

# SAFETY DATA SHEET

**CR 22686**

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**Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly**

**EXPOSURE GUIDELINES**

| OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200) | | | | | |
|---|---|---|---|---|---|
| | | EXPOSURE LIMITS | | | |
| | | OSHA PEL | | ACGIH TLV | |
| **Chemical Name** | | **ppm** | **mg/m³** | **ppm** | **mg/m³** |
| Potassium Perchlorate | **TWA** | [1] | mg/m³ [1] | [2] | mg/m³ [2] |
| Zirconium | **TWA** | | 5 mg/m³ | [3] | 5 mg/m³ [3] |
| | **STEL** | | | | 10 |
| Nitroglycerin | **TWA** | | | 0.05 [4] | 0.46 mg/m³ [4] |

**Footnotes:**
**1**. mg/m³ (total), 5 mg/m³ (resp) for nuisance dusts
**2**. mg/m³ (total) for PNOC containing no asbestos and <1% crystalline silica
**3**. STEL, 10 mg/m³
**4**. (skin)

**ENGINEERING CONTROLS:** Product is intended for indoor and outdoor use. Provide ventilation for indoor use. Provide ventilation for repetitive indoor testing. Provide local exhaust and mechanical ventilation as needed so as not to exceed the PEL.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Safety glasses with side shields are recommended for normal operations.

**SKIN:** Protective gloves of rubber or Neoprene should be worn to prevent contact with spilled explosive powder.

**RESPIRATORY:** OSHA/NIOSH approved dust, mist, and fume filter respirator.

**OTHER USE PRECAUTIONS:** The product is to be handled only by qualified and authorized personnel. Refer to the Manufacturer's Instructions and Warnings supplied with the product.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

# SAFETY DATA SHEET

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| Chemical Name | Melting Point (°C) | Boiling Point (°C) | Solubility in Water | Specific Gravity |
|---|---|---|---|---|
| Potassium Perchlorate | | | 1.5 g in 100 g Water | 2.52 |
| Zirconium | 1852 | 3577 | Insoluble | 6.51 |
| Nitroglycerin | 13.3 | 50 Begins to decompose | 0.1% | 1.599 |

**PHYSICAL STATE:** Solid Product

**ODOR:** Odorless.

**COLOR:** Silver or gray material.

## 10. STABILITY AND REACTIVITY

**HAZARDOUS POLYMERIZATION:** Will not occur.

**STABILITY:** Stable under normal conditions, but improper handling can result in accidental detonation.

**CONDITIONS TO AVOID:** Friction, impact, static, heat, and shock.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Detonation and burning will produce nitrogen oxides. Avoid breathing the fumes from detonation and burning.

**INCOMPATIBLE MATERIALS:** Incompatible with acids and alkalis.

## 11. TOXICOLOGICAL INFORMATION

**CARCINOGENICITY**

# SAFETY DATA SHEET

**CR 22686**

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| Chemical Name | NTP Status | IARC Status | OSHA Status | Other | General Toxicity |
|---|---|---|---|---|---|
| Potassium Perchlorate | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | | No Data. |
| Zirconium | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | Not Listed | Non-toxic. |
| Nitrocellulose | Not Listed | Not listed by NTP, IARC, or OSHA. | Not Listed | | Non-toxic. |
| Nitroglycerin | Not Listed | Not Listed. | Not Listed | Not Listed | Toxic effects may occur by ingestion, inhalation of dust, or absorbtion through intact skin. |

**COMMENTS:** See Section 3.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA:** No Data Available.

**ECOTOXICOLOGICAL INFORMATION:** No Data Available.

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Waste explosive products covered by this SDS are classified as hazardous wastes with the characteristic of reactivity. Any such waste should be handled, treated, and stored in accordance with local, state, and federal regulations.

**RCRA/EPA WASTE INFORMATION:** Waste Explosive Products covered by this SDS: EPA Hazardous Waste Number D003.

# SAFETY DATA SHEET

**CR 22686**

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**Date Revised :** 07/05/2016
**Revision No :** 3

**Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly**

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME:** CARTRIDGES, POWER DEVICE

**PRIMARY HAZARD CLASS/DIVISION:** 1.4S

**SECONDARY HAZARD CLASS/DIVISION:** EX2013040458

**UN/NA NUMBER:** 0323

**COMMENTS:** Transport only in accordance with local, state, and federal regulations for transportation of explosives. Additional reference information for transportation of explosives and energetic materials is provided in the DoD Contractor's Safety Manual for Ammunition and Explosives, DoD 4145.26-M.

## 15. REGULATORY INFORMATION

**UNITED STATES**

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**TITLE III NOTES:** This product does not contain any constituents that are subject to the reporting requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986, and 40 CFR Part 372. Statment on ozone depleting substances (ODS): There are no ODS contained within or used in the manufacture of this product. Labeling is not required.

## 16. OTHER INFORMATION

**APPROVED BY:** Ensign-Bickford Aerospace & Defense Company

**Date Revised:** 07/05/2016

**REVISION SUMMARY:** This SDS replaces the 04/22/2015 SDS. Revised: **Section 1:** . **Section 2:** .

**MANUFACTURER DISCLAIMER:** The information described in this material safety data sheet cannot possibly cover every application of the product or variation of conditions under which the product is used. The recommendations are based on the manufacturer's experiences and research. They are believed to be accurate, but no warranties are made, expressed, or implied. The information is offered as typical and not as a product specification. The recommended handling procedures are believed to be generally applicable, however, each user should review these recommendations in the context of the specific intended use.

## Hazardous Article Safety Data Sheet

Shipping Pipe DOT-SP-8451
Articles Explosive, NOS (BKN03/ZPP)

Manufacturer's Name
Ensign-Bickford Aerospace & Defense
14370 White Sage Road
Moorpark, California 93021

Emergency Telephone No.
(805) 292-4000 Moorpark, CA

Chem Tel (800)424-9300

date prepared- 6-13-17 date rev. A

### Section 1 - Identity

Common Name: Cutter Assy, Cord
p/n D11805-1 CAS # NA
Chemical Family (see section 2)
Formula
**Sealed Article - containing material listed in section 2.**

### Section 2 - Hazardous Ingredients

Principal Hazardous Component(s) (chemical & common name(s))
Ignition ZPP Composition
Zirconium/Potassium Perchlorate/Viton

**Output composition**
Boron/Potassium Nitrate/Binder

### Section 3 - Physical & Chemical Characteristic (Fire & Explosion Data)

| | | | | | |
|---|---|---|---|---|---|
| Boiling Point | NA | Specific Gravity (H20=1) | N/A | Vapor Pressure (mm Hg) | N/A |
| Percent Volatile by Volume(%) | NA | Vapor Density (Air=1) | | NA | |
| Evaporation Rate(____=1) | NA | | | | |
| Solubility in Water | none | Reactivity in Water | | none | |

Appearance and Odor: metallic part- no odor

Flash Point: N/A
Flammable Limits in Air % by Volume: Lower-NA Upper-NA
Auto Ignition Temperature: >350° F
Extinguishing Media: "Explosives" Do Not Fight Explosive Fires.

Special Fire Fighting Procedures: "Explosives" Do Not Fight Explosive Fires.

Unusual Fire and Explosion Hazards: May explode or ignite when exposed to fire or Electrical energy source. (see section 4 and 7). See Section 2 for explosive formulation.
An external fire will not cause the entire contents of this package to ignite all at one time.
**( N/A means not applicable because the Igniter is a sealed Article)**

HASDS 2002020 6/13/2017

**Section 4 - Physical Hazards**

Stability: Stable X Unstable

Conditions to Avoid: Temperature in excess of 300° F, Fire, and Electrical Energy Source

Incompatibility (Materials to Avoid): Keep fire and electrical energy sources away.

Hazardous Decomposition Products: may occur if ignited

Hazardous Polymerization: May Occur Will Not Occur X

**Section 5 - Health Hazards**

Threshold Limit Value NA

Signs and Symptoms of Exposure: 1. Acute Overexposure NA

2. Chronic Overexposure NA

Medical Conditions Generally Aggravate by Exposure: NA

| | | | | | | |
|---|---|---|---|---|---|---|
| Chemical Listed as Carcinogen or Potential Carcinogen | | National Toxico Program | Yes No X | I.A.R.C. Monographs | Yes No X | OSHA Yes No X |
| OSHA Permissible Exposure Limit | none | ACGIH Threshold Limit Value | N/A | Other Exposure Limit Value | N/A | |

Emergency and First Aid Procedures

1. Inhalation NA
2. Eyes NA
3. Skin NA
4. Ingestion NA

**(N/A means not applicable because units are sealed)**

**Section 6 - Special Protection Information**

Respiratory Protection (Specify Type) NA

Ventilation: NA Local Exhaus NA Mechanical NA

Special NA Other NA

Protective Gloves NA

Eye Protection Approved safety glasses meeting ANSI Z87.1 standards

Other protective Clothing or Equipment **Recommend** Wearing fire retardant (shop Coat) over all clothing containing at least 50% cotton and electrostatic charge dissipating personal protective equipment (shoes)

**(N/A means not applicable because units are sealed)**

**Section - 7 Special Precautions and Spill/Leak Procedures**

Precautions to be taken in Handling and Storage: keep fire away; keep away from electrical source.

Grounding and bonding (of individuals & work surfaces) **recommended** while handling individual units.

The following statement is required by California 22 CCR 67384.4 for all Perchlorate containing materials:

Perchlorate Material- special handling may apply, see www.dtsc.ca.gov/hazardous waste/perchlorate

Shipping Name: Shipping Pipe DOT-SP-8451 Articles explosive NOS

Hazard Class & Compatibility Group: 1.4E

Reference Number: D11805-1

UN Number: UN0471

Steps to be taken in case Material is Released or Spilled: If in transport call emergency telephone #s

Only trained personnel should handle explosive devices

Waste Disposal Methods: Dispose of waste product in accordance with all Local, State and Federal regulations.

- Ammonia

# SAFETY DATA SHEET

Airgas
an Air Liquide company

Ammonia

## Section 1. Identification

| | | |
|---|---|---|
| **GHS product identifier** | : | Ammonia |
| **Chemical name** | : | ammonia, anhydrous |
| **Other means of identification** | : | ammonia; anhydrous ammonia; Aqueous ammonia; Aqua ammonia |
| **Product use** | : | Synthetic/Analytical chemistry. |
| **Synonym** | : | ammonia; anhydrous ammonia; Aqueous ammonia; Aqua ammonia |
| **SDS #** | : | 001003 |
| **Supplier's details** | : | Airgas USA, LLC and its affiliates<br>259 North Radnor-Chester Road<br>Suite 100<br>Radnor, PA 19087-5283<br>1-610-687-5253 |
| **24-hour telephone** | : | 1-866-734-3438 |

## Section 2. Hazards identification

| | | |
|---|---|---|
| **OSHA/HCS status** | : | This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200). |
| **Classification of the substance or mixture** | : | FLAMMABLE GASES - Category 2<br>GASES UNDER PRESSURE - Liquefied gas<br>ACUTE TOXICITY (inhalation) - Category 4<br>SKIN CORROSION/IRRITATION - Category 1<br>SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1<br>AQUATIC HAZARD (ACUTE) - Category 1 |

**GHS label elements**

**Hazard pictograms** :

| | | |
|---|---|---|
| **Signal word** | : | Danger |
| **Hazard statements** | : | Flammable gas.<br>Contains gas under pressure; may explode if heated.<br>May cause frostbite.<br>May form explosive mixtures in Air.<br>Harmful if inhaled.<br>Causes severe skin burns and eye damage.<br>Very toxic to aquatic life. |

**Precautionary statements**

| | | |
|---|---|---|
| **General** | : | Read and follow all Safety Data Sheets (SDS'S) before use. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Approach suspected leak area with caution. |
| **Prevention** | : | Wear protective gloves. Wear eye or face protection. Wear protective clothing. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Avoid breathing gas. Wash hands thoroughly after handling. |

## Section 2. Hazards identification

**Response** : Collect spillage. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or physician. IF SWALLOWED: Immediately call a POISON CENTER or physician. Rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. Wash contaminated clothing before reuse. Immediately call a POISON CENTER or physician. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or physician. Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

**Storage** : Store locked up. Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

**Disposal** : Dispose of contents and container in accordance with all local, regional, national and international regulations.

**Hazards not otherwise classified** : Liquid can cause burns similar to frostbite.

## Section 3. Composition/information on ingredients

**Substance/mixture** : Substance

**Chemical name** : ammonia, anhydrous

**Other means of identification** : ammonia; anhydrous ammonia; Aqueous ammonia; Aqua ammonia

**CAS number/other identifiers**

**CAS number** : 7664-41-7

**Product code** : 001003

| Ingredient name | % | CAS number |
|---|---|---|
| ammonia, anhydrous | 100 | 7664-41-7 |

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

**There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.**

**Occupational exposure limits, if available, are listed in Section 8.**

## Section 4. First aid measures

**Description of necessary first aid measures**

**Eye contact** : Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician.

**Inhalation** : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

**Skin contact** : Get medical attention immediately. Call a poison center or physician. Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Continue to rinse for at least 10 minutes. In case of contact with liquid, warm frozen tissues slowly with lukewarm water and get medical attention. Do not rub affected area. Chemical burns must be treated promptly by a physician. Wash clothing before reuse. Clean shoes thoroughly before reuse.

## Section 4. First aid measures

**Ingestion** : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. Chemical burns must be treated promptly by a physician. Ingestion of liquid can cause burns similar to frostbite. If frostbite occurs, get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. As this product rapidly becomes a gas when released, refer to the inhalation section.

**Most important symptoms/effects, acute and delayed**

**Potential acute health effects**

**Eye contact** : Causes serious eye damage. Liquid can cause burns similar to frostbite.

**Inhalation** : Harmful if inhaled.

**Skin contact** : Causes severe burns. Dermal contact with rapidly evaporating liquid could result in freezing of the tissues or frostbite.

**Frostbite** : Try to warm up the frozen tissues and seek medical attention.

**Ingestion** : Ingestion of liquid can cause burns similar to frostbite.

**Over-exposure signs/symptoms**

**Eye contact** : Adverse symptoms may include the following:, pain, watering, redness, frostbite

**Inhalation** : No specific data.

**Skin contact** : Adverse symptoms may include the following:, pain or irritation, redness, blistering may occur, frostbite

**Ingestion** : Adverse symptoms may include the following:, frostbite, stomach pains

**Indication of immediate medical attention and special treatment needed, if necessary**

**Notes to physician** : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

**Specific treatments** : No specific treatment.

**Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

**See toxicological information (Section 11)**

## Section 5. Fire-fighting measures

**Extinguishing media**

**Suitable extinguishing media** : Use an extinguishing agent suitable for the surrounding fire.

**Unsuitable extinguishing media** : None known.

**Specific hazards arising from the chemical** : Contains gas under pressure. Flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. This material is very toxic to aquatic life. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

**Hazardous thermal decomposition products** : Decomposition products may include the following materials:
nitrogen oxides

## Section 5. Fire-fighting measures

**Special protective actions for fire-fighters** : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

**Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. For incidents involving large quantities, thermally insulated undergarments and thick textile or leather gloves should be worn.

## Section 6. Accidental release measures

### Personal precautions, protective equipment and emergency procedures

**For non-emergency personnel** : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

**For emergency responders** : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

**Environmental precautions** : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

### Methods and materials for containment and cleaning up

**Small spill** : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

**Large spill** : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

## Section 7. Handling and storage

### Precautions for safe handling

**Protective measures** : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get in eyes or on skin or clothing. Do not breathe gas. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

**Advice on general occupational hygiene** : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

## Section 7. Handling and storage

**Conditions for safe storage, including any incompatibilities** : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

## Section 8. Exposure controls/personal protection

**Control parameters**

**Occupational exposure limits**

| Ingredient name | Exposure limits |
|---|---|
| ammonia, anhydrous | **ACGIH TLV (United States, 3/2015).**<br>STEL: 24 mg/m³ 15 minutes.<br>STEL: 35 ppm 15 minutes.<br>TWA: 17 mg/m³ 8 hours.<br>TWA: 25 ppm 8 hours.<br>**NIOSH REL (United States, 10/2013).**<br>STEL: 27 mg/m³ 15 minutes.<br>STEL: 35 ppm 15 minutes.<br>TWA: 18 mg/m³ 10 hours.<br>TWA: 25 ppm 10 hours.<br>**OSHA PEL (United States, 2/2013).**<br>TWA: 35 mg/m³ 8 hours.<br>TWA: 50 ppm 8 hours.<br>**OSHA PEL 1989 (United States, 3/1989).**<br>STEL: 27 mg/m³ 15 minutes.<br>STEL: 35 ppm 15 minutes. |

**Appropriate engineering controls** : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

**Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

**Individual protection measures**

**Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

**Eye/face protection** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles and/or face shield. If inhalation hazards exist, a full-face respirator may be required instead.

**Skin protection**

**Hand protection** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. If contact with the liquid is possible, insulated gloves suitable for low temperatures should be worn. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

## Section 8. Exposure controls/personal protection

**Body protection** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

**Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

**Respiratory protection** : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

## Section 9. Physical and chemical properties

Appearance

**Physical state** : Gas. [Liquefied gas]

**Color** : Colorless.

**Molecular weight** : 17.03 g/mole

**Molecular formula** : H3-N

**Boiling/condensation point** : -33°C (-27.4°F)

**Melting/freezing point** : -77.7°C (-107.9°F)

**Critical temperature** : 132.85°C (271.1°F)

**Odor** : Pungent.

**Odor threshold** : Not available.

**pH** : Not available.

**Flash point** : Not available.

**Burning time** : Not applicable.

**Burning rate** : Not applicable.

**Evaporation rate** : Not available.

**Flammability (solid, gas)** : Extremely flammable in the presence of the following materials or conditions: oxidizing materials.

**Lower and upper explosive (flammable) limits** : Lower: 15%
Upper: 28%

**Vapor pressure** : 114.1 (psig)

**Vapor density** : 0.59 (Air = 1)

**Specific Volume ($ft^3/lb$)** : 22.7273

**Gas Density ($lb/ft^3$)** : 0.044

**Relative density** : Not applicable.

**Solubility** : Not available

**Solubility in water** : 540 g/l

**Partition coefficient: n-octanol/water** : Not available.

**Auto-ignition temperature** : 651°C (1203.8°F)

**Decomposition temperature** : Not available.

**SADT** : Not available.

**Viscosity** : Not applicable.

**Physical/chemical properties comments** : SPECIFIC GRAVITY (AIR=1): @ 70°F (21.1°C) = 0.59
PH: Approx. 11.6 for 1 N Sol'n. in water

## Section 10. Stability and reactivity

**Reactivity** : No specific test data related to reactivity available for this product or its ingredients.

**Chemical stability** : The product is stable.

**Possibility of hazardous reactions** : Under normal conditions of storage and use, hazardous reactions will not occur.

**Conditions to avoid** : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

**Incompatible materials** : Oxidizers

**Hazardous decomposition products** : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

**Hazardous polymerization** : Under normal conditions of storage and use, hazardous polymerization will not occur.

## Section 11. Toxicological information

**Information on toxicological effects**

**Acute toxicity**

| Product/ingredient name | Result | Species | Dose | Exposure |
|---|---|---|---|---|
| ammonia, anhydrous | LC50 Inhalation Gas. | Rat | 7338 ppm | 1 hours |

**IDLH** : 300 ppm

**Irritation/Corrosion**

Not available.

**Sensitization**

Not available.

**Mutagenicity**

Not available.

**Carcinogenicity**

Not available.

**Reproductive toxicity**

Not available.

**Teratogenicity**

Not available.

**Specific target organ toxicity (single exposure)**

Not available.

**Specific target organ toxicity (repeated exposure)**

Not available.

**Aspiration hazard**

Not available.

**Information on the likely routes of exposure** : Not available.

**Potential acute health effects**

## Section 11. Toxicological information

**Eye contact** : Causes serious eye damage. Liquid can cause burns similar to frostbite.

**Inhalation** : Harmful if inhaled.

**Skin contact** : Causes severe burns. Dermal contact with rapidly evaporating liquid could result in freezing of the tissues or frostbite.

**Ingestion** : Ingestion of liquid can cause burns similar to frostbite.

**Symptoms related to the physical, chemical and toxicological characteristics**

**Eye contact** : Adverse symptoms may include the following:, pain, watering, redness, frostbite

**Inhalation** : No specific data.

**Skin contact** : Adverse symptoms may include the following:, pain or irritation, redness, blistering may occur, frostbite

**Ingestion** : Adverse symptoms may include the following:, frostbite, stomach pains

**Delayed and immediate effects and also chronic effects from short and long term exposure**

**Short term exposure**

**Potential immediate effects** : Not available.

**Potential delayed effects** : Not available.

**Long term exposure**

**Potential immediate effects** : Not available.

**Potential delayed effects** : Not available.

**Potential chronic health effects**

Not available.

**General** : No known significant effects or critical hazards.

**Carcinogenicity** : No known significant effects or critical hazards.

**Mutagenicity** : No known significant effects or critical hazards.

**Teratogenicity** : No known significant effects or critical hazards.

**Developmental effects** : No known significant effects or critical hazards.

**Fertility effects** : No known significant effects or critical hazards.

**Numerical measures of toxicity**

**Acute toxicity estimates**

Not available.

**Other information** : IDLH : 300 ppm

## Section 12. Ecological information

**Toxicity**

| Product/ingredient name | Result | Species | Exposure |
|---|---|---|---|
| ammonia, anhydrous | Acute EC50 29.2 mg/l Marine water | Algae - Ulva fasciata - Zoea | 96 hours |
| | Acute LC50 2080 µg/l Fresh water | Crustaceans - Gammarus pulex | 48 hours |
| | Acute LC50 0.53 ppm Fresh water | Daphnia - Daphnia magna | 48 hours |
| | Acute LC50 300 µg/l Fresh water | Fish - Hypophthalmichthys nobilis | 96 hours |
| | Chronic NOEC 0.204 mg/l Marine water | Fish - Dicentrarchus labrax | 62 days |

**Persistence and degradability**

Not available.

*Ammonia*

## Section 12. Ecological information

**Bioaccumulative potential**

Not available.

**Mobility in soil**

**Soil/water partition coefficient ($K_{OC}$)** : Not available.

**Other adverse effects** : No known significant effects or critical hazards.

## Section 13. Disposal considerations

**Disposal methods** : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

## Section 14. Transport information

| | DOT | TDG | Mexico | IMDG | IATA |
|---|---|---|---|---|---|
| **UN number** | UN1005 | UN1005 | UN1005 | UN1005 | UN1005 |
| **UN proper shipping name** | AMMONIA, ANHYDROUS | AMMONIA, ANHYDROUS; OR ANHYDROUS AMMONIA | AMMONIA, ANHYDROUS | AMMONIA, ANHYDROUS | AMMONIA, ANHYDROUS |
| **Transport hazard class(es)** | 2.2  | 2.3 (8)  | 2.3 (8)  | 2.3 (8)  | 2.3 (8)  |
| **Packing group** | - | - | - | - | - |
| **Environment** | No. | No. | No. | Yes. | No. |
| **Additional information** | Inhalation hazard<br><br>This product is not regulated as a marine pollutant when transported on inland waterways in sizes of ≤5 L or ≤5 kg or by road, rail, or inland air in non-bulk sizes, provided the packagings meet the general provisions of §§ 173.24 and 173.24a.<br><br>**Reportable quantity**<br>100 lbs / 45.4 kg<br>Package sizes shipped in quantities less than the product reportable quantity are not subject | Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2), 2.40-2.42 (Class 8), 2.7 (Marine pollutant mark).<br><br>The marine pollutant mark is not required when transported by road or rail.<br><br>**Explosive Limit and Limited Quantity Index**<br>0<br><br>**ERAP Index**<br>3000 | Toxic Inhalation Hazard Zone D | The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg. | The environmentally hazardous substance mark may appear if required by other transportation regulations.<br>**Passenger and Cargo Aircraft**Quantity limitation: 0 Forbidden<br>**Cargo Aircraft Only**<br>Quantity limitation: Forbidden |

## Section 14. Transport information

| | | | | | |
|---|---|---|---|---|---|
| | to the RQ (reportable quantity) transportation requirements.<br><br>**Limited quantity**<br>Yes.<br><br>**Packaging instruction**<br>**Passenger aircraft**<br>Quantity limitation: Forbidden.<br><br>**Cargo aircraft**<br>Quantity limitation: Forbidden.<br><br>**Special provisions**<br>13,T50 | **Passenger Carrying Ship Index**<br>Forbidden<br><br>**Passenger Carrying Road or Rail Index**<br>Forbidden<br><br>**Special provisions** | | | |

**"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."**

**Special precautions for user** : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code** : Not available.

## Section 15. Regulatory information

**U.S. Federal regulations** : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

**United States inventory (TSCA 8b)**: This material is listed or exempted.

**Clean Water Act (CWA) 311**: ammonia, anhydrous

**Clean Air Act (CAA) 112 regulated toxic substances**: ammonia, anhydrous

**Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs)** : Not listed

**Clean Air Act Section 602 Class I Substances** : Not listed

**Clean Air Act Section 602 Class II Substances** : Not listed

**DEA List I Chemicals (Precursor Chemicals)** : Not listed

**DEA List II Chemicals (Essential Chemicals)** : Not listed

**SARA 302/304**

**Composition/information on ingredients**

| Name | % | EHS | SARA 302 TPQ (lbs) | SARA 302 TPQ (gallons) | SARA 304 RQ (lbs) | SARA 304 RQ (gallons) |
|---|---|---|---|---|---|---|
| ammonia, anhydrous | 100 | Yes. | 500 | - | 100 | - |

**SARA 304 RQ** : 100 lbs / 45.4 kg

**SARA 311/312**

**Classification** : Fire hazard
Sudden release of pressure
Immediate (acute) health hazard

## Section 15. Regulatory information

**Composition/information on ingredients**

| Name | % | Fire hazard | Sudden release of pressure | Reactive | Immediate (acute) health hazard | Delayed (chronic) health hazard |
|---|---|---|---|---|---|---|
| ammonia, anhydrous | 100 | Yes. | Yes. | No. | Yes. | No. |

**SARA 313**

| | Product name | CAS number | % |
|---|---|---|---|
| Form R - Reporting requirements | ammonia, anhydrous | 7664-41-7 | 100 |
| Supplier notification | ammonia, anhydrous | 7664-41-7 | 100 |

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

**State regulations**

**Massachusetts** : This material is listed.
**New York** : This material is listed.
**New Jersey** : This material is listed.
**Pennsylvania** : This material is listed.

**International regulations**

**International lists**

**National inventory**

**Australia** : This material is listed or exempted.
**Canada** : This material is listed or exempted.
**China** : This material is listed or exempted.
**Europe** : This material is listed or exempted.
**Japan** : This material is listed or exempted.
**Malaysia** : This material is listed or exempted.
**New Zealand** : This material is listed or exempted.
**Philippines** : This material is listed or exempted.
**Republic of Korea** : This material is listed or exempted.
**Taiwan** : This material is listed or exempted.

**Canada**

**WHMIS (Canada)** : Class A: Compressed gas.
Class B-1: Flammable gas.
Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class E: Corrosive material

**CEPA Toxic substances**: This material is listed.
**Canadian ARET**: This material is not listed.
**Canadian NPRI**: This material is listed.
**Alberta Designated Substances**: This material is not listed.
**Ontario Designated Substances**: This material is not listed.
**Quebec Designated Substances**: This material is not listed.

## Section 16. Other information

**Canada Label requirements** : Class A: Compressed gas.
Class B-1: Flammable gas.
Class D-1A: Material causing immediate and serious toxic effects (Very toxic).
Class E: Corrosive material

**Hazardous Material Information System (U.S.A.)**

## Section 16. Other information

| | |
|---|---|
| Health | 3 |
| Flammability | 1 |
| Physical hazards | 2 |

**Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.**

**The customer is responsible for determining the PPE code for this material.**

**National Fire Protection Association (U.S.A.)**


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**Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.**

**Procedure used to derive the classification**

| Classification | Justification |
|---|---|
| Flam. Gas 2, H221 | Expert judgment |
| Press. Gas Liq. Gas, H280 | Expert judgment |
| Acute Tox. 4, H332 | Expert judgment |
| Skin Corr. 1, H314 | Expert judgment |
| Eye Dam. 1, H318 | Expert judgment |
| Aquatic Acute 1, H400 | Expert judgment |

**History**

| | | |
|---|---|---|
| **Date of printing** | : | 5/24/2016 |
| **Date of issue/Date of revision** | : | 5/24/2016 |
| **Date of previous issue** | : | 2/19/2016 |
| **Version** | : | 0.06 |
| **Key to abbreviations** | : | ATE = Acute Toxicity Estimate<br>BCF = Bioconcentration Factor<br>GHS = Globally Harmonized System of Classification and Labelling of Chemicals<br>IATA = International Air Transport Association<br>IBC = Intermediate Bulk Container<br>IMDG = International Maritime Dangerous Goods<br>LogPow = logarithm of the octanol/water partition coefficient<br>MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)<br>UN = United Nations |
| **References** | : | Not available. |

**Indicates information that has changed from previously issued version.**

**Notice to reader**

## Section 16. Other information

**To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.**
**Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.**

- **Coolant** - DuPont Hydro-fluorocarbon (HFC) 134a



**SAFETY DATA SHEET**

Chemours

## Freon™ 134a (HFC-134a) Refrigerant - Propellant

| Version | Revision Date: | SDS Number: | Date of last issue: 11/22/2017 |
|---|---|---|---|
| 9.0 | 02/06/2018 | 1325513-00037 | Date of first issue: 02/27/2017 |

### SECTION 1. IDENTIFICATION

Product name : Freon™ 134a (HFC-134a) Refrigerant - Propellant

SDS-Identcode : 130000000349

**Manufacturer or supplier's details**

Company name of supplier : The Chemours Company FC, LLC

Address : 1007 Market Street
Wilmington, DE 19899 United States of America (USA)

Telephone : 1-844-773-CHEM (outside the U.S. 1-302-773-1000)

Emergency telephone : Medical emergency: 1-866-595-1473 (outside the U.S. 1-302-773-2000) ; Transport emergency: +1-800-424-9300 (outside the U.S. +1-703-527-3887)

**Recommended use of the chemical and restrictions on use**

Recommended use : Refrigerant

Restrictions on use : For professional and industrial installation and use only.

### SECTION 2. HAZARDS IDENTIFICATION

**GHS classification in accordance with 29 CFR 1910.1200**

Gases under pressure : Liquefied gas

Simple Asphyxiant

**GHS label elements**

Hazard pictograms :

Signal Word : Warning

Hazard Statements : H280 Contains gas under pressure; may explode if heated. May displace oxygen and cause rapid suffocation.

Precautionary Statements : **Storage:**
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

SAFETY DATA SHEET

Freon™ 134a (HFC-134a) Refrigerant - Propellant

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**Other hazards**

Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing.
Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects.
Rapid evaporation of the product may cause frostbite.

## SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Substance name : 1,1,1,2-Tetrafluoroethane

CAS-No. : 811-97-2

**Hazardous ingredients**

| Chemical name | CAS-No. | Concentration (% w/w) |
|---|---|---|
| 1,1,1,2-Tetrafluoroethane* | 811-97-2 | 100 |

* Voluntarily-disclosed non-hazardous substance

## SECTION 4. FIRST AID MEASURES

General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical advice.

If inhaled : If inhaled, remove to fresh air.
Get medical attention if symptoms occur.

In case of skin contact : Thaw frosted parts with lukewarm water. Do not rub affected area.
Get medical attention immediately.

In case of eye contact : Get medical attention immediately.

If swallowed : Ingestion is not considered a potential route of exposure.

Most important symptoms and effects, both acute and delayed : Contact with liquid or refrigerated gas can cause cold burns and frostbite.
May cause cardiac arrhythmia.
Other symptoms potentially related to misuse or inhalation abuse are
Cardiac sensitization
Anaesthetic effects
Light-headedness
Dizziness
confusion
Lack of coordination
Drowsiness
Unconsciousness

Protection of first-aiders : No special precautions are necessary for first aid responders.

**SAFETY DATA SHEET**

**Freon™ 134a (HFC-134a) Refrigerant - Propellant**

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Notes to physician : Treat symptomatically and supportively.

## SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : Not applicable
Will not burn

Unsuitable extinguishing media : Not applicable
Will not burn

Specific hazards during fire fighting : Exposure to combustion products may be a hazard to health.
If the temperature rises there is danger of the vessels bursting due to the high vapor pressure.

Hazardous combustion products : Hydrogen fluoride
carbonyl fluoride
Carbon oxides

Specific extinguishing methods : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Fight fire remotely due to the risk of explosion.
Use water spray to cool unopened containers.
Remove undamaged containers from fire area if it is safe to do so.
Evacuate area.

Special protective equipment for fire-fighters : Wear self-contained breathing apparatus for firefighting if necessary.
Use personal protective equipment.

## SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures : Evacuate personnel to safe areas.
Avoid skin contact with leaking liquid (danger of frostbite).
Ventilate the area.
Follow safe handling advice and personal protective equipment recommendations.

Environmental precautions : Prevent further leakage or spillage if safe to do so.
Retain and dispose of contaminated wash water.

Methods and materials for containment and cleaning up : Ventilate the area.
Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable.
Sections 13 and 15 of this SDS provide information regarding certain local or national requirements.

## SECTION 7. HANDLING AND STORAGE

**SAFETY DATA SHEET**

## Freon™ 134a (HFC-134a) Refrigerant - Propellant

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| | | |
|---|---|---|
| Technical measures | : | Use equipment rated for cylinder pressure. Use a backflow preventative device in piping. Close valve after each use and when empty. |
| Local/Total ventilation | : | Use only with adequate ventilation. |
| Advice on safe handling | : | Avoid breathing gas.<br>Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment<br>Wear cold insulating gloves/ face shield/ eye protection.<br>Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point.<br>Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.<br>Prevent backflow into the gas tank.<br>Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems.<br>Close valve after each use and when empty. Do NOT change or force fit connections.<br>Prevent the intrusion of water into the gas tank.<br>Never attempt to lift cylinder by its cap.<br>Do not drag, slide or roll cylinders.<br>Use a suitable hand truck for cylinder movement.<br>Keep away from heat and sources of ignition.<br>Take precautionary measures against static discharges.<br>Take care to prevent spills, waste and minimize release to the environment. |
| Conditions for safe storage | : | Cylinders should be stored upright and firmly secured to prevent falling or being knocked over.<br>Separate full containers from empty containers.<br>Do not store near combustible materials.<br>Avoid area where salt or other corrosive materials are present.<br>Keep in properly labeled containers.<br>Keep in a cool, well-ventilated place.<br>Keep away from direct sunlight.<br>Store in accordance with the particular national regulations. |
| Materials to avoid | : | Do not store with the following product types:<br>Self-reactive substances and mixtures<br>Organic peroxides<br>Oxidizing agents<br>Flammable liquids<br>Flammable solids<br>Pyrophoric liquids<br>Pyrophoric solids<br>Self-heating substances and mixtures<br>Substances and mixtures which in contact with water emit flammable gases<br>Explosives<br>Acutely toxic substances and mixtures<br>Substances and mixtures with chronic toxicity |

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| | | |
|---|---|---|
| Recommended storage temperature | : | < 52 °C |
| Storage period | : | > 10 y |
| Further information on storage stability | : | The product has an indefinite shelf life when stored properly. |

## SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**Ingredients with workplace control parameters**

| Ingredients | CAS-No. | Value type (Form of exposure) | Control parameters / Permissible concentration | Basis |
|---|---|---|---|---|
| 1,1,1,2-Tetrafluoroethane | 811-97-2 | TWA | 1,000 ppm | US WEEL |

**Engineering measures** : Ensure adequate ventilation, especially in confined areas. Minimize workplace exposure concentrations.

**Personal protective equipment**

Respiratory protection : General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and use NIOSH/MSHA approved respirators. Protection provided by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection.

Hand protection
Material : Low temperature resistant gloves

Remarks : Choose gloves to protect hands against chemicals depending on the concentration specific to place of work. For special applications, we recommend clarifying the resistance to chemicals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday. Breakthrough time is not determined for the product. Change gloves often!

Eye protection : Wear the following personal protective equipment:
Chemical resistant goggles must be worn.
Face-shield

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| | | |
|---|---|---|
| Skin and body protection | : | Skin should be washed after contact. |
| Protective measures | : | Wear cold insulating gloves/ face shield/ eye protection. |
| Hygiene measures | : | Ensure that eye flushing systems and safety showers are located close to the working place.<br>When using do not eat, drink or smoke.<br>Wash contaminated clothing before re-use. |

## SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

| | | |
|---|---|---|
| Appearance | : | Liquefied gas |
| Color | : | colorless |
| Odor | : | slight, ether-like |
| Odor Threshold | : | No data available |
| pH | : | No data available |
| Melting point/freezing point | : | -108 °C |
| Initial boiling point and boiling range | : | -26 °C<br>(1,013 hPa) |
| Flash point | : | Not applicable |
| Evaporation rate | : | > 1<br>(CCL4=1.0) |
| Flammability (solid, gas) | : | Will not burn |
| Self-ignition | : | The substance or mixture is not classified as pyrophoric. |
| Upper explosion limit / Upper flammability limit | : | Upper flammability limit<br>Method: ASTM E681<br>None. |
| Lower explosion limit / Lower flammability limit | : | Lower flammability limit<br>Method: ASTM E681<br>None. |
| Vapor pressure | : | 5,700 hPa (20 °C) |
| Relative vapor density | : | No data available |
| Relative density | : | 1.208 (25 °C) |
| Density | : | 1.21 g/cm³ (25 °C)<br>(as liquid) |
| Solubility(ies) | | |

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| | | |
|---|---|---|
| Water solubility | : | 1.5 g/l (25 °C) |
| Partition coefficient: n-octanol/water | : | log Pow: 0.025 (25 °C) |
| Autoignition temperature | : | > 743 °C |
| Decomposition temperature | : | No data available |
| Viscosity | | |
| Viscosity, kinematic | : | Not applicable |
| Explosive properties | : | Not explosive |
| Oxidizing properties | : | The substance or mixture is not classified as oxidizing. |
| Particle size | : | Not applicable |

## SECTION 10. STABILITY AND REACTIVITY

| | | |
|---|---|---|
| Reactivity | : | Not classified as a reactivity hazard. |
| Chemical stability | : | Stable if used as directed. Follow precautionary advice and avoid incompatible materials and conditions. |
| Possibility of hazardous reactions | : | Can react with strong oxidizing agents. |
| Conditions to avoid | : | Heat, flames and sparks. |
| Incompatible materials | : | Oxidizing agents |
| Hazardous decomposition products | : | No hazardous decomposition products are known. |

## SECTION 11. TOXICOLOGICAL INFORMATION

**Information on likely routes of exposure**

Inhalation
Skin contact
Eye contact

**Acute toxicity**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

| | | |
|---|---|---|
| Acute inhalation toxicity | : | LC50 (Rat): > 567000 ppm<br>Exposure time: 4 h<br>Test atmosphere: gas<br><br>No observed adverse effect concentration (Dog): 40000 ppm |

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Test atmosphere: gas
Symptoms: Cardiac sensitization

Lowest observed adverse effect concentration (Dog): 80000 ppm
Test atmosphere: gas
Symptoms: Cardiac sensitization

Cardiac sensitisation threshold limit (Dog): 334,000 mg/m³
Test atmosphere: gas
Symptoms: Cardiac sensitization

**Skin corrosion/irritation**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Species: Rabbit
Result: No skin irritation

**Serious eye damage/eye irritation**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Species: Rabbit
Result: No eye irritation

**Respiratory or skin sensitization**

**Skin sensitization**

Not classified based on available information.

**Respiratory sensitization**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Routes of exposure: Skin contact
Species: Guinea pig
Result: negative

Species: Rat
Result: negative

**Germ cell mutagenicity**

Not classified based on available information.

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**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Germ cell mutagenicity - Assessment : Weight of evidence does not support classification as a germ cell mutagen.

**Carcinogenicity**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Carcinogenicity - Assessment : Weight of evidence does not support classification as a carcinogen

**IARC** No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

**OSHA** No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

**NTP** No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

**Reproductive toxicity**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Reproductive toxicity - Assessment : Weight of evidence does not support classification for reproductive toxicity

**STOT-single exposure**

Not classified based on available information.

**STOT-repeated exposure**

Not classified based on available information.

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Assessment: No significant health effects observed in animals at concentrations of 250 ppmV/6h/d or less.

**Repeated dose toxicity**

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

Species: Rat

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NOAEL: 50000 ppm
LOAEL: > 50000 ppm
Application Route: inhalation (gas)
Exposure time: 90 d
Method: OECD Test Guideline 413
Remarks: No significant adverse effects were reported

**Aspiration toxicity**

Not classified based on available information.

## SECTION 12. ECOLOGICAL INFORMATION

**Ecotoxicity**

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

| | | |
|---|---|---|
| Toxicity to fish | : | LC50 (Oncorhynchus mykiss (rainbow trout)): 450 mg/l<br>Exposure time: 96 h |
| Toxicity to daphnia and other aquatic invertebrates | : | EC50 (Daphnia magna (Water flea)): 980 mg/l<br>Exposure time: 48 h |
| Toxicity to algae | : | ErC50 (algae): 142 mg/l<br>Exposure time: 96 h<br>Remarks: Based on data from similar materials<br><br>NOEC (Pseudokirchneriella subcapitata (green algae)): 13.2 mg/l<br>Exposure time: 72 h<br>Remarks: Based on data from similar materials |

**Persistence and degradability**

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

| | | |
|---|---|---|
| Biodegradability | : | Result: Not readily biodegradable. |

**Bioaccumulative potential**

**Ingredients:**

**1,1,1,2-Tetrafluoroethane:**

| | | |
|---|---|---|
| Partition coefficient: n-octanol/water | : | log Pow: 1.06 |

**Mobility in soil**

No data available

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**Other adverse effects**

**Product:**

| | | |
|---|---|---|
| Results of PBT and vPvB assessment | : | This substance is not considered to be persistent, bioaccumulating and toxic (PBT). This substance is not considered to be very persistent and very bioaccumulating (vPvB). |

## SECTION 13. DISPOSAL CONSIDERATIONS

**Disposal methods**

| | | |
|---|---|---|
| Waste from residues | : | Dispose of in accordance with local regulations. |
| Contaminated packaging | : | Empty containers should be taken to an approved waste handling site for recycling or disposal.<br>Empty pressure vessels should be returned to the supplier.<br>If not otherwise specified: Dispose of as unused product. |

## SECTION 14. TRANSPORT INFORMATION

**International Regulations**

**UNRTDG**

| | | |
|---|---|---|
| UN number | : | UN 3159 |
| Proper shipping name | : | 1,1,1,2-TETRAFLUOROETHANE |
| Class | : | 2.2 |
| Packing group | : | Not assigned by regulation |
| Labels | : | 2.2 |

**IATA-DGR**

| | | |
|---|---|---|
| UN/ID No. | : | UN 3159 |
| Proper shipping name | : | 1,1,1,2-Tetrafluoroethane |
| Class | : | 2.2 |
| Packing group | : | Not assigned by regulation |
| Labels | : | Non-flammable, non-toxic Gas |
| Packing instruction (cargo aircraft) | : | 200 |
| Packing instruction (passenger aircraft) | : | 200 |

**IMDG-Code**

| | | |
|---|---|---|
| UN number | : | UN 3159 |
| Proper shipping name | : | 1,1,1,2-TETRAFLUOROETHANE |
| Class | : | 2.2 |
| Packing group | : | Not assigned by regulation |
| Labels | : | 2.2 |
| EmS Code | : | F-C, S-V |
| Marine pollutant | : | no |

**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code**

Not applicable for product as supplied.

**Domestic regulation**

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**49 CFR**

| | | |
|---|---|---|
| UN/ID/NA number | : | UN 3159 |
| Proper shipping name | : | 1,1,1,2-Tetrafluoroethane |
| Class | : | 2.2 |
| Packing group | : | Not assigned by regulation |
| Labels | : | NON-FLAMMABLE GAS |
| ERG Code | : | 126 |
| Marine pollutant | : | no |

## SECTION 15. REGULATORY INFORMATION

**EPCRA - Emergency Planning and Community Right-to-Know**

**CERCLA Reportable Quantity**

This material does not contain any components with a CERCLA RQ.

**SARA 304 Extremely Hazardous Substances Reportable Quantity**

This material does not contain any components with a section 304 EHS RQ.

**SARA 302 Extremely Hazardous Substances Threshold Planning Quantity**

This material does not contain any components with a section 302 EHS TPQ.

**SARA 311/312 Hazards** : Gases under pressure
Simple Asphyxiant

**SARA 313** : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**US State Regulations**

**Pennsylvania Right To Know**

| | |
|---|---|
| 1,1,1,2-Tetrafluoroethane | 811-97-2 |

**California Prop. 65**

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

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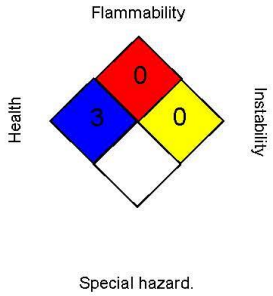
## SECTION 16. OTHER INFORMATION

### Further information

**NFPA:**




**HMIS® IV:**


HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. The "*" represents a chronic hazard, while the "/" represents the absence of a chronic hazard.


Before use read Chemours safety information.
For further information contact the local Chemours office or nominated distributors.
All chemical substances in this material are included on or exempted from listing on the TSCA Inventory of Chemical Substances.

### Full text of other abbreviations

| | | |
|---|---|---|
| US WEEL | : | USA. Workplace Environmental Exposure Levels (WEEL) |
| US WEEL / TWA | : | 8-hr TWA |

AICS - Australian Inventory of Chemical Substances; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Hazardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse)

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Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

Sources of key data used to compile the Material Safety Data Sheet : Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, http://echa.europa.eu/

Revision Date : 02/06/2018

Items where changes have been made to the previous version are highlighted in the body of this document by two vertical lines.

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and shall not be considered a warranty or quality specification of any type. The information provided relates only to the specific material identified at the top of this SDS and may not be valid when the SDS material is used in combination with any other materials or in any process, unless specified in the text. Material users should review the information and recommendations in the specific context of their intended manner of handling, use, processing and storage, including an assessment of the appropriateness of the SDS material in the user's end product, if applicable.

US / Z8

# Appendix B –Dispersion Modeling of Hydrazine H4N2 Using Areal Locations of Hazardous (ALOHA)

## Introduction

The proposed action involves the use of hydrazine (H4N2). Hydrazine is a colorless flammable liquid with an ammonia-like odor. The purpose of this dispersion modeling analysis is to provide predictive estimates of the potential impact of various individual release scenarios of the hydrazine.

ALOHA is an atmospheric dispersion model available from the U.S. Environmental Protection Agency used to evaluate releases of hazardous chemical vapors and therefore was selected to model the hydrazine release scenarios. ALOHA generates estimates of the downwind dispersion of a chemical cloud based on the toxicological/physical characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release. With the use of the ALOHA air dispersion model, it shows that a release of hydrazine will disperse out from a source in a predictive manner.

## Model Scenarios

Three cases were evaluated and modeled. These are based on the release of the worst-case propellant left in the Starliner spacecraft after an ISS mission, under three different weather conditions for each. These three cases provided results that enveloped all possible combinations of weather conditions. These are referred to as Test Case 1- 3 and are detailed below. In all cases, the model shows the leaking hydrazine could cause a flammability hazard within approximately 150 yards downwind of the spacecraft; however, the concentrations are not high enough to allow for a detonation.

.

**Hydrazine Release Scenarios**

**Nominal Propellant:** Represents the nominal end of mission case based on the propellant loading for the two test missions and a typical mission to the ISS. In this scenario, the Starliner spacecraft would land with no more than 90 pounds of hydrazine remaining in its propellant tanks. This scenario assumes a leak in the propellant system that is not isolatable, causing a leak of the entire 90 pounds.

**Test Case 1 -** Daytime Landing, Low Cloud Cover and Wind speed

**Note:** the majority of Starliner landings are planned for these conditions.

**Test Case 2 -** Nighttime Landing, Low Cloud Cover and Wind speed

**Test Case 3 -** Anytime Landing, High Cloud Cover and Wind speed

## Model Results

The ALOHA model output shows a toxic threat zone is an overhead view of the area where the ground-level pollutant concentration is predicted to exceed the Level of Concern (LOC) at some time after a release begins. That is, for any point within the threat zone, ALOHA predicts that the LOC will be exceeded at some time after the release begins—typically, this happens shortly after the cloud of pollutant gas reaches that point. Not all points within the threat zone will exceed the LOC for the same length of time. ALOHA displays the corresponding threat zones in red, orange, and yellow, and overlays them on a single threat zone picture as shown in Figures C-1 though C-3. By default, the red zone represents the worst hazard. (NOAA 2013)

AEGL

The Acute Exposure Guideline Level (AEGL) is a guideline intended to describe the risk to humans resulting from once-in-a-lifetime, or rare, exposure to airborne chemicals. Acute exposures are defined as single, non-repetitive exposures for not more than 8 hours. The development of the AEGLs is a collaborative effort of the public and private sectors worldwide. The National Advisory Committee for the Development of Acute Exposure Guideline Levels for Hazardous Substances (AEGL Committee) is involved in developing these guidelines to help both national and local authorities, as well as private companies, deal with emergencies involving spills, or other catastrophic exposures.

There three AEGL values are:

AEGL-1: Discomfort, non-disabling.

AEGL-2: Irreversible or other serious, long-lasting effects or impaired ability to escape.

AEGL-3: Life-threatening effects or death

(EPA 2013)(CDC NIOSH 2013)

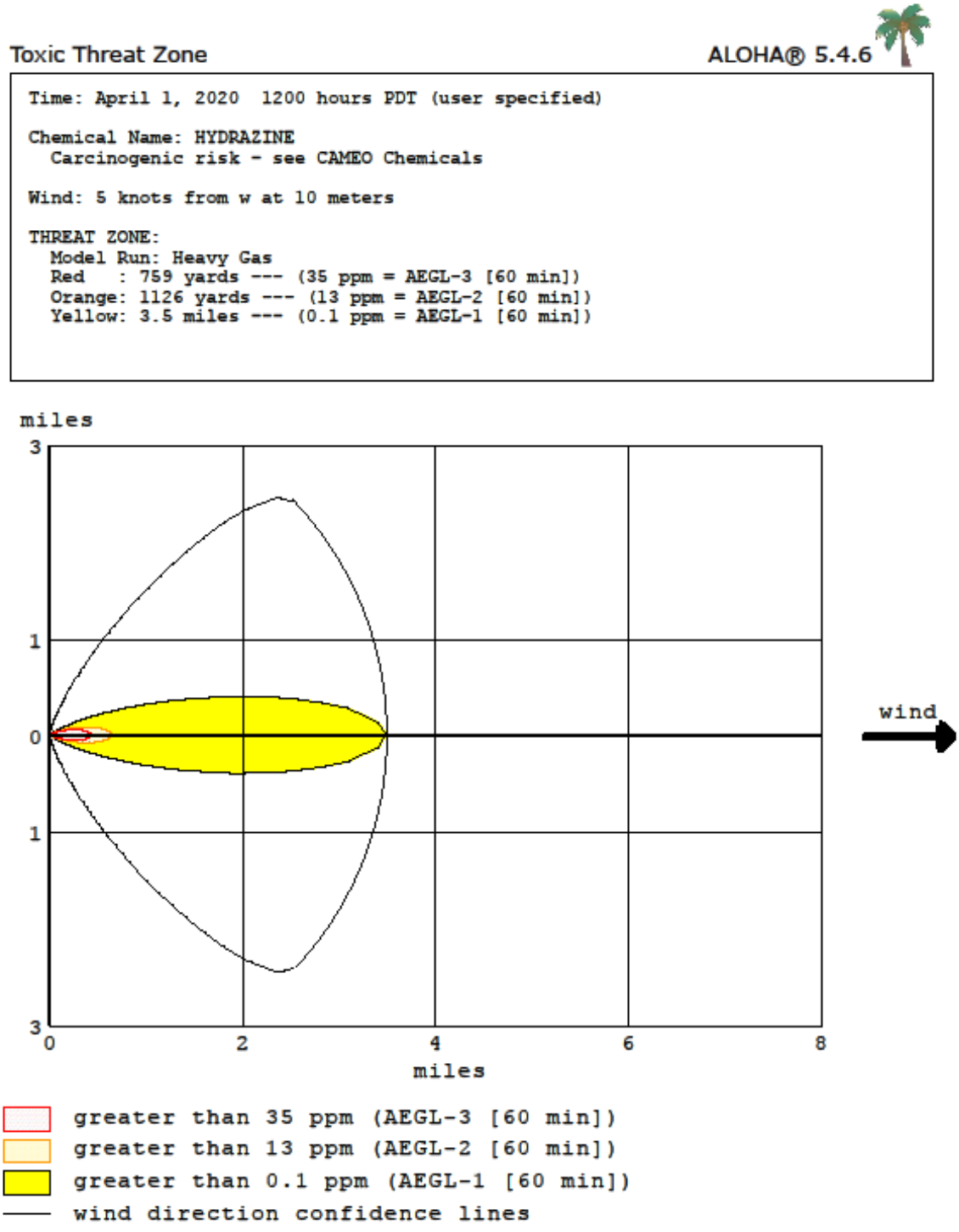



**Figure C- 1: EAFB Test Case 1 - Daytime Landing, Low Cloud Cover and Wind Speed**

Toxic Threat Zone ALOHA® 5.4.6

```
Time: April 1, 2020  0000 hours PDT (user specified)

Chemical Name: HYDRAZINE
  Carcinogenic risk - see CAMEO Chemicals

Wind: 5 knots from w at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 1366 yards --- (35 ppm = AEGL-3 [60 min])
  Orange: 1.1 miles --- (13 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (0.1 ppm = AEGL-1 [60 min])
```

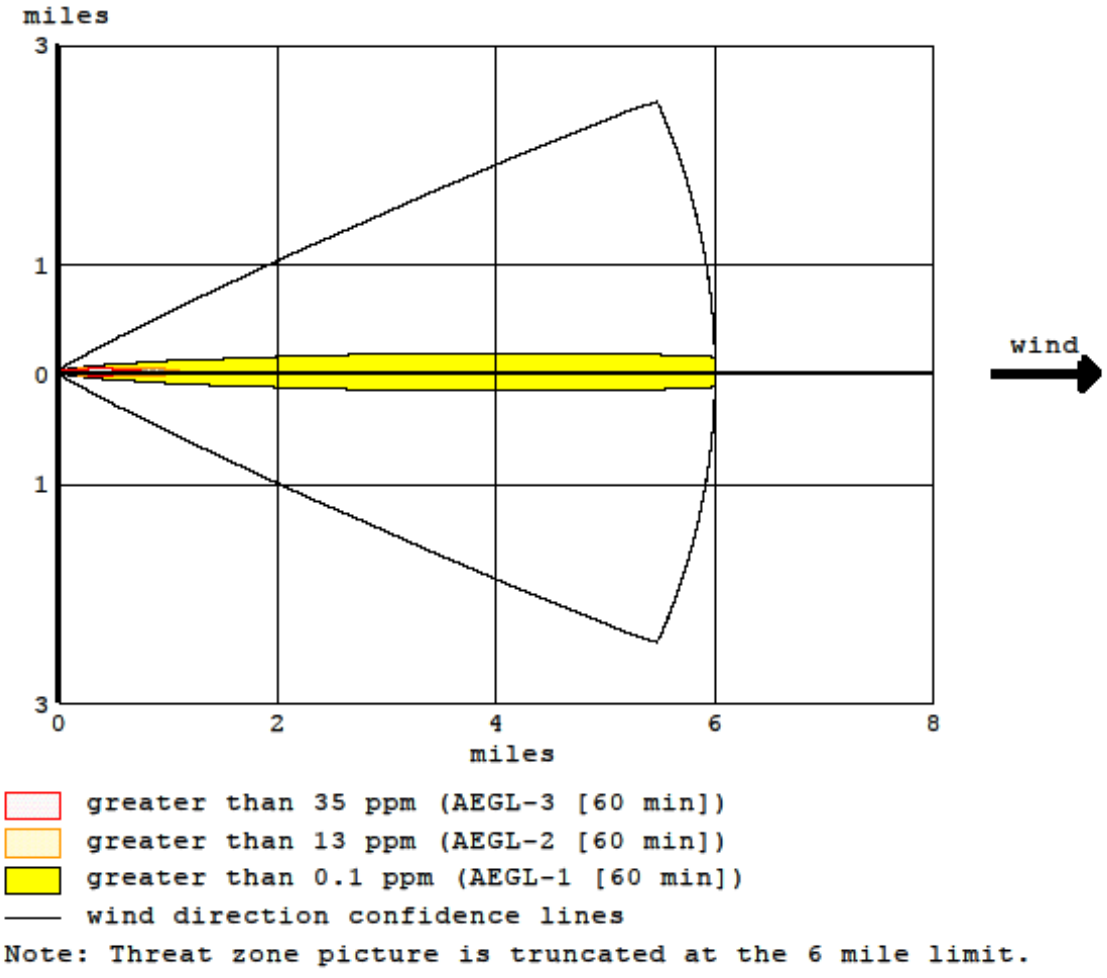



**Figure C- 2: EAFB Test Case 2 - Nighttime Landing, Low Cloud Cover and Wind Speed**

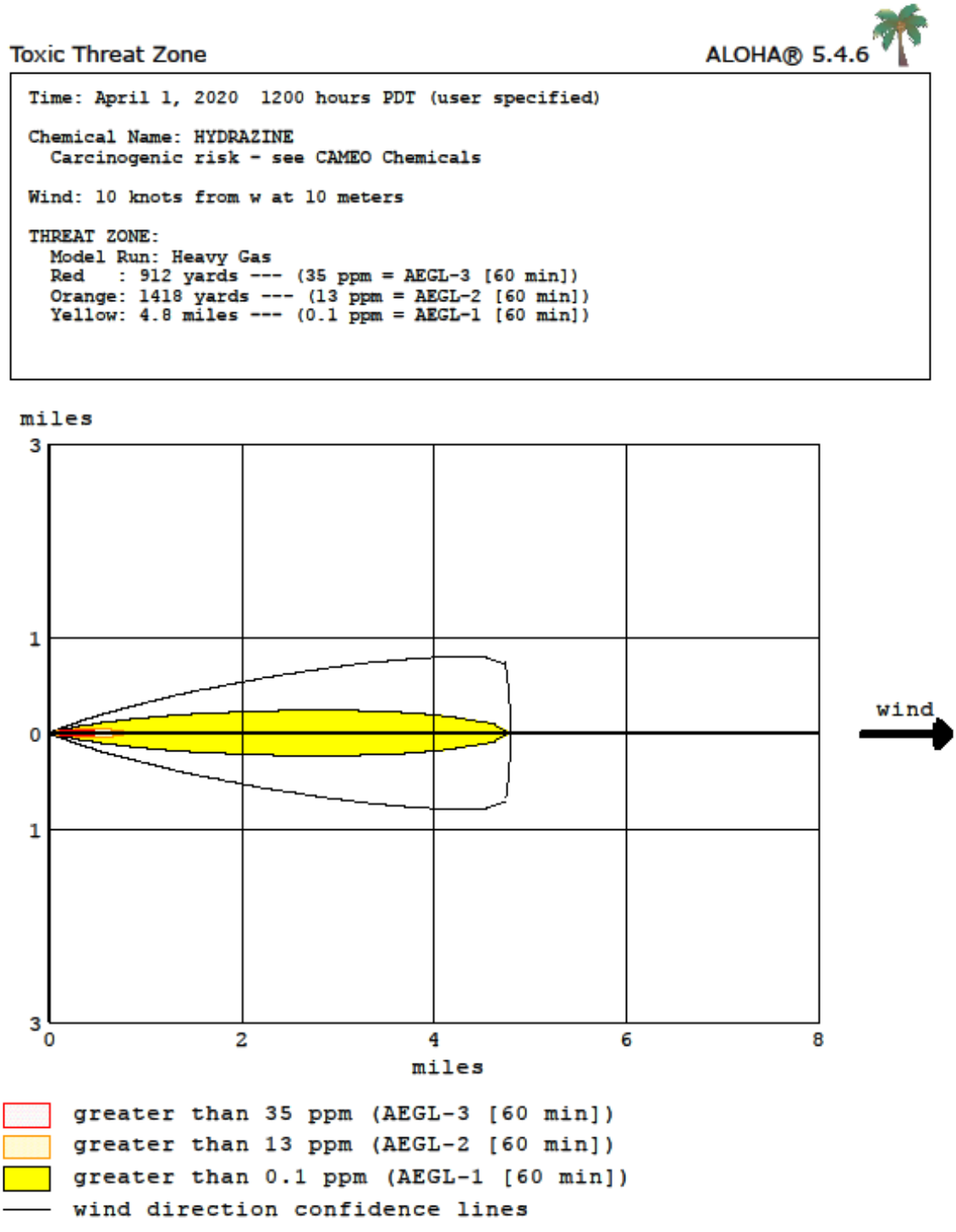



**Figure C- 3: EAFB Test Case 3 - Anytime Landing, High Cloud Cover and Wind Speed**

# Appendix C – Sonic Boom Modeling Using PCBoom

The sonic boom footprint was computed for the Starliner spacecraft using NASA-provided PCBoom6 software. The model was run utilizing an approximation of a blunt spacecraft and with the Boeing-provided trajectory information for each approach. The sonic boom is generated while the Starliner is traveling at supersonic speed during it's decent to the landing site.

The Starliner could approach the landing site from two directions, one approach from the southwest (entry from a descending node of the Starliner orbit) and one from the northwest (entry from an ascending node of the Starliner orbit). The trajectory selected for a particular landing will be based on several factors, including selecting a de-orbit that allows for one or more backup opportunities, time of day, and weather.

Figure D-1 shows the descending node trajectory to EAFB. Figure D-2 shows the sonic boom footprint for this trajectory.

Figure D-3 shows the ascending node trajectory to EAFB. Figure D-4 shows the sonic boom footprint for this trajectory.

The Mach 1 transition takes place at approximately 60,000 feet altitude above sea level. This transition takes place over EAFB for both trajectories.

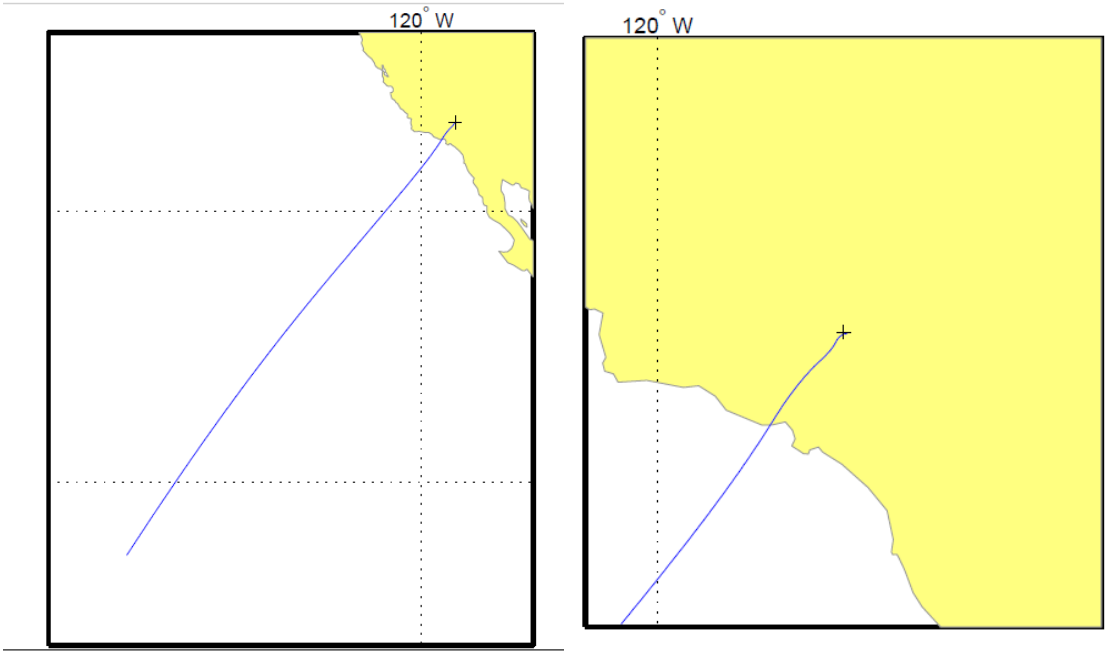



**Figure D- 1: EAFB Descending Node Trajectory**

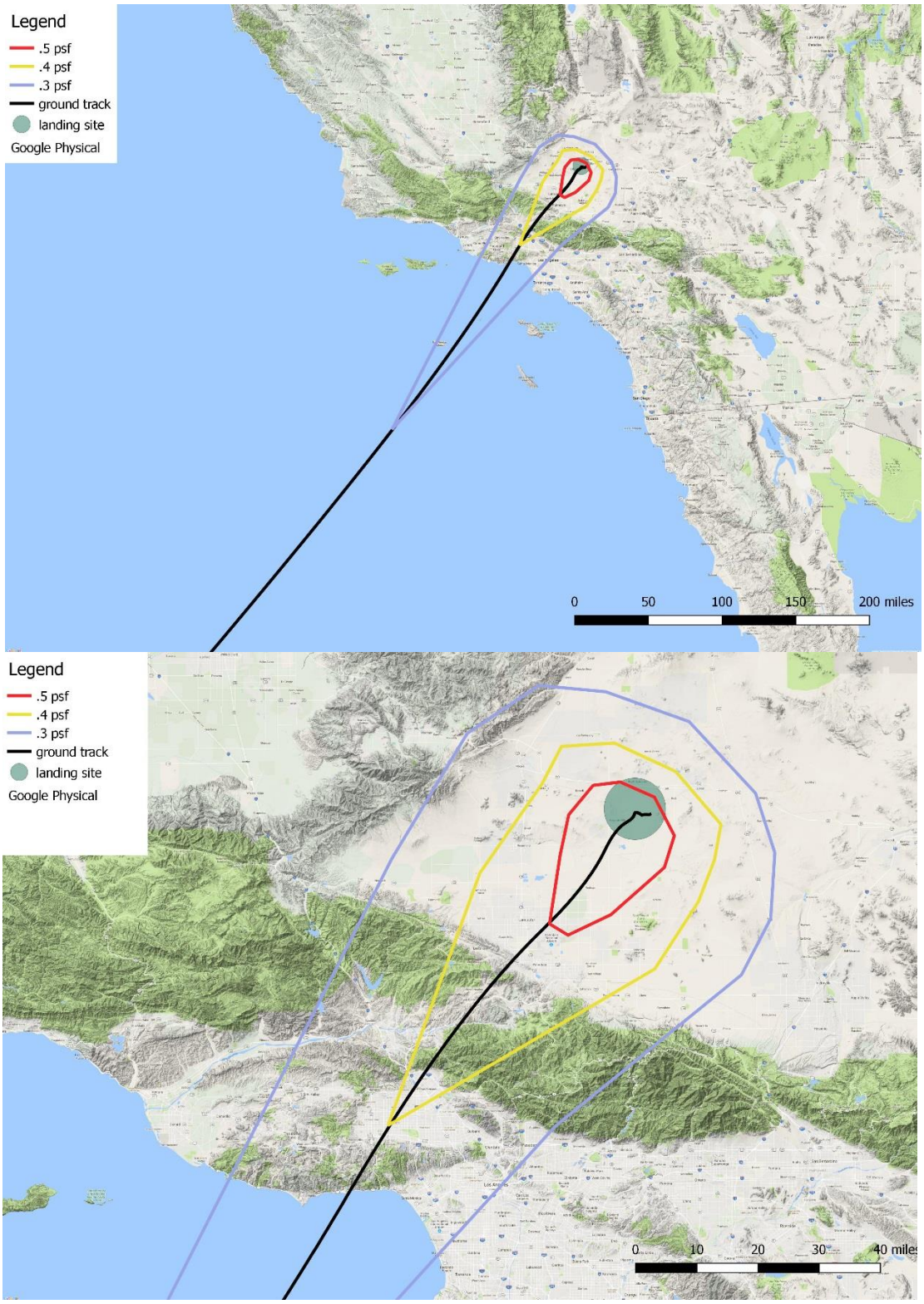



**Figure D- 2: EAFB Descending Node Trajectory Sonic Boom Footprint**

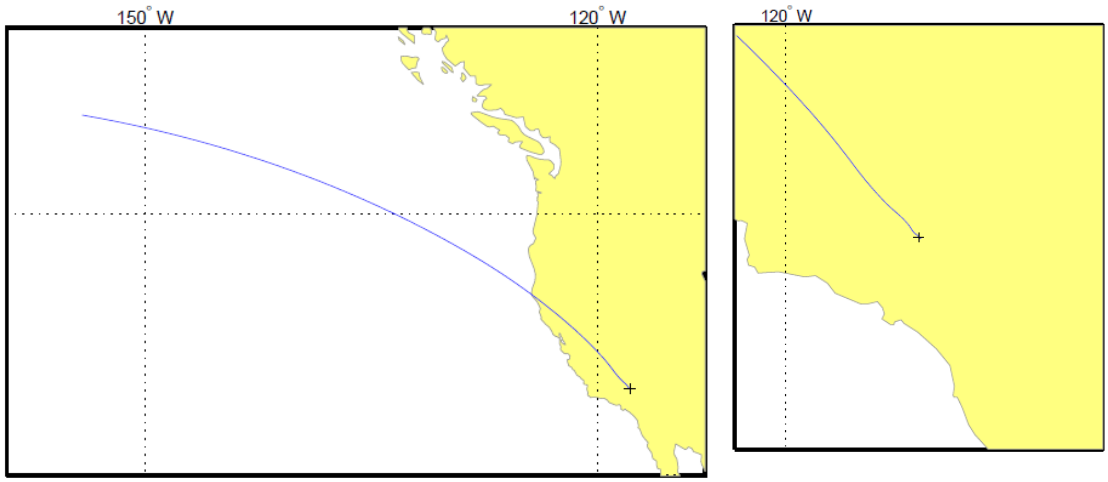



**Figure D- 3: EAFB Ascending Node Trajectory**

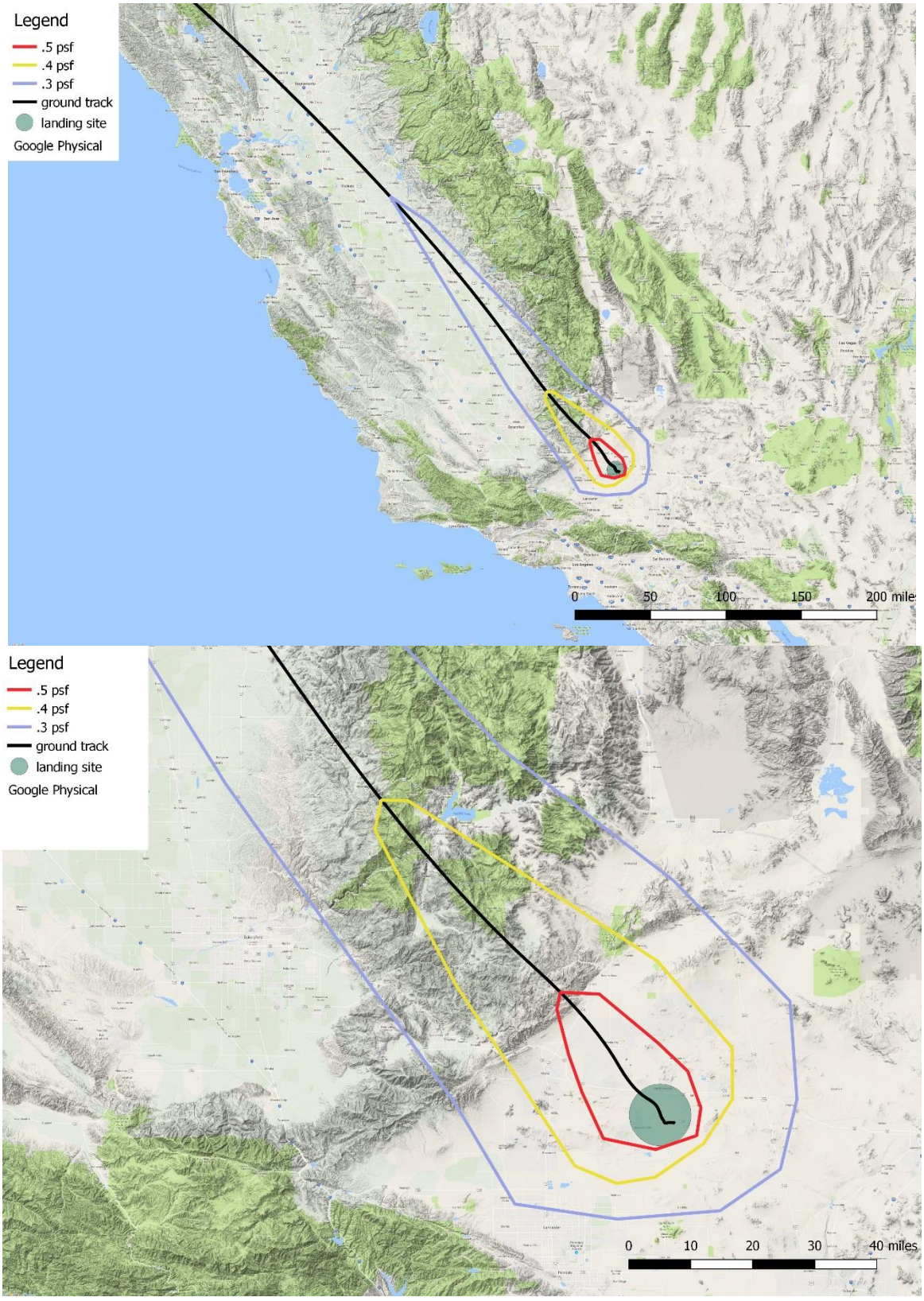



**Figure D- 4: EAFB Ascending Node Trajectory Sonic Boom Footprint**

Booms in the 0.2 to 0.3 psf range could be heard by someone who is expecting and listening for it, but usually would not be noticed. Booms of 0.5 psf are more likely to be noticed, and booms of 1.0 psf are certain to be noticed. Some residents may be concerned about property damage, mostly to fragile items like glass. The probability of a 1 psf boom breaking a typical residential window is somewhat less than one in a million.(Hershey, 1974)

# Appendix D - Biological Opinion for Operations and Activities at Edwards Air Force Base, California

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003

IN REPLY REFER TO:
08EVEN00-2014-F-0123

March 11, 2014

412 CE/CL
James E. Judkins
Base Civil Engineer
225 North Rosamond Boulevard
Edwards Air Force Base, California 93524

Subject: Biological Opinion for Operations and Activities at Edwards Air Force Base, California (8-8-14-F-14)

Dear Mr. Judkins:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion regarding the effects on the federally threatened desert tortoise (*Gopherus agassizii*) and its critical habitat, in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.), of all identified existing and future similar actions that are likely to occur on Edwards Air Force Base. This document also describes the criteria by which the U.S. Air Force will determine whether its actions are likely to adversely affect the desert tortoise or its critical habitat and our concurrence with actions that are undertaken within the framework of these criteria. We received your request for formal consultation on February 22, 2008.

This biological opinion is based on information which accompanied your request for consultation, conversations and correspondence with Edwards Air Force Base staff, and information contained in our files. A complete record of this consultation can be made available at the Ventura Fish and Wildlife Office.

**Consultation History**

Since 1990, the Air Force and Service have consulted formally on the effects of Air Force actions on the desert tortoise and its critical habitat 49 times; we have consulted informally on other actions. To date, we have completed consultations on a wide range of activities and uses, including recreational activities, construction and maintenance of infrastructure, remediation of contaminated sites, black box projects, and disposal of unstable rocket fuel. Prior to the initiation of formal consultation, staff from the Air Force and Service discussed the basic concepts of this base-wide consultation informally on several occasions.

On January 30, 2014, the Service (2014) provided the Air Force with a draft biological opinion. The Air Force (2014b) provided comments on the draft biological opinion on March 4, 2014; we have incorporated the Air Force's comments into this biological opinion, as appropriate.

ADMINISTRATION OF THE CONSULTATION

Future actions that may affect the desert tortoise or its critical habitat at Edwards Air Force Base will be evaluated in the following manner. The Environmental Management Office at Edwards Air Force Base will review all discretionary actions that the Air Force proposes on Edwards Air Force Base. Based on the nature of the activity, its potential to adversely affect desert tortoises or their critical habitat, and any measures that can be implemented to avoid or minimize the effect, the Air Force will determine whether the action will not affect, is not likely to adversely affect, or is likely to adversely affect the desert tortoise or its critical habitat.

The Air Force will maintain a record of all its activities that undergo this evaluation. For actions that do not affect or are not likely to adversely affect the desert tortoise or its critical habitat, the Air Force will include in its record:

1. The title of the action;
2. A description of the proposed action;
3. Location;
4. Size; and
5. The rationale that it used to reach its determination regarding effects to the desert tortoise or its critical habitat.

For actions that are likely to adversely affect the desert tortoise or its critical habitat, the Air Force will include in its record:

1. The title of the action;
2. A description of the proposed action;
3. Location;
4. Size;
5. The number of desert tortoises that are killed, injured, and moved from harm's way;
6. The amount of habitat disturbed or lost, with a notation as to whether the affected area was designated critical habitat;
7. A listed of authorized biologists who worked on actions covered by this consultation in the reporting year; and
8. A brief but comprehensive discussion of whether the protective measures were effective. If the measures were not effective, the Air Force will explain why the measures did not function as expected and recommendations for implementing more effective measures.

In past consultations with the Air Force, the Service has authorized biologists to implement protective measures and handle desert tortoises on a project-by-project basis. Upon completion of this consultation, the Air Force will not request such authorization on a project-by-project basis. From this point, any person that is approved by the Service to undertake the duties of an authorized biologist for actions proposed by the Air Force that are covered by this biological

opinion may also perform those duties on future actions. If the Air Force determines that an authorized biologist is not performing his or her duties in a satisfactory manner, the Air Force will notify the Service at the earliest possible time it makes this determination.

The Service and Air Force agree that some actions may be proposed in the future that may result in effects beyond the scope of those considered in this biological opinion. In the case of such actions, the Air Force and Service will discuss whether this biological opinion sufficiently considered effects to the desert tortoise and its critical habitat in light of the proposed action and whether re-initiation of formal consultation or initiation of a separate consultation is appropriate.

If staff from the Service and Air Force cannot agree on a course of action after discussions on this or other issues, any disagreement will be elevated to the Ventura Fish and Wildlife Office's Assistant Field Supervisor and the Air Force Civil Engineer Director and/or Environmental Management Division Chief for resolution. If further elevation is required, the Field Supervisor of the Ventura Fish and Wildlife Office and the Installation Commander of Edwards Air Force Base will be contacted to resolve the issue. Although the elevation of issues is likely to be an infrequent occurrence, the Air Force and Service consider this procedure to be a useful tool to maintain efficient processes and a healthy working relationship between our agencies.

The Air Force will provide the Service with an annual report of the activities that it conducts under the auspices of this consultation. The annual report will include the information that the Air Force will maintain in its records for any activity it determined was likely to adversely affect the desert tortoise or its critical habitat, as described in this section. The annual report will be provided to the Service by January 31 of each year this biological opinion is in effect.

The annual report will also contain information on conservation activities that the Air Force undertook in the previous year. Such activities may include, but are not limited to, acquisition of land through the Readiness and Environmental Preparedness Initiative, results of research on desert tortoises conducted or funded by the Air Force, and the results of relevant research conducted under the Air Force's Small Business Initiative.

The Ventura Fish and Wildlife Office's Assistant Field Supervisor, the Air Force Civil Engineer Director and/or Environmental Management Division Chief, and appropriate staff will meet annually to review how this consultation is functioning and to discuss any potentially important events in the upcoming year. This meeting could be held in conjunction with the quarterly meeting of the Desert Managers Group that occurs nearest the time the annual report is due. If the Service and Air Force agree that such a meeting is unnecessary in any given year, the meeting may be cancelled.

**Criteria for Use in Reaching Appropriate Determinations**

The Air Force will use the following outline to determine the appropriate level of consultation required for each proposed action.

1) Projects in which any effects would occur outside of desert tortoise habitat would have no effect on the species; the Air Force will document its determinations in these situations for its own records but would not need to contact the Ventura Fish and Wildlife Office. If the Air Force requires technical assistance from the Service to determine if suitable habitat for desert tortoises would be affected, it should contact us by phone or electronic mail.

2) If the following criteria are met, a determination of not likely to adversely affect the desert tortoise would be appropriate:

   a) The project is within habitat of the desert tortoise;

   b) Desert tortoise habitat is present, but degraded or disturbed, in the project area. For the purposes of this consultation, the Air Force and Service consider degraded habitat to be that habitat which has been affected by previous activities. Degraded habitat will generally exhibit a lower diversity and density of native shrubs and disrupted substrates than undisturbed habitat. The Air Force and Service may consider certain washes to be disturbed habitat; the fundamental guidance in such areas is that the evidence of the maintenance activity would no longer be visible after an event where water flows in the wash. The loss or disturbance of a minor amount of undisturbed habitat may also be considered as being not likely to adversely affect the species, when considered with regard to its distribution in the action area; and

   c) Neither desert tortoises nor their diagnostic sign are observed during surveys or a habitat assessment.

      In cases where a determination is not entirely clear from a verbal description, the Air Force will provide the Service with a photograph (aerial or otherwise, as appropriate) of the project site to assist in its determination.

3) If the following criteria are met, a determination of not likely to adversely affect critical habitat for the desert tortoise would be appropriate:

   a) The project is within designated critical habitat, but the primary constituent elements of desert tortoise critical habitat are not present;

   b) The primary constituent elements would not be affected by the proposed project; or

   c) Effects to the primary constituent elements would be so minor that they are not substantially measurable when considered within the context of the critical habitat unit. Such effects may occur, for example, when a narrow strip of land supporting the primary constituent elements of critical habitat at the edge of an existing road may be affected by an action.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Air Force requested consultation on a variety of mission support actions, including recurring and predicted new projects and future unknown projects. For this biological opinion, we worked with the Air Force to assess the threats to desert tortoises and their critical habitat associated with each type of proposed activity. Future actions under the control of the Air Force are expected to cause impacts that are similar to those discussed in the biological evaluation. The following table lists the Air Force's activities and notes the general manner by which the activity would affect the desert tortoise and its critical habitat (e.g., ground disturbance, use of roads, etc.). We will then consider more specifically the nature of these effects on the desert tortoise and its critical habitat and the measures that the Air Force has proposed to avoid, reduce, or minimize these effects. The biological evaluation contains a more detailed description of its proposed activities (Air Force 2008a).

Table 1 - Threats and Associated Activities of Proposed Actioin

| | | Driving off-road | Driving on road | Ground Disturbance | Explosions (potential for fire) | Non-native Plants | Common Ravens | Moving desert tortoise from harm | Personnel on Foot | Habitat Conversion |
|---|---|---|---|---|---|---|---|---|---|---|
| Range Flight Operations | Desert tortoise | N | Y | Y | Y | N | N | N | N | N |
| | Critical Habitat | N | Y | Y | Y | N | N | N | N | N |
| Airfield Flight Operations | Desert tortoise | N | N | N | N | N | N | N | N | N |
| | Critical Habitat | N/A | | | | | | | | |
| Range Ground Operations | Desert tortoise | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Critical Habitat | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Directed Energy Operations | Desert tortoise | N | Y | N | Y | N | N | N | Y | N |
| | Critical Habitat | N | Y | N | Y | N | N | N | Y | N |
| Ordnance Expenditures | Desert tortoise | Y | Y | Y | y | N | N | Y | Y | N |
| | Critical Habitat | Y | Y | Y | Y | N | N | Y | Y | N |
| Energetic Material Expenditures | Desert tortoise | N | Y | N | y | N | N | Y | Y | N |
| | Critical Habitat | N | Y | N | Y | N | N | Y | Y | N |
| Native American Uses | Desert tortoise | N | Y | N | N | N | N | N | N | N |
| | Critical Habitat | N | Y | N | N | N | N | N | N | N |
| Research and Education | Desert tortoise | N | Y | N | N | N | N | Y | Y | N |
| | Critical Habitat | N | Y | N | N | N | N | Y | Y | N |
| Recreation | Desert tortoise | Y | Y | N | N | N | N | Y | Y | N |
| | Critical Habitat | N/A | | | | | | | | |
| Feral Grazing Management | Desert tortoise | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Critical Habitat | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Monitoring | Desert tortoise | Y | N | Y | N | N | Y | Y | Y | Y |
| | Critical Habitat | Y | N | Y | N | N | Y | Y | Y | Y |
| Inventories/Surveys | Desert tortoise | Y | N | Y | N | Y | Y | N | Y | N |
| | Critical Habitat | Y | N | Y | N | Y | Y | N | Y | N |
| Utility Maintenance | Desert tortoise | Y | Y | Y | Y | N | N | Y | Y | N |
| | Critical Habitat | Y | Y | Y | Y | N | N | Y | Y | Y |
| Fire Management | Desert tortoise | Y | Y | Y | N | N | N | Y | Y | N |
| | Critical Habitat | Y | Y | Y | N | N | N | Y | Y | Y |
| Future Development | Desert tortoise | Y | Y | Y | N | Y | Y | Y | Y | Y |
| | Critical Habitat | Y | Y | Y | Y | Y | Y | Y | Y | Y |

Y = Associated activity may affect the desert tortoise or its critical habitat in this manner. (Activities would affect critical habitat and habitat not designated as critical in the same basic manner; however, we do not consider effects to non-critical habitat in assessing whether a proposed action is likely to destroy or adversely modify critical habitat.)

N = Associated activity does not affect the desert tortoise or its critical habitat.

N/A = Associated activity does not occur in area of concern (desert tortoise habitat or critical habitat).

The Air Force anticipates that it may need 20,000 acres for future development of solar facilities, infrastructure, and mission activities and operations. The Air Force estimates that up to 5,000 acres of new disturbance may occur within critical habitat and 15,000 acres may occur outside of critical habitat. The Air Force would manage desert tortoises during the course of future development by following its integrated natural resources management plan.

The construction and operation of the Oro Verde Solar Project would occur within the boundaries of Edwards Air Force Base; this solar plant would require an interconnecting power line (gen-tie line) to the Windhub Substation, which lies to the northwest of base. For this reason, the Air Force requested that the Service also consider the effects of the construction and operation of the gen-tie line on the desert tortoise in this biological opinion. (The gen-tie line would not affect critical habitat; the nearest critical habitat for the desert tortoise is approximately 20 miles to the east of the easternmost portion of the gen-tie line.) The method used to construct the gen-tie line would occur in a manner similar to how the Air Force (or service companies operating within the base) would maintain utilities, although the impacts of construction would be more intense than would occur during maintenance.

To ensure that its activities do not result in numerous injuries to or mortalities of desert tortoises, the Air Force has proposed a set of thresholds that, if reached, will prompt additional action on its part to protect desert tortoises (Reinke 2009, Mull 2013a). If a desert tortoise is injured or killed in a calendar year, the Air Force will retrain those individuals that were responsible for implementing the activity, determine how to avoid future injuries or mortalities, and implement appropriate measures to reduce the number of future injuries or mortalities. The Air Force will also determine the root cause of the activities that resulted in the injury or mortality, determine appropriate measures to reduce, to the maximum extent possible, future injury or mortality, and obtain the Service's concurrence on implementation of the measures. Finally, the Air Force has proposed to re-initiate formal consultation if five desert tortoises are killed or injured in a calendar year.

The Air Force has also proposed to re-initiate formal consultation if the amount of desert tortoise habitat disturbed by its activities reaches 15,000 acres in the portion of Edwards Air Force Base that is outside of the boundaries of critical habitat. For the portion of the base within the boundaries of critical habitat, the Air Force has proposed to re-initiate formal consultation if the amount of desert tortoise habitat disturbed by its activities reaches 5,000 acres. The Air Force has been restoring lands disturbed by its activities so that these areas can support their ecological functions; the Air Force has also proposed to evaluate the effectiveness of its restoration activities and to subtract the acreage of restored habitat from the acreage of disturbed habitat as it monitors the activities it conducts under the auspices of this consultation. For example, if, in any given year, the Air Force disturbs 10 acres during its activities and restores 3 acres, the cumulative loss of habitat for the year would be 7 acres. For the purposes of tracking whether re-initiation is required, the Air Force will track the amount of habitat disturbed and restored upon completion of this biological opinion. Previously disturbed areas are not considered to be desert tortoise habitat for the purpose of tracking habitat loss; for example, any disturbance within the bed of an unpaved road would not be considered disturbance of desert tortoise habitat

because the biological and physical attributes of habitat are generally absent from such disturbed areas.

Adaptive Management Strategy

The Air Force has proposed three primary goals for its adaptive management strategy: 1) ensure that mission-related activities are conducted in compliance with Federal and State natural resource and other environmental legislation; 2) assess and monitor populations of listed, proposed, and sensitive species and general habitat conditions over time; and 3) ensure the long-term viability of desert tortoise populations within the Fremont-Kramer Desert Wildlife Management Area, while fully supporting the military mission at Edwards Air Force Base (Air Force 2008a). These goals apply to the annual and 5-year revisions of Edwards Air Force Base's integrated natural resources management plans.

Protective Measures

The Air Force has implemented a set of standardized minimization measures derived from numerous biological opinions to protect desert tortoises and conserve their habitat. These measures are applied selectively through the National Environmental Policy Act process via the Air Force Environmental Impact Analysis Process for each ground-disturbing action. The Air Force will continue implementing these minimization measures in the future as new types of projects occur in new areas that are expected to have similar impacts from mission activities.

a. Desert tortoises will be handled in full accordance with all applicable provisions and regulations of the Endangered Species Act. The phrases "authorized biologist" and "desert tortoise monitor", as used in this section are taken from the most up-to-date Service guidance (Service 2010a) and defined as follows:

    1. Authorized biologists must have thorough and current knowledge of desert tortoise behavior, natural history, ecology, and physiology, and demonstrate substantial field experience and training to safely and successfully conduct their required duties. Authorized biologists are approved to monitor project activities within desert tortoise habitat and are responsible for locating desert tortoises and their sign (i.e., conduct clearance surveys). Authorized biologists must ensure proper implementation of protective measures, and make certain that the effects of the project on the desert tortoise and its habitat are minimized in accordance with a biological opinion or incidental take permit. All incidents of noncompliance in accordance with the biological opinion or permit must be recorded and reported.

    2. Desert tortoise monitors will be approved by the authorized biologist to monitor project activities within desert tortoise habitat, ensure proper implementation of protective measures, and record and report desert tortoise and sign observations in accordance with approved protocol. They will report incidents of noncompliance in accordance with a biological opinion or permit, move desert tortoises from harm's way when desert tortoises enter project sites and place these animals in "safe areas"

pre-selected by authorized biologists or maintain the desert tortoises in their immediate possession until an authorized biologist assumes care of the animal. Desert tortoise monitors assist authorized biologists during surveys and serve as "apprentices" to acquire experience. Monitors should not conduct clearance surveys or other specialized duties of the authorized biologist unless directly supervised by an authorized biologist; "directly supervised" means the authorized biologist has direct voice and sight contact with the monitor. The desert tortoise monitor may directly supervise other personnel to assist with surveying for desert tortoises when deemed necessary.

3. None of the proposed measures will prohibit any individual from handling a desert tortoise when necessary to protect the safety or health of the animal.

b. Authorized biologists are the only individuals approved to handle desert tortoises on base. The Service's standardized form will be used for individuals to work on specific projects to verify the capabilities and experience of the potential desert tortoise biologist.

c. All base personnel (including contractors, civilian, and military employees) will be provided, at a minimum, a description of the desert tortoise, its status, and measures to minimize impacts. The material may also include the use of a multimedia presentation (videotape and printed material).

d. To the maximum extent practicable, activities will be sited to avoid effects to desert tortoises and their habitat.

e. Personnel will immediately report sightings of desert tortoises or sign found in the project area to the authorized biologist, desert tortoise monitor, or the Environmental Management Office.

f. Pre-activity surveys will be conducted, where deemed necessary, in project areas prior to ground-disturbing activities.

g. The project work areas will be fenced, flagged, or marked to define the limit of project activities.

h. Vehicles will generally remain on previously established roads and within staging areas and follow flagged off road routes that have been surveyed or cleared of desert tortoises. When driving off road, operators will minimize disturbance to vegetation and not exceed 10 miles per hour. All personnel will inspect under vehicles for desert tortoises prior to operating them in desert tortoise habitat.

i. Open excavations will be checked three times a day and authorized personnel will remove any trapped animals. Open excavations will be covered, backfilled, or fenced at the end of each workday. At the ends of a ditch or trench, a 3:1 slope will be created to allow wildlife to exit should they become trapped in the ditch or trench. All open excavations that are left unattended will be fenced, unless other methods of excluding desert tortoises are employed.

j. Any pipes left or stored on the ground in the project area will be capped on the ends to prevent entry by desert tortoises or other wildlife.

k. Parking and staging areas will be restricted to previously disturbed areas as much as possible.

l. Acres of disturbance will be tracked to provide a basis for possible future re-vegetation and restoration efforts.

m. All trash and food items will be disposed of in common raven-proof containers, and regularly removed from project sites to reduce attraction of common ravens.

n. Project activities between dusk and dawn will be confined to areas free of vegetation and cleared of desert tortoises by authorized personnel.

o. An annual report will be submitted to the Service summarizing any injury, mortality, or handling of desert tortoises, disturbance of critical habitat, and habitat restoration.

Other Measures Implemented for Specific Activities

The following minimization measures are being implemented to aid overall management of the desert tortoise on base.

*Motorized Recreation Areas*

a. Signs will be maintained along the designated off-road vehicle area boundaries.

b. Bulletin boards displaying up-to-date rules and safety information will be placed at the main access areas at each off-road vehicle area.

c. Law Enforcement personnel will patrol the areas to ensure that riders remain within the boundaries and use existing trails.

d. All operators of motor vehicles will take desert tortoise awareness training and carry proof of training when riding.

e. Environmental Management will monitor and record habitat disturbance. Solutions to problems that may develop will be suggested by the off-road vehicle area subcommittee and implemented by the Air Force.

*Non-motorized Recreation Areas*

a. Signs, notices, and other media will be used to inform personnel that use of off-road vehicle area 3 requires desert tortoise awareness training.

b. Desert tortoises crossing trails will not be moved; bikers and joggers will wait until the desert tortoise moves off the trail.

c. Activities will occur on established trails.

d. Pets not on leashes will not be allowed in the non-motorized recreation area.

*Road Construction and Maintenance*

a. All drainage recontouring will be limited to the greatest extent possible to reduce habitat fragmentation, where practicable.

b. Maintenance of drainage ditches will not be altered to change the direction of stormwater runoff from existing conditions to avoid potential flooding of desert tortoise burrows downslope of maintenance activities to the greatest extent possible.

c. Herbicide applicators will be instructed to watch for desert tortoises on road shoulders and to take precautions, as necessary, to ensure that no desert tortoises are sprayed.

d. Fugitive dust generated during construction will be controlled with water; the amount of water used will be restricted to the minimum amount required to maintain air quality standards.

e. Water tanks and trucks will be maintained in good working order and free of leaks so common ravens will not be attracted to standing water.

f. Installation of fencing along roadways will be implemented in areas deemed hazardous to desert tortoises to prevent injury or mortality.

*Utilities*

a. Aboveground gas lines will be placed at least 18 inches aboveground when they traverse desert tortoise habitat.

b. If, at any time after installation, the height of the gas pipes above the ground has been reduced to less than 18 inches, the pipelines will either be raised or the materials causing the reduction will be removed.

c. Lands above underground utilities will be re-vegetated unless a road needs to be constructed and maintained for access and maintenance activities.

d. Roads needed for utility maintenance will be concentrated in previously established corridors when possible.

e. Underground utilities will be located adjacent to or within previously disturbed areas when possible.

*Re-vegetation*

a. Habitat restoration required under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended under the Superfund Amendments and Reauthorization Act of 1986 for mission related ground disturbance would include using techniques to control soil erosion that have been proven successful in the desert environment and will also include use of native plants and seeds in an attempt to mimic natural biodiversity.

b. Priority for re-vegetation will be given to desert tortoise critical habitat.

c. Restoration activities will be conducted in accordance with the re-vegetation plans prepared by Edwards Air Force Base (Air Force 1994; Air Force 2012) and any new scientifically proven methodology.

d. Monitoring success of efforts will be implemented for a longer period than the standard 5-year monitoring period due to slow recovery rates of re-vegetated areas in the desert.

*Management of Common Ravens*

The Air Force will implement protective measures to reduce the adverse effects associated with predation of desert tortoises by common ravens. In general, the Air Force proposes to manage common ravens by controlling the use of landfills and sewage ponds, designing facilities to discourage common raven use, minimizing or eliminating food and water subsidies, providing training to on-site personnel, monitoring the presence of common ravens and their use of subsidies, and studying common raven predation on juvenile tortoises. The biological evaluation (Air Force 2008a) and integrated natural resource management plan (Air Force 2008b) contain more detailed information on these management actions.

*Relocation of Desert Tortoises*

In the event that future development or activities would result in the clearing of a large area of suitable desert tortoise habitat, the Air Force would relocate desert tortoises from these sites to other habitat. The Air Force will monitor all translocated desert tortoises to determine the success of the relocation.

*Monitoring of the Desert Tortoise Population*

Since 1988, Environmental Management has conducted numerous surveys for desert tortoises. The Air Force monitors desert tortoise populations using data collected by researchers and consultants who conduct studies or monitor projects on base. The Air Force uses these data to update database files and various Geographic Information System databases and spreadsheets to facilitate effective management of desert tortoises on base. It will thoroughly analyze and evaluate existing data and provide an up-to-date status of the current estimated distribution,

abundance, and trends of the on-base population of desert tortoises. Currently, the density of the tortoise population on base is unknown.

*Long-Term Monitoring of Ecological Trends*

The protection, restoration, and conservation of desert habitat are an ongoing management process at Edwards Air Force Base. One key component of this process is the ability to check progress against established benchmarks and use this information to develop effective management strategies that are expected to change over time. As part of the habitat quality analysis studies initiated at Edwards Air Force Base in 1992, the Air Force established 60 long-term monitoring plots to determine baseline conditions of habitat quality and to monitor long-term trends of habitat quality and species diversity. Periodic vegetation and wildlife surveys provide the benchmarks to evaluate environmental change. Each restored area is analyzed in comparison to 3 or 4 study sites with similar habitat characteristics (Reinke 2013). Information obtained from the long-term study plots and natural restoration are also used to determine habitat stability and support the regional desert tortoise recovery effort and the goals and objectives of Edwards Air Force Base's integrated natural resources management plan (Air Force 2008b).

The primary purpose of the integrated natural resources management plan for Edwards Air Force Base is "to implement natural resource management practices that strive to maintain or enhance habitat quality of the installation's natural resources resulting in stabilizing and/or increasing the biodiversity of the desert environment" (Air Force 2008b). The Air Force intends to achieve this purpose through the goals identified in the integrated natural resources management plan, which include but are not limited to monitoring of natural resources, collection of data, management of invasive species, conservation of habitat, and increasing the environmental awareness of all base personnel. The integrated natural resources management plan calls for the meeting of these goals "... in concert with other base organizations, and their programs and plans while ensuring no net loss to the capability of the military mission' (Air Force 2008b).

## ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

### Jeopardy Determination

Section 7(a)(2) of the Endangered Species Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 Code of Federal Regulations 402.02).

The jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which describes the range-wide condition of the desert tortoise, the factors responsible for that condition, and its survival and recovery needs; (2) the Environmental Baseline, which analyzes the condition of the desert tortoise in the action area, the factors responsible for that

condition, and the relationship of the action area to the survival and recovery of the desert tortoise; (3) the Effects of the Action, which determine the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the desert tortoise; and (4) the Cumulative Effects, which evaluate the effects of future, non-federal activities in the action area on the desert tortoise.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed federal action in the context of the current status of the desert tortoise, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the desert tortoise in the wild.

**Adverse Modification Determination**

Section 7(a)(2) of the Endangered Species Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of the critical habitat of listed species. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 Code of Federal Regulations 402.02. Instead, we have relied on the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the Status of Critical Habitat, which describes the range-wide condition of designated critical habitat for the desert tortoise in terms of primary constituent elements, the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the Environmental Baseline, which analyzes the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated and interdependent activities on the primary constituent elements and how that will influence the recovery role of the affected critical habitat units; and (4) Cumulative Effects, which evaluates the effects of future non-federal activities in the action area on the primary constituent elements and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on the critical habitat of the desert tortoise are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the primary constituent elements to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the desert tortoise.

STATUS OF THE DESERT TORTOISE AND CRITICAL HABITAT

**Status of the Desert Tortoise**

Section 4(c)(2) of the Act requires the Service to conduct a status review of each listed species at least once every five years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review); these reviews, at the time of their completion, provide the most up-to-date information on the range-wide status of the species. For this reason, we are appending the 5-year review of the status of the desert tortoise (Appendix 1; Service 2010b) to this biological opinion and are incorporating it by reference to provide most of the information needed for this section of the biological opinion. The following paragraphs provide a summary of the relevant information in the 5-year review.

In the 5-year review, the Service discusses the status of the desert tortoise as a single distinct population segment and provides information on the Federal Register notices that resulted in its listing and the designation of critical habitat. The Service also describes the desert tortoise's ecology, life history, spatial distribution, abundance, habitats, and the threats that led to its listing (i.e., the 5-factor analysis required by section 4(a)(1) of the Act). In the 5-year review, the Service concluded by recommending that the status of the desert tortoise as a threatened species be maintained.

With regard to the status of the desert tortoise as a distinct population segment, the Service concluded in the 5-year review that the recovery units recognized in the original and revised recovery plans (Service 1994a and 2011a, respectively) do not qualify as distinct population segments under the Service's distinct population segment policy (61 Federal Register 4722; February 7, 1996). We reached this conclusion because individuals of the listed taxon occupy habitat that is relatively continuously distributed, exhibit genetic differentiation that is consistent with isolation-by-distance in a continuous-distribution model of gene flow, and likely vary in behavioral and physiological characteristics across the area they occupy as a result of the transitional nature of, or environmental gradations between, the described subdivisions of the Mojave and Colorado deserts.

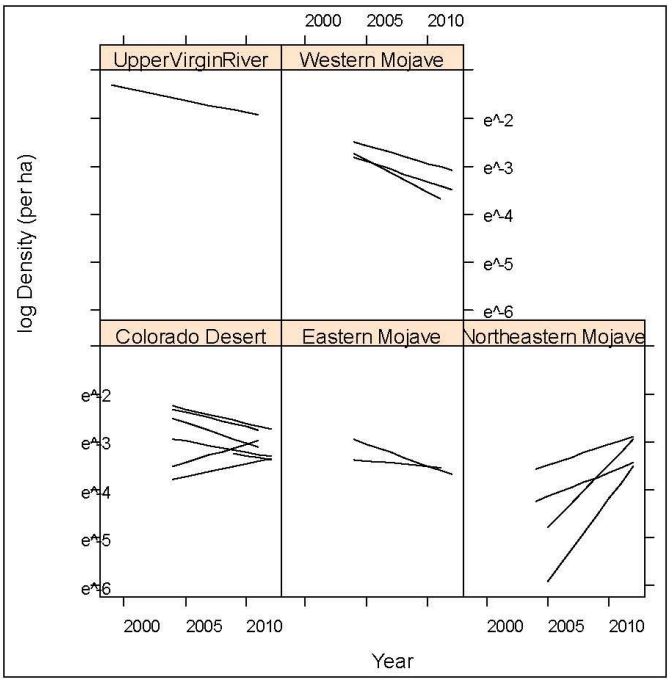
In the 5-year review, the Service summarizes information with regard to the desert tortoise's ecology and life history. Of key importance to assessing threats to the species and to developing and implementing a strategy for recovery is that desert tortoises are long lived, require up to 20 years to reach sexual maturity, and have low reproductive rates during a long period of reproductive potential. The number of eggs that a female desert tortoise can produce in a season is dependent on a variety of factors including environment, habitat, availability of forage and drinking water, and physiological condition. Predation seems to play an important role in clutch failure. Predation and environmental factors also affect the survival of hatchlings.

In the 5-year review, the Service also discusses various means by which researchers have attempted to determine the abundance of desert tortoises and the strengths and weaknesses of those methods. Due to differences in area covered and especially to the non-representative

nature of earlier sample sites, data gathered by the Service's current range-wide monitoring program cannot be reliably compared to information gathered through other means at this time.

The Service provides a summary table of the results of range-wide monitoring, initiated in 2001, in the 5-year review. This ongoing sampling effort is the first comprehensive attempt to determine the densities of desert tortoises across their range. Table 1 of the 5-year review provides a summary of data collected from 2001 through 2007; we summarize data from the 2008 through 2012 sampling efforts in subsequent reports (Service 2012a, 2012b, 2012c, 2012d).

The Service's Desert Tortoise Recovery Office (2014) used annual density estimates to compare a set of models that describe abundance patterns based on linear and quadratic response over time, spatial variation between desert tortoise conservation areas (e.g., national parks, desert wildlife management areas, the Desert Tortoise Natural Area, etc.) and recovery units, and survey team experience. The best model describing range-wide patterns in desert tortoise densities indicated different linear trends in different recovery units (see following figure); an effective training program precluded effects of surveyor experience or the lack thereof. In the original recovery plan for the desert tortoise, the Service (1994a) expected monitoring to detect increasing population trends of no more than 2 percent per year over a 25-year period. The Service has found much larger annual increases (greater than 19.7 percent) in the Northeastern Mojave Recovery Unit since 2004, with the rate of increase apparently resulting from increased survival of adults and subadults moving into the adult size class. The weight of evidence indicates that populations in the other 4 recovery units are declining: Upper Virgin River (-5.1 percent), Eastern Mojave (-5.8 percent), Western Mojave (-9.8 percent), and Colorado Desert (-2.4 percent; however, 2 desert tortoise conservation areas within this unit seem to be increasing).




Allison (2013) also evaluated changes in size distribution of desert tortoises since 2001. In the Western Mojave, Eastern Mojave, and Colorado Desert recovery units, the median size of large individuals has increased, indicating less recruitment of younger (therefore smaller) desert tortoises. In the Western Mojave and Colorado Desert recovery units, the relative number of smaller desert tortoises is about half what it was in 2001. Taken together, these trends suggest fewer small desert tortoises are reaching sexual maturity, which may be explained because they comprise a smaller proportion of the population or possibly because their survival rates are relatively lower than those of adults. Either possibility indicates that smaller size classes, like adults, are affected by ongoing threats; however, because most small desert tortoises die before reaching 180 millimeters in length, we do not know whether the reduced number of small animals has directly contributed to the observed declining trends in adults. For instance, a small increase in adult mortality would have a much larger effect on adult densities. None of these demographic rates have been measured in parallel with this study, so we cannot point to specific demographic rates that are associated with these overall population declines.

In the 5-year review, the Service provides a brief summary of habitat use by desert tortoises; more detailed information is available in the revised recovery plan (Service 2011a). In the absence of specific and recent information on the location of habitable areas of the Mojave Desert, especially at the outer edges of this area, the 5-year review also describes and relies heavily on a quantitative, spatial habitat model for the desert tortoise north and west of the Colorado River that incorporates environmental variables such as precipitation, geology,

heavily on a quantitative, spatial habitat model for the desert tortoise north and west of the Colorado River that incorporates environmental variables such as precipitation, geology, vegetation, and slope and is based on occurrence data of desert tortoises from sources spanning more than 80 years, including data from the 2001 to 2005 range-wide monitoring surveys (Nussear et al. 2009). The model predicts the probability that desert tortoises will be present in any given location; calculations of the amount of desert tortoise habitat in the 5-year review and in this biological opinion use a threshold of 0.5 or greater predicted value for potential desert tortoise habitat. The model does not account for anthropogenic effects to habitat and represents the potential for occupancy by desert tortoises absent these effects.

To begin integrating anthropogenic activities and the variable risk levels they bring to different parts of the Mojave and Colorado deserts, the Service completed an extensive review of the threats known to affect desert tortoises at the time of their listing and updated that information with more current findings in the 5-year review. The review follows the format of the five-factor analysis required by section 4(a)(1) of the Act. The Service described these threats as part of the process of its listing (55 Federal Register 12178; April 2, 1990), further discussed them in the original recovery plan (Service 1994a), and reviewed them again in the revised recovery plan (Service 2011a).

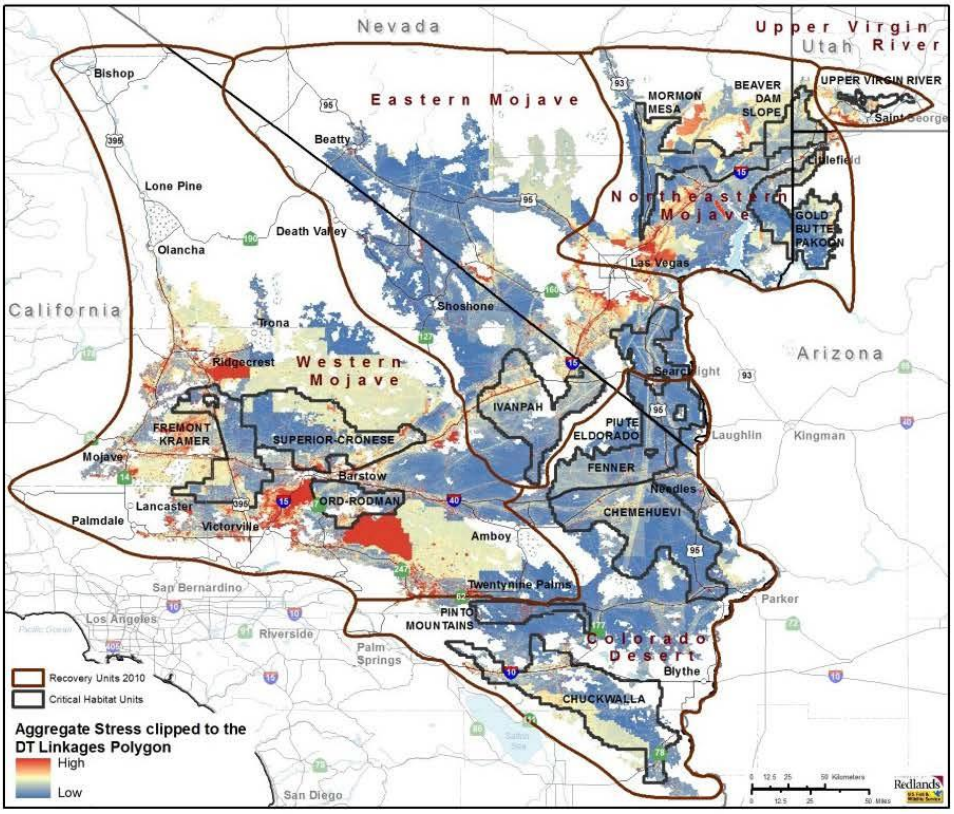
To understand better the relationship of threats to populations of desert tortoises and the most effective manner to implement recovery actions, the Desert Tortoise Recovery Office is developing a spatial decision support system that models the interrelationships of threats to desert tortoises and how those threats affect population change. The spatial decision support system describes the numerous threats that desert tortoises face, explains how these threats interact to affect individual animals and habitat, and how these effects in turn bring about changes in populations. For example, we have long known that the construction of a transmission line can result in the death of desert tortoises and loss of habitat. We have also known that common ravens, known predators of desert tortoises, use the transmission line's pylons for nesting, roosting, and perching and that the access routes associated with transmission lines provide a vector for the introduction and spread of invasive weeds and facilitate increased human access into an area. Increased human access can accelerate illegal collection and release of desert tortoises and their deliberate maiming and killing, as well as facilitate the spread of other threats associated with human presence, such as vehicle use, garbage and dumping, and invasive plants (Service 2011a). Changes in the abundance of native plants because of invasive weeds can compromise the physiological health of desert tortoises, making them more vulnerable to drought, disease, and predation. The spatial decision support system allows us to map threats across the range of the desert tortoise and model the intensity of stresses that these multiple and combined threats place on desert tortoise populations.

The threats described in the listing rule and both recovery plans continue to affect the species. Indirect impacts to desert tortoise populations and habitat occur in accessible areas that interface with human activity. Most threats to the desert tortoise or its habitat are associated with human land uses; research since 1994 has clarified many mechanisms by which these threats act on desert tortoises. As stated earlier, increases in human access can accelerate illegal collection and

release of desert tortoises and deliberate maiming and killing, as well as facilitate the spread of other threats associated with human presence, such as vehicle use, garbage and dumping, and invasive weeds.

Some of the most apparent threats to the desert tortoise are those that result in mortality and permanent habitat loss across large areas, such as urbanization and large-scale renewable energy projects, and those that fragment and degrade habitats, such as proliferation of roads and highways, off-highway vehicle activity, and habitat invasion by non-native invasive plant species. However, we remain unable to quantify how threats affect desert tortoise populations. The assessment of the original recovery plan emphasized the need for a better understanding of the implications of multiple, simultaneous threats facing desert tortoise populations and of the relative contribution of multiple threats on demographic factors (i.e., birth rate, survivorship, fecundity, and death rate; Tracy et al. 2004).

The following map depicts the 12 critical habitat units of the desert tortoise, linkages between conservation areas for the desert tortoise, and the aggregate stress that multiple, synergistic threats place on desert tortoise populations. Conservation areas include designated critical habitat, lands managed by the National Park Service, and other lands managed for the long-term conservation of the desert tortoise (e.g., the Desert Tortoise Natural Area in Kern County, California). The revised recovery plan (Service 2011a) recommended the linkages based on an analysis of least-cost pathways (i.e., areas with the highest potential to support desert tortoises) between conservation areas for the desert tortoise. This map illustrates that, across the range, desert tortoises in areas under the highest level of conservation management remain subject to numerous threats, stresses, and mortality sources.




Since the completion of the 5-year review, the Service has issued several biological opinions that affect large areas of desert tortoise habitat because of numerous proposals to develop renewable energy within its range. These biological opinions concluded that proposed solar plants were not likely to jeopardize the continued existence of the desert tortoise primarily because they were located outside of critical habitat and desert wildlife management areas that contain most of the land base required for the recovery of the species. The proposed actions also included numerous measures intended to protect desert tortoise during the construction of the projects, such as translocation of affected individuals. In aggregate, these projects would result in an overall loss of approximately 37,503 acres of habitat of the desert tortoise. We also predicted that these projects would translocate or kill up to 1,732 desert tortoises; we concluded that most of the individuals in these totals would be juveniles. To date, 372 desert tortoises have been observed during construction of projects; most of these individuals were translocated from work areas, although some desert tortoises have been killed (see appendix 2). The mitigation required by the Bureau and California Energy Commission, the agencies permitting these facilities, will result in the acquisition of private land within critical habitat and desert wildlife management areas and funding for the implementation of various actions that are intended to promote the recovery of

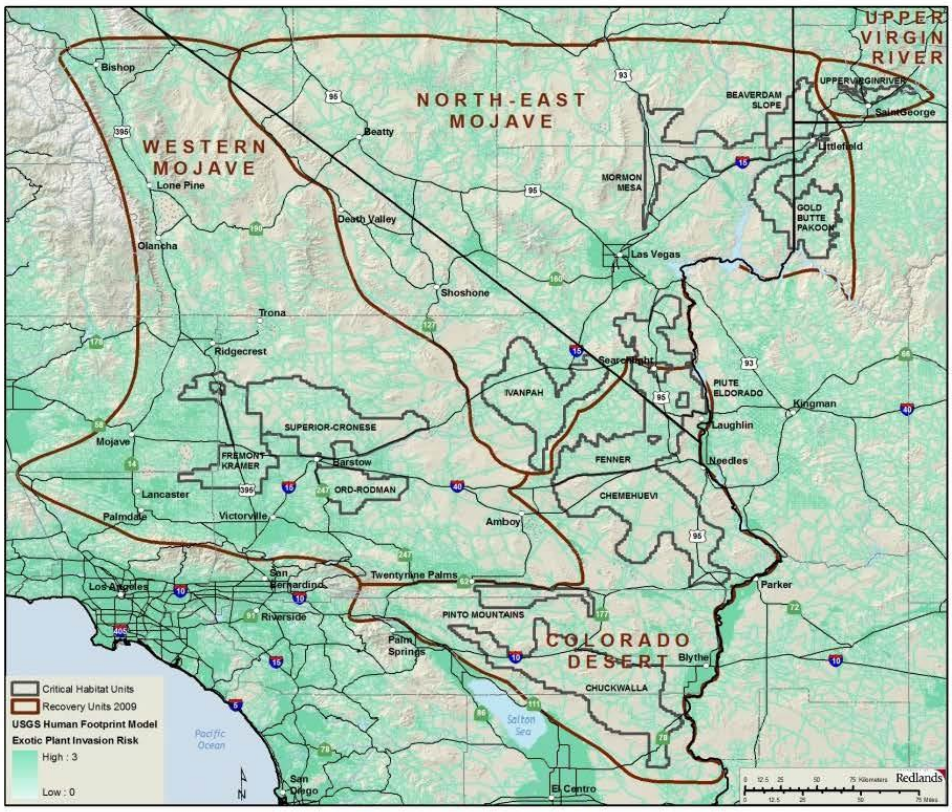
funding for the implementation of various actions that are intended to promote the recovery of the desert tortoise. Although most of these mitigation measures are consistent with recommendations in the recovery plans for the desert tortoise and the Service continues to support their implementation, we cannot assess how desert tortoise populations will respond because of the long generation time of the species.

In addition to the biological opinions issued for solar development within the range of the desert tortoise, the Service (2012e) also issued a biological opinion to the Department of the Army for the use of additional training lands at Fort Irwin. As part of this proposed action, the Army removed approximately 650 desert tortoises from 18,197 acres of the southern area of Fort Irwin, which had been off-limits to training. The Army would also use an additional 48,629 acres that lie east of the former boundaries of Fort Irwin; much of this parcel is either too mountainous or too rocky and low in elevation to support numerous desert tortoises.

The Service also issued a biological opinion to the Marine Corps that considered the effects of the expansion of the Marine Corps Air Ground Combat Center at Twentynine Palms (Service 2012f). We concluded that the Marine Corps' proposed action, the use of approximately 167,971 acres for training, was not likely to jeopardize the continued existence of the desert tortoise. Most of the expansion area lies within the Johnson Valley Off-high Vehicle Management Area.

The incremental effect of the larger actions (i.e., solar development, the expansions of Fort Irwin, and the Marine Corps Air Ground Combat Center) on the desert tortoise is unlikely to be positive, despite the numerous conservation measures that have been (or will be) implemented as part of the actions. The acquisition of private lands as mitigation for most of these actions increases the level of protection afforded these lands; however, these acquisitions do not create new habitat and Federal, State, and privately managed lands remain subject to most of the threats and stresses we discussed previously in this section. Although land managers have been implementing measures to manage these threats, we have been unable, to date, to determine whether the measures have been successful, at least in part because of the low reproductive capacity of the desert tortoise. Therefore, the conversion of habitat into areas that are unsuitable for this species continues the trend of constricting the desert tortoise into a smaller portion of its range.

As the Service notes in the 5-year review (Service 2010b), "(t)he threats identified in the original listing rule continue to affect the (desert tortoise) today, with invasive species, wildfire, and renewable energy development coming to the forefront as important factors in habitat loss and conversion. The vast majority of threats to the desert tortoise or its habitat are associated with human land uses." Oftedal's work (2002 in Service 2010b) suggests that invasive weeds may adversely affect the physiological health of desert tortoises. Current information indicates that invasive species likely affect a large portion of the desert tortoise's range (see following map). Furthermore, high densities of weedy species increase the likelihood of wildfires; wildfires, in turn, destroy native species and further the spread of invasive weeds.




Global climate change is likely to affect the prospects for the long-term conservation of the desert tortoise. For example, predictions for climate change within the range of the desert tortoise suggest more frequent and/or prolonged droughts with an increase of the annual mean temperature by 3.5 to 4.0 degrees Celsius. The greatest increases will likely occur in summer (June-July-August mean increase of as much as 5 degrees Celsius [Christensen et al. 2007 in Service 2010b]). Precipitation will likely decrease by 5 to 15 percent annually in the region with winter precipitation decreasing by up to 20 percent and summer precipitation increasing by up to 5 percent. Because germination of the desert tortoise's food plants is highly dependent on cool-season rains, the forage base could be reduced due to increasing temperatures and decreasing precipitation in winter. Although drought occurs routinely in the Mojave Desert, extended periods of drought have the potential to affect desert tortoises and their habitats through physiological effects to individuals (i.e., stress) and limited forage availability. To place the consequences of long-term drought in perspective, Longshore et al. (2003) demonstrated that even short-term drought could result in elevated levels of mortality of desert tortoises. Therefore, long-term drought is likely to have even greater effects, particularly given that the current fragmented nature of desert tortoise habitat (e.g., urban and agricultural development, Lakes allotments, which are located within critical habitat in the Western Mojave Recovery Unit;

current fragmented nature of desert tortoise habitat (e.g., urban and agricultural development, highways, freeways, military training areas, etc.) will make recolonization of extirpated areas difficult, if not impossible.

The Service notes in the 5-year review that the combination of the desert tortoise's late breeding age and a low reproductive rate challenges our ability to achieve recovery. When determining whether a proposed action is likely to jeopardize the continued existence of a species, we are required to consider whether the action would "reasonably be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 Code of Federal Regulations 402.02). Although the Service does not explicitly address these metrics in the 5-year review, we have used the information in that document to summarize the status of the desert tortoise with respect to its reproduction, numbers, and distribution.

In the 5-year review, the Service notes that desert tortoises increase their reproduction in high rainfall years; more rain provides desert tortoises with more high quality food (i.e., plants that are higher in water and protein), which, in turn, allows them to lay more eggs. Conversely, the physiological stress associated with foraging on food plants with insufficient water and nitrogen may leave desert tortoises vulnerable to disease (Oftedal 2002 in Service 2010b), and the reproductive rate of diseased desert tortoises is likely lower than that of healthy animals. Young desert tortoises also rely upon high-quality, low-fiber plants (e.g., native forbs) with nutrient levels not found in the invasive weeds that have increased in abundance across its range (Oftedal et al. 2002; Tracy et al. 2004). Compromised nutrition of young desert tortoises likely represents an effective reduction in reproduction by reducing the number that reaches adulthood. Consequently, although we do not have quantitative data that show a direct relationship, the abundance of weedy species within the range of the desert tortoise has the potential to negatively affect the reproduction of desert tortoises and recruitment into the adult population.

Data from long-term study plots, which were first established in 1976, cannot be extrapolated to provide an estimate of the number of desert tortoises on a range-wide basis; historic densities in some parts of the desert exceeded 100 adults in a square mile (Desert Tortoise Recovery Office 2014). Using data from the long-term study plots, the Service (2010b) concluded that "appreciable declines at the local level in many areas, which coupled with other survey results, suggest that declines may have occurred more broadly." Other sources indicate that local declines are continuing to occur. For example, surveyors found "lots of dead [desert tortoises]" in the western expansion area of Fort Irwin (Western Mojave Recovery Unit) in 2008 (Fort Irwin Research Coordination Meeting 2008). After the onset of translocation, coyotes killed 105 desert tortoises in Fort Irwin's southern translocation area (Western Mojave Recovery Unit); other canids may have been responsible for some of these deaths. Other incidences of predation were recorded throughout the range of the desert tortoise during this time (Esque et al. 2010). Esque et al. (2010) hypothesized that this high rate of predation on desert tortoises was influenced by low population levels of typical prey for coyotes due to drought conditions in previous years. Recent surveys in the Ivanpah Valley (Eastern Mojave Recovery Unit) for a proposed solar facility detected 31 live desert tortoises and the carcasses of 25 individuals that

had been dead less than 4 years (Ironwood 2011); this ratio of carcasses to live individuals over such a short period of time may indicate an abnormally high rate of mortality for a long-lived animal. In summary, the number of desert tortoises range-wide likely decreased substantially from 1976 through 1990 (i.e., when long-term study plots were initiated through the time the desert tortoise was listed as threatened), although we cannot quantify the amount of this decrease. Additionally, more recent data collected from various sources throughout the range of the desert tortoise suggest that local declines continue to occur (e.g., Bureau et al. 2005, Esque et al. 2010).

The distribution of the desert tortoise has not changed substantially since the publication of the original recovery plan in 1994 (Service 2010b) in terms of the overall extent of its range. Prior to 1994, desert tortoises were extirpated from large areas within their distributional limits by urban and agricultural development (e.g., the cities of Barstow, Lancaster, Las Vegas, St. George, etc.; agricultural areas south of Edwards Air Force Base and east of Barstow), military training (e.g., Fort Irwin, Leach Lake Gunnery Range), and off-road vehicle use (e.g., portions of off-road management areas managed by the Bureau and unauthorized use in areas such as east of California City). Since 1994, urban development around Las Vegas has likely been the largest contributor to habitat loss throughout the range. Desert tortoises have been essentially removed from the 18,197-acre southern expansion area at Fort Irwin (Service 2012e).

The following table depicts acreages of habitat (as modeled by Nussear et al. 2009) within various regions of the desert tortoise's range and of impervious surfaces as of 2006 (Xian et al. 2009). Impervious surfaces include paved and developed areas and other disturbed areas that have zero probability of supporting desert tortoises.

| Regions[1] | Modeled Habitat (acres) | Impervious Surfaces within Modeled Habitat | Percent of Modeled Habitat that is now Impervious |
|---|---|---|---|
| **Western Mojave** | 7,582,092 | 1,864,214 | 25 |
| **Colorado Desert** | 4,948,900 | 494,981 | 10 |
| **Northeast Mojave** | 7,776,934 | 1,173,025 | 15 |
| **Upper Virgin River** | 232,320 | 80,853 | 35 |
| **Total** | 20,540,246 | 3,613,052 | 18 |

[1]The regions do not correspond to recovery unit boundaries; we used a more general separation of the range for this illustration.

In conclusion, we have used the 5-year review (Service 2010b), revised recovery plan (Service 2011a), and additional information that has become available since these publications to review the reproduction, numbers, and distribution of the desert tortoise. The reproductive capacity of the desert tortoise may be compromised to some degree by the abundance and distribution of invasive weeds across its range; the continued increase in human access across the desert likely continues to facilitate the spread of weeds and further affect the reproductive capacity of the

species. Prior to its listing, the number of desert tortoises likely declined range-wide, although we cannot quantify the extent of the decline; since the time of listing, data suggest that declines continue to occur throughout most of the range, although recent information suggests that densities may have increased slightly in the Northeastern Mojave Recovery Unit. The continued increase in human access across the desert continues to expose more desert tortoises to the potential of being killed by human activities. The distributional limits of the desert tortoise's range have not changed substantially since the issuance of the original recovery plan in 1994; however, desert tortoises have been extirpated from large areas within their range (e.g., Las Vegas, other desert cities). The species' low reproductive rate, the extended time required for young animals to reach breeding age, and the multitude of threats that continue to confront desert tortoises combine to render its recovery a substantial challenge.

**Status of Critical Habitat of the Desert Tortoise**

The Service designated critical habitat for the desert tortoise in portions of California, Nevada, Arizona, and Utah in a final rule published February 8, 1994 (59 Federal Register 5820). The Service designates critical habitat to identify the key biological and physical needs of the species and key areas for recovery and to focus conservation actions on those areas. Critical habitat is composed of specific geographic areas that contain the biological and physical features essential to the species' conservation and that may require special management considerations or protection. These features, which include space, food, water, nutrition, cover, shelter, reproductive sites, and special habitats, are called the primary constituent elements of critical habitat. The specific primary constituent elements of desert tortoise critical habitat are: sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow; sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species; suitable substrates for burrowing, nesting, and overwintering; burrows, caliche caves, and other shelter sites; sufficient vegetation for shelter from temperature extremes and predators; and habitat protected from disturbance and human-caused mortality.

Critical habitat of the desert tortoise would not be able to fulfill its conservation role without each of the primary constituent elements being functional. As examples, having a sufficient amount of forage species is not sufficient if human-caused mortality is excessive; an area with sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow would not support desert tortoises without adequate forage species.

The final rule for designation of critical habitat did not explicitly ascribe specific conservation roles or functions to the various critical habitat units. Rather, it refers to the strategy of establishing recovery units and desert wildlife management areas recommended by the recovery plan for the desert tortoise, which had been published as a draft at the time of the designation of critical habitat, to capture the "biotic and abiotic variability found in desert tortoise habitat" (59 Federal Register 5820, see page 5823). Specifically, we designated the critical habitat units to follow the direction provided by the draft recovery plan (Service 1993a) for the establishment of

desert wildlife management areas. The critical habitat units in aggregate are intended to protect the variability that occurs across the large range of the desert tortoise; the loss of any specific unit would compromise the ability of critical habitat as a whole to serve its intended function and conservation role.

Despite the fact that desert tortoises do not necessarily need to move between critical habitat units to complete their life histories, both the original and revised recovery plans highlight the importance of these critical habitat units and connectivity between them for the recovery of the species. Specifically, the revised recovery plan states that "aggressive management as generally recommended in the 1994 Recovery Plan needs to be applied within existing (desert) tortoise conservation areas (defined as critical habitat, among other areas being managed for the conservation of desert tortoises) or other important areas … to ensure that populations remain distributed throughout the species' range …. (Desert tortoise) conservation areas capture the diversity of the Mojave population of the desert tortoise within each recovery unit, conserving the genetic breadth of the species, providing a margin of safety for the species to withstand catastrophic events, and providing potential opportunities for continued evolution and adaptive change …. Especially given uncertainties related to the effects of climate change on desert tortoise populations and distribution, we consider (desert) tortoise conservation areas to be the minimum baseline within which to focus our recovery efforts (pages 34 and 35, Service 2011a)."

The 12 critical habitat units range in area from 85 to 1,595 square miles. However, the optimal reserve size recommended to preserve viable desert tortoise populations was 1,000 square miles (Service 1994a); only 4 critical habitat units meet this threshold. Consequently, for some smaller critical habitat units, their future effectiveness in conserving the desert tortoise is largely dependent on the status of populations immediately adjacent to their boundaries or within intervening linkages that connect these smaller critical habitat units to other protected areas. Although the Service (1994a) recommended the identification of buffer zones and linkages for smaller desert tortoise conservation areas, land management agencies have generally not established such areas.

Population viability analyses indicate that reserves should contain from 10,000 to 20,000 adult desert tortoises to maximize estimated time to extinction (i.e., approximately 390 years, depending on rates of population change; Service 1994a). However, during the three most recent years of monitoring within the critical habitat units, only three (in 2009 and 2010) to five (in 2008) of the critical habitat units met this target (McLuckie et al. 2010; Service 2009, 2012a, 2012b). Some critical habitat units share boundaries and form contiguous blocks (e.g. Superior-Cronese and Fremont-Kramer Critical Habitat Units), and those blocks in California include combined estimated abundances of over 10,000 adult desert tortoises. These blocks are adjacent to smaller, more isolated units (e.g., Ord-Rodman Critical Habitat Unit) that are not currently connected to other protected habitat by preserved habitat linkages.

We did not designate the Desert Tortoise Natural Area and Joshua Tree National Park in California and the Desert National Wildlife Refuge in Nevada as critical habitat because they are "primarily managed as natural ecosystems" (59 Federal Register 5820, see page 5825) and

provide adequate protection to desert tortoises. Since the designation of critical habitat, Congress increased the size of Joshua Tree National Park and created the Mojave National Preserve. A portion of the expanded boundary of Joshua Tree National Park lies within critical habitat of the desert tortoise; portions of other critical habitat units lie within the boundaries of the Mojave National Preserve.

Within each critical habitat unit, both natural and anthropogenic factors affect the function of the primary constituent elements of critical habitat. As an example of a natural factor, in some specific areas within the boundaries of critical habitat, such as within and adjacent to dry lakes, some of the primary constituent elements are naturally absent because the substrate is extremely silty; desert tortoises do not normally reside in such areas. Comparing the acreage of desert tortoise habitat as depicted by Nussear et al.'s (2009) model to the gross acreage of the critical habitat units demonstrates quantitatively that the entire area within the boundaries of critical habitat likely does not support the primary constituent elements; see the following table. The acreage for modeled habitat is for the area in which the probability that desert tortoises are present is greater than 0.5. The acreages of modeled habitat are from Service (2012b); they do not include loss of habitat due to human-caused impacts. The difference between gross acreage and modeled habitat is 653,214 acres; that is, approximately 10 percent of the gross acreage of the designated critical habitat is not considered modeled habitat.

| **Critical Habitat Unit** | **Gross Acreage** | **Modeled Habitat** |
|---|---|---|
| Superior-Cronese | 766,900 | 724,967 |
| Fremont-Kramer | 518,000 | 501,095 |
| Ord-Rodman | 253,200 | 184,155 |
| Pinto Mountain | 171,700 | 144,056 |
| Piute-Eldorado | 970,600 | 930,008 |
| Ivanpah Valley | 632,400 | 510,711 |
| Chuckwalla | 1,020,600 | 809,319 |
| Chemehuevi | 937,400 | 914,505 |
| Gold Butte-Pakoon | 488,300 | 418,189 |
| Mormon Mesa | 427,900 | 407,041 |
| Beaver Dam Slope | 204,600 | 202,499 |
| Upper Virgin River | 54,600 | 46,441 |
| **Totals** | 6,446,200 | 5,792,986 |

*Condition of the Primary Constituent Elements of Critical Habitat*

Human activities can have obvious or more subtle effects on the primary constituent elements. The grading of an area and subsequent construction of a building removes the primary constituent elements of critical habitat; this action has an obvious effect on critical habitat. The revised recovery plan identifies human activities such as urbanization and the proliferation of roads and highways as threats to the desert tortoise and its habitat; these threats are examples of activities that have a clear effect on the primary constituent elements of critical habitat.

We have included the following paragraphs from the revised recovery plan for the desert tortoise (Service 2011a) to demonstrate that other anthropogenic factors affect the primary constituent elements of critical habitat in more subtle ways. All references are in the revised recovery plan (i.e., in Service 2011a); we have omitted some information from the revised recovery plan where the level of detail was unnecessary for the current discussion.

> Surface disturbance from [off-highway vehicle] activity can cause erosion and large amounts of dust to be discharged into the air. Recent studies on surface dust impacts on gas exchanges in Mojave Desert shrubs showed that plants encrusted by dust have reduced photosynthesis and decreased water-use efficiency, which may decrease primary production during seasons when photosynthesis occurs (Sharifi et al. 1997). Sharifi et al. (1997) also showed reduction in maximum leaf conductance, transpiration, and water-use efficiency due to dust. Leaf and stem temperatures were also shown to be higher in plants with leaf-surface dust. These effects may also impact desert annuals, an important food source for [desert] tortoises.
>
> [Off-highway vehicle] activity can also disturb fragile cyanobacterial-lichen soil crusts, a dominant source of nitrogen in desert ecosystems (Belnap 1996). Belnap (1996) showed that anthropogenic surface disturbances may have serious implications for nitrogen budgets in cold desert ecosystems, and this may also hold true for the hot deserts that [desert] tortoises occupy. Soil crusts also appear to be an important source of water for plants, as crusts were shown to have 53 percent greater volumetric water content than bare soils during the late fall when winter annuals are becoming established (DeFalco et al. 2001). DeFalco et al. (2001) found that non-native plant species comprised greater shoot biomass on crusted soils than native species, which demonstrates their ability to exploit available nutrient and water resources. Once the soil crusts are disturbed, non-native plants may colonize, become established, and out-compete native perennial and annual plant species (DeFalco et al. 2001, D'Antonio and Vitousek 1992). Invasion of non-native plants can affect the quality and quantity of plant foods available to desert tortoises. Increased presence of invasive plants can also contribute to increased fire frequency.
>
> Proliferation of invasive plants is increasing in the Mojave and Sonoran deserts and is recognized as a substantial threat to desert tortoise habitat. Many species of non-native plants from Europe and Asia have become common to abundant in some areas, particularly where disturbance has occurred and is ongoing. As non-native plant species become established, native perennial and annual plant species may decrease, diminish, or die out (D'Antonio and Vitousek 1992). Land managers and field scientists identified 116 species of non-native plants in the Mojave and Colorado deserts (Brooks and Esque 2002).
>
> Increased levels of atmospheric pollution and nitrogen deposition related to increased human presence and combustion of fossil fuels can cause increased levels of soil nitrogen, which in turn may result in significant changes in plant communities (Aber et

> al. 1989). Many of the non-native annual plant taxa in the Mojave region evolved in more fertile Mediterranean regions and benefit from increased levels of soil nitrogen, which gives them a competitive edge over native annuals. Studies at three sites within the central, southern, and western Mojave Desert indicated that increased levels of soil nitrogen can increase the dominance of non-native annual plants and promote the invasion of new species in desert regions. Furthermore, increased dominance by non-native annuals may decrease the diversity of native annual plants, and increased biomass of non-native annual grasses may increase fire frequency (Brooks 2003).

This summary from the revised recovery plan (Service 2011a) demonstrates how the effects of human activities on habitat of the desert tortoise are interconnected. In general, surface disturbance causes increased rates of erosion and generation of dust. Increased erosion alters additional habitat outside of the area directly affected by altering the nature of the substrate, removing shrubs, and possibly destroying burrows and other shelter sites. Increased dust affects photosynthesis in the plants that provide cover and forage to desert tortoises. Disturbed substrates and increased atmospheric nitrogen enhance the likelihood that invasive species will become established and outcompete native species; the proliferation of weedy species increases the risk of large-scale fires, which further move habitat conditions away from those that are favorable to desert tortoises.

The following paragraphs generally describe how the threats described in the revised recovery plan affect the primary constituent elements of critical habitat of the desert tortoise.

Sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow.

In considering the following discussion, bear in mind the information provided previously in this biological opinion regarding the recommended and actual sizes of critical habitat units for the desert tortoise. The original recovery team based the recommended size of desert wildlife management areas on the amount of space required to maintain viable populations. (The recovery plan [Service 1994a] defined conservation areas for the desert tortoise as 'desert wildlife management areas;' we based the boundaries of critical habitat on the recovery team's general recommendation for the desert wildlife management areas.) The current low densities of desert tortoises within critical habitat units exacerbate the difficulties of effecting recovery within these areas.

Urban and agricultural development, concentrated use by off-road vehicles, and other activities of this nature completely remove habitat. Although we are aware of local areas within the boundaries of critical habitat that have been heavily disturbed, we do not know of any areas that have been disturbed to the intensity and extent that this primary constituent element has been compromised. To date, the largest single loss of critical habitat is the use of 18,197 acres of additional training land in the southern portion of Fort Irwin. In our biological opinion for that proposed action (Service 2012e), we stated:

> The proposed action would essentially eliminate the primary constituent elements from approximately 2.40 percent of the Superior-Cronese Critical Habitat Unit; additionally, the conservation role of the remainder of this critical habitat unit and the other critical habitat units has been compromised by substantial human impact on the second and sixth primary constituent elements. However, the protective measures that the Army implemented as part of the proposed action offset, at least to some extent, the adverse effects of the use of the additional training lands in the southern expansion area. Consequently, we have concluded that, although the second and sixth primary constituent elements are not functioning appropriately throughout most of designated critical habitat of the desert tortoise and the proposed action would result in substantial disturbance to 18,197 acres of the Superior-Cronese Critical Habitat Unit, the change in the condition of critical habitat brought about by the Army's proposed action (i.e., use of the southern expansion area for training and implementation of the conservation actions) is not likely to cause an overall decrease in the conservation value and function of the Superior-Cronese Critical Habitat Unit.

The widening of existing freeways likely caused the second largest loss of critical habitat. Despite these losses of critical habitat, which occur in a linear manner, the critical habitat units continue to support sufficient space to support viable populations within each of the six recovery units.

In some cases, major roads likely disrupt the movement, dispersal, and gene flow of desert tortoises. Highways 58 and 395 in the Fremont-Kramer Critical Habitat Unit and Fort Irwin Road in the Superior-Cronese Critical Habitat Unit are examples of large and heavily travelled roads that likely disrupt movement, dispersal, and gene flow. Roads that have been fenced and provided with underpasses may alleviate this fragmentation to some degree; however, such facilities have not been in place for sufficient time to determine whether they will eliminate fragmentation.

The threats of invasive plant species described in the revised recovery plan generally do not result in the removal of this primary constituent element because they do not convert habitat into impervious surfaces, as would urban development.

Sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species.

This primary constituent element addresses the ability of critical habitat to provide adequate nutrition to desert tortoises. As described in the revised recovery plan and 5-year review, grazing, historical fire, invasive plants, altered hydrology, drought, wildfire potential, fugitive dust, and climate change/temperature extremes contribute to the stress of "nutritional compromise." Paved and unpaved roads through critical habitat of the desert tortoise provide avenues by which invasive native species disperse; these legal routes also provide the means by which unauthorized use occurs over large areas of critical habitat. Nitrogen deposition from atmospheric pollution likely occurs throughout all the critical habitat units and exacerbates the

effects of the disturbance of substrates. Because paved and unpaved roads are so widespread through critical habitat, this threat has compromised the conservation value and function of critical habitat throughout the range of the desert tortoise, to some degree. See the Status of the Desert Tortoise section of this biological opinion for a map that depicts the routes by which invasive weeds have access to critical habitat; the routes shown on the map are a subset of the actual number of routes that actually cross critical habitat of the desert tortoise.

Suitable substrates for burrowing, nesting, and overwintering.

Surface disturbance, motor vehicles traveling off route, use of OHV management areas, OHV events, unpaved roads, grazing, historical fire, wildfire potential, altered hydrology, and climate change leading to shifts in habitat composition and location, storms, and flooding can alter substrates to the extent that they are no longer suitable for burrowing, nesting, and overwintering. Erosion caused by these activities can alter washes to the extent that desert tortoise burrows placed along the edge of a wash, which is a preferred location for burrows, could be destroyed. We expect that the area within critical habitat that is affected by off-road vehicle use to the extent that substrates are no longer suitable is relatively small in relation to the area that desert tortoises have available for burrowing, nesting, and overwintering; consequently, off-road vehicle use has not had a substantial effect on this primary constituent element.

Most livestock allotments have been eliminated from within the boundaries of critical habitat. Of those that remain, livestock would compact substrates to the extent that they would become unsuitable for burrowing, nesting, and overwintering only in areas of concentrated use, such as around watering areas and corrals. Because livestock grazing occurs over a relatively small portion of critical habitat and the substrates in most areas within livestock allotments would not be substantially affected, suitable substrates for burrowing, nesting, and overwintering remain throughout most of the critical habitat units.

Burrows, caliche caves, and other shelter sites.

Human-caused effects to burrows, caliche caves, and other shelter sites likely occur at a similar rate as effects to substrates for burrowing, nesting, and overwintering for the same general reasons. Consequently, sufficient burrows, caliche caves, and other shelter sites remain throughout most of the critical habitat units.

Sufficient vegetation for shelter from temperature extremes and predators.

In general, sufficient vegetation for shelter from temperature extremes and predators remains throughout critical habitat. In areas where large fires have occurred in critical habitat, many of the shrubs that provide shelter from temperature extremes and predators have been destroyed; in such areas, cover sites may be a limiting factor. The proliferation of invasive plants poses a threat to shrub cover throughout critical habitat as the potential for larger and more frequent wildfires increases.

In 2005, wildfires in Nevada, Utah, and Arizona burned extensive areas of critical habitat (Service 2010b). Although different agencies report slightly different acreages, the following table provides an indication of the scale of the fires.

| Critical Habitat Unit | Total Area Burned (acres) | Percent of the Critical Habitat Unit Burned |
|---|---|---|
| Beaver Dam Slope | 53,528 | 26 |
| Gold-Butte Pakoon | 65,339 | 13 |
| Mormon Mesa | 12,952 | 3 |
| Upper Virgin River | 10,557 | 19 |

The revised recovery plan notes that the fires caused statistically significant losses of perennial plant cover, although patches of unburned shrubs remained. Given the patchiness with which the primary constituent elements of critical habitat are distributed across the critical habitat units and the varying intensity of the wildfires, we cannot quantify precisely the extent to which these fires disrupted the function and value of the critical habitat.

Habitat protected from disturbance and human-caused mortality.

In general, the Federal agencies that manage lands within the boundaries of critical habitat have adopted land management plans that include implementation of some or all of the recommendations contained in the original recovery plan for the desert tortoise. (See pages 70 to 72 of Service 2010b.) To at least some degree, the adoption of these plans has resulted in the implementation of management actions that are likely to reduce the disturbance and human-caused mortality of desert tortoises. For example, these plans resulted in the designation of open routes of travel and the closure (and, in some cases, physical closure) of unauthorized routes. Numerous livestock allotments have been relinquished by the permittees and cattle no longer graze these allotments. Because of these planning efforts, the Bureau's record of decision included direction to withdraw some areas of critical habitat from mineral entry. Because of actions on the part of various agencies, many miles of highways and other paved roads have been fenced to prevent desert tortoises from wandering into traffic and being killed. The Service and other agencies of the Desert Managers Group in California are implementing a plan to remove common ravens that prey on desert tortoises and to undertake other actions that would reduce subsidies (i.e., food, water, sites for nesting, roosting, and perching, etc.) that facilitate their abundance in the California desert (Service 2008).

Despite the implementation of these actions, disturbance and human-caused mortality continue to occur in many areas of critical habitat (which overlap the desert wildlife management areas for the most part and are the management units for which most data are collected) to the extent that the conservation value and function of critical habitat is, to some degree, compromised. For example, many highways and other paved roads in California remain unfenced. Twelve desert tortoises were reported to be killed on paved roads from within Mojave National Preserve in 2011, and we fully expect that desert tortoises are being killed at similar rates on many other roads, although these occurrences are not discovered and reported as diligently as by the

National Park Service. Employees of the Southern California Gas Company reported two desert tortoises in 2011 that were crushed by vehicles on unpaved roads.

Unauthorized off-road vehicle use continues to disturb habitat and result in loss of vegetation within the boundaries of critical habitat (e.g., Coolgardie Mesa in the Western Mojave Recovery Unit); although we have not documented the death of desert tortoises as a direct result of this activity, it likely occurs. Additionally, the habitat disturbance caused by this unauthorized activity exacerbates the spread of invasive plants, which displace native plants that are important forage for the desert tortoise, thereby increasing the physiological stress faced by desert tortoises.

Although the Bureau has approved, through its land use planning processes, the withdrawal of areas of critical habitat from mineral entry, it has not undertaken the administrative procedures to complete withdrawals in all areas. Absent this withdrawal, new mining claims can be filed and further disturbance of critical habitat could occur.

Finally, the Bureau has not allowed the development of solar power plants on public lands within the boundaries of its desert wildlife management areas (which largely correspond to the boundaries of critical habitat). Conversely, the County of San Bernardino is considering the approval of the construction and operation of at least two such facilities within the boundaries of the Superior-Cronese Critical Habitat Unit north of Interstate 15 near the Minneola Road exit.

*Summary of the Status of Critical Habitat of the Desert Tortoise*

As noted in the revised recovery plan for the desert tortoise and 5-year review (Service 2011a, 2010b), critical habitat of the desert tortoise is subject to landscape level impacts in addition to the site-specific effects of individual human activities. On the landscape level, atmospheric pollution is increasing the level of nitrogen in desert substrates; the increased nitrogen exacerbates the spread of invasive plants, which outcompete the native plants necessary for desert tortoises to survive. As invasive plants increase in abundance, the threat of large wildfires increases; wildfires have the potential to convert the shrubland-native annual plant communities upon which desert tortoises depend to a community with fewer shrubs and more invasive plants. In such a community, shelter and forage would be more difficult for desert tortoises to find. Invasive plants have already compromised the conservation value and function of critical habitat to some degree with regard to the second primary constituent element (i.e., sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species). These effects likely extend to the entirety of critical habitat, given the numerous routes by which invasive plants can access critical habitat and the large spatial extent that is subject to nitrogen from atmospheric pollution. (See maps from previous sections of this biological opinion regarding the extent of the threat of invasive plants and the aggregate stress that multiple threats, including invasive plants, place on critical habitat.)

Critical habitat has been compromised to some degree with regard to the last primary constituent element (i.e., habitat protected from disturbance and human-caused mortality) as a result of the wide variety of human activities that continues to occur within its boundaries. These effects

result from the implementation of discrete human activities and are thus more site-specific in nature.

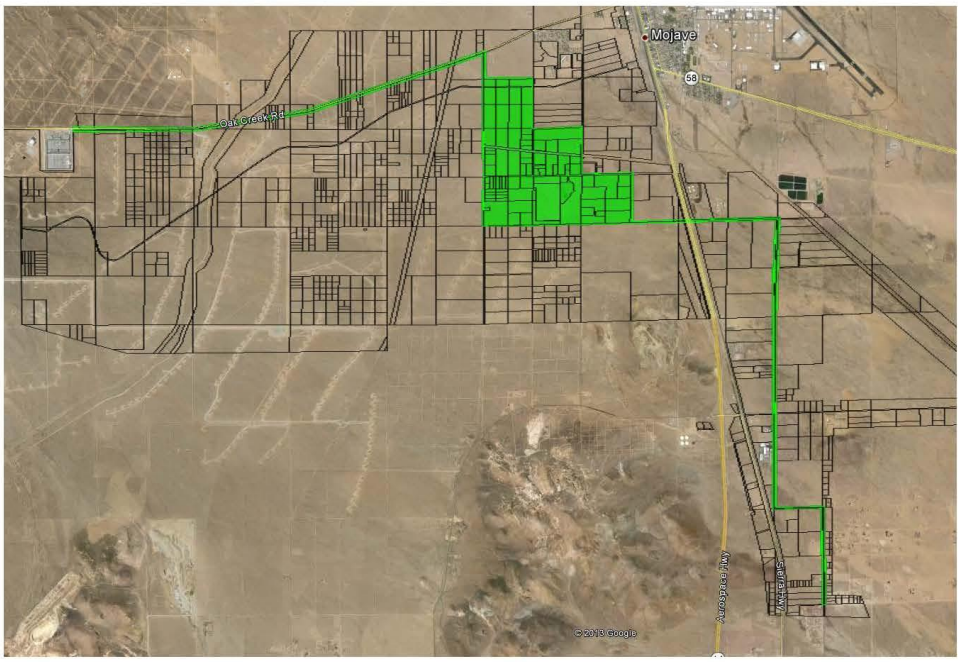
Although the remaining primary constituent elements have been affected to some degree by human activities, these impacts have not, to date, substantially compromised the conservation value and function of the critical habitat units. We have reached this conclusion primarily because the effects are localized and thus do not affect the conservation value and function of large areas of critical habitat.

Land managers have undertaken actions to improve the status of critical habitat. For example, as part of its efforts to offset the effects of the use of additional training maneuver lands at Fort Irwin (Service 2004), the Army acquired the private interests in the Harper Lake and Cronese Lakes allotments, which are located within critical habitat in the Western Mojave Recovery Unit; as a result, cattle have been removed from these allotments. Livestock have been removed from numerous other allotments through various means throughout the range of the desert tortoise. The retirement of allotments assists in the recovery of the species by eliminating disturbance to the primary constituent elements of critical habitat by cattle and range improvements.

ENVIRONMENTAL BASELINE

**Action Area**

The implementing regulations for section 7(a)(2) of the Act define the "action area" as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 Code of Federal Regulations 402.02). The action area for this biological opinion is the footprint of Edwards Air Force Base, which consists of 307,516 acres, and the route of the gen-tie line from the proposed Oro Verde Solar Project in the northwestern corner of the base to the Windhub Substation, as depicted on the following map (Brewer-Anderson 2013). The precise route for the gen-tie line has not been finalized. The easement for the gen tie line would be 13.9 miles long and up to 110 feet wide. The easement would cover approximately 147 acres.




**Habitat Characteristics of the Action Area**

The following information provides a summary of the discussion of habitat characteristics from the biological evaluation (Air Force 2008a) and integrated natural resources management plan (Air Force 2008b). The proposed action area is located in the western portion of the Mojave Desert mid-way between the southern end of the Sierra Nevada and the San Bernardino Mountains. Edwards Air Force Base is visually dominated by three dry lakebeds: Rosamond, Rogers, and Buckhorn dry lakes. The area is characterized as high desert with broad expansive valleys bordered by low rocky hills.

The main plant communities on base include creosote bush scrub, saltbush scrub, Joshua tree woodland, and mesquite woodland. The zonal plant communities are primarily based on soil characteristics and elevation; elevation ranges on the base range between 2,500 to 3,300 feet, and topography gradually slopes from west to east. Vegetation in the upland areas on base consists of two main plant communities: creosote bush scrub and Joshua tree woodland. Lowland communities consist of the alkali sink and saltbush communities.

**Existing Conditions in the Action Area**

In this section, we discuss the anthropogenic and natural conditions in the action area as they relate to desert tortoises and their habitat. Unless we have noted otherwise by citing a biological opinion, the anthropogenic conditions present in the action area were constructed or instituted prior to the listing of the desert tortoise. We summarized the following information from the biological evaluation (Air Force 2008a), integrated natural resources management plan (Air Force 2008b), and communications with Edwards Air Force Base personnel.

*Land Use*

Edwards Air Force Base is divided into 7 environmental management areas or support zones to better manage the variety of environmental management programs. Figure 3-2 in the integrated natural resource management plan depicts the boundaries of each support zone.

The first zone is a relatively isolated developed area which contains the Air Force Research Laboratory. This area is surrounded by the Precision Impact Range Area in the northeastern portion of the base; desert tortoises are occasionally encountered in this zone.

The second and third zones are composed of main base south and main base north, respectively. Main base south supports areas developed for residential, recreational and commercial use. Main base north is the third zone and supports developed and undeveloped areas; developments in this area support a wide range of operations conducted by the base. Environmental issues in this zone include off-road vehicle areas and the presence of desert tortoise populations.

Zones four and five were developed to support flightline activities. The fourth zone, which is south base, is the original flightline that now primarily functions as a taxiway. Zone five contains the flightline, taxiways and associated hangars. Environmental issues of concern while operating in zone five include desert tortoise and habitat recovery.

The sixth environmental zone consists of the north base and Precision Impact Range Areas. The Precision Impact Range Area covers a large portion of the eastern part of the base and supports low-level aircraft flight-testing, open burn/open detonation facility, and various other facilities; this area also contains desert tortoise critical habitat. The Service (1994b) issued a biological opinion regarding the effects of establishing the Precision Impact Range Area on the desert tortoise and its critical habitat; in this biological opinion, we concluded that the proposed action was not likely to jeopardize the continued existence of the desert tortoise or destroy or adversely modify its critical habitat because of implementation of numerous measures intended to minimize the effects of the proposed action on desert tortoises. The open burn/open detonation area on the Precision Impact Range Area is equipped with desert tortoise exclusion fencing to prevent individuals from entering the facility; due to regular grading, very little vegetation persists within or immediately adjacent to the fenced area of the open burn-open detonation unit. Zone seven comprises undeveloped lands used for a wide variety of base activities including, but not limited to buffer zone around the three lakebeds, aircraft drop zones, shooting ranges,

training area, and lakebed runways. Environmental issues in this management area include desert tortoise, water wells, unpaved roads and emergency landing areas.

The Service has issued biological opinions regarding the effects of establishing, operating, and maintaining a suite of facilities and training areas throughout Edwards Air Force Base on the desert tortoise and its critical habitat. Desert tortoises have been translocated from the areas as necessary to successfully carry out the proposed actions and minimize impacts to desert tortoise. We concluded that the proposed actions were not likely to jeopardize the continued existence of the desert tortoise or destroy or adversely modify its critical habitat; we expect that these actions led to an overall decrease in the number of individuals in these areas.

The type and frequency of use varies greatly between areas. Some areas are heavily used and others remain virtually untouched (Air Force 2008b). Large areas of the base remain undeveloped and accommodate testing activities. A perimeter fence was installed around the base to help conserve desert tortoise habitat, in particular critical habitat. Areas designated as desert tortoise critical habitat require personnel to follow different levels of protection measures based upon the activities planned within that area.

The Air Force has re-vegetated areas disturbed by wildfire burns, unused vehicle routes, abandoned targets, closed borrow pits, closed landfills, and other areas within desert tortoise habitat. As of May 2013, the base has re-vegetated approximately 135 acres of habitat (much of which took place in previously burned areas) (Air Force 2014a). Of this amount, approximately 55 acres are located in critical habitat on the Precision Impact Range Area.

Impacts to natural resources may result in the release of hazardous substances, pollutants, and contaminants into the environment from mission-related activities. The Service issued five biological opinions regarding the effect of the Installation Restoration Program on desert tortoises and its critical habitat; in the biological opinions, we concluded that the proposed actions were not likely to jeopardize the continued existence of the desert tortoise or destroy or adversely modify its critical habitat because a reduction in disturbance is likely to benefit desert tortoises by reducing the amount of habitat that is lost or degraded.

The area between the northwest corner of the base and the Windhub Substation generally supports desert habitat with some scattered residences and businesses. The western end of the gen-tie line crosses through areas that have been developed as wind farms.

*Use by Feral and Domestic Livestock*

One of the primary historic uses of the land within Edwards Air Force Base included livestock grazing. Although livestock grazing has not legally occurred on base since 1950, portions are still recovering from past overgrazing practices. Illegal sheep grazing occasionally occurred along the northern boundary of the base; installation of boundary fence along the base perimeter has eliminated this problem. Sheep grazing still occurs around the base periphery resulting in some edge effects. Sheep likely occasionally graze in areas along the route of the proposed gen-tie line.

*Non-native Species*

The processes of grazing, urbanization, agriculture, and road and utility construction have resulted in the introduction of invasive annuals to the native flora, particularly split grass (*Schismus barbatus*), cheat grass (*Bromus tectorum*), and red brome (*Bromus madritensis* ssp. *rubens*). More recently, Sahara mustard (*Brassica tournfortii*) has spread into the western Mojave Desert from the Colorado Desert; it has been observed along U.S. Highway 395 along the edge of the eastern boundary of the base. We expect the abundance of these species to be higher in portions of the base that experienced the most recent livestock grazing.

The abundance and diversity of non-native species in any area vary in relation to the seasonal weather; consequently, the composition of the non-native plant flora may be substantially different from year to year. An overabundance of weedy species likely compromises the nutritional status of desert tortoises, as we discussed in the Status of the Species section of this biological opinion. We do not have specific information on the distribution of non-native species nor on their specific effects on desert tortoises in the action area.

*Paved and Unpaved Roads*

Highway 395 traverses the northeast corner of Edwards Air Force Base. State Route 58 parallels the northern boundary, with the exception of a small portion that crosses into the base. The construction of Highway 395 and State Route 58 resulted in the loss of viable desert tortoise habitat and poses as a barrier to movement of desert tortoises; we anticipate that at least a few desert tortoises are killed on these roads annually. State Highway 14 crosses the proposed route of the gen-tie line at about its midpoint. Furthermore, we expect that desert tortoise densities adjacent to these major roads are depressed, as discussed by Hoff and Marlow (2002), but we are not aware of surveys that quantify this effect in these specific areas.

The paved roads within the base are focused in areas supporting development and urbanization. The Service (1993b) issued a biological opinion that concluded that the proposed maintenance and repair of roads throughout the base was not likely to jeopardize the continued existence of the desert tortoise or destroy or adversely modify its critical habitat because most of the proposed actions would occur in previously disturbed areas.

In addition to the paved roads within the base, unpaved roads also traverse the action area. One of the primary historic uses of the land within Edwards Air Force Base included off-road and off-highway vehicle activities. Currently, off-road driving is generally prohibited except for within three designated off-road vehicle areas on base (see figure 7-8 in Air Force 2008b). Off-road vehicle area 1 is approximately 100 acres and designated only for use by the Desert Wheels Motorcycle Club. Off-road vehicle area 2 is approximately 15,040 acres located west of military family housing and is jointly used for off-road vehicles, equestrians, and general recreation. Off-road vehicle area 3 is approximately 4,328 acres, including 32 miles of trails, and is only used for non-motorized mountain biking and jogging. No motorized off-road vehicles are permitted in this area. The Service (1996) issued a biological opinion to the Air Force that considered the

effects of establishment and continued use of off-road vehicle area 2 on the desert tortoise. We concluded that the proposed action was not likely to jeopardize the continued existence of the desert tortoise. We expect that recreational use of these areas likely results in the death or injury of desert tortoises.

In July 2002, the Air Force (2008a) had installed approximately 42 miles of desert tortoise exclusion fencing throughout the base. The Air Force fenced roads to reduce injury and mortality to desert tortoises associated with their use. However, the Air Force subsequently determined that the increased fragmentation of habitat and barriers to movement could outweigh the benefit of reducing the injury and mortality of desert tortoises. Edwards Air Force Base currently has approximately 13 miles of desert tortoise exclusion fencing along areas where desert tortoises and threats overlap (Mull 2013b). The Air Force continues to evaluate the need for desert tortoise barrier fencing along roads to maintain connectivity of adjacent habitat.

Since the listing of the desert tortoise, five known desert tortoise deaths have occurred on Edwards Air Force Base; most of the deaths resulted from desert tortoises getting run over by mission-related traffic (Mull 2013c, 2013d). Environmental Management has closed rarely used dirt roads on portions of the base by constructing barriers across those roads; more road closures are planned in the future. New road construction is limited on base. Edwards Air Force Base personnel are encouraged to use existing roads for access throughout the base whenever possible. New roads were created in the past for projects; however, for many years, new projects have been designed to use existing roads as much as possible.

*Utilities*

Several underground utilities have been constructed in the northern border of the base paralleling State Highway 58. The Service (1995) issued a biological opinion to the Air Force that considered the effects of installing underground communication lines and related facilities at Edwards Air Force Base. We concluded that the proposed action was not likely to jeopardize the continued existence of the desert tortoise.

Large utility poles occur along the eastern boundary paralleling Highway 395. Utility construction on the base from the south and west has also occurred along well-traveled roads. These utilities were installed in the road shoulder or beneath paved or unpaved roads, which presents no new ground disturbance to the habitat adjacent to the road.

The most substantial ongoing effect of utility poles is their ongoing use by common ravens for perching and nesting. The presence of this additional nesting substrate, which allows common ravens to nest far above the reach of ground-dwelling predators, likely contributes substantially to the increase in the number of common ravens in the desert. As previously discussed, common ravens prey on desert tortoises and are likely detrimental to the recovery of the desert tortoise. The need for road maintenance on the utility corridors has left permanent bare areas. Roads along and above utility corridors are occasionally used for maintenance. As we previously

mentioned, the Air Force participates in ongoing re-vegetation efforts which aide in reducing impacts from the establishment of utility corridors.

**Status of the Desert Tortoise in the Action Area**

The Air Force conducted four major surveys throughout the base between 1991 and 1994 to determine relative density estimates of the desert tortoise. With some exceptions, results of these surveys indicate desert tortoises occur throughout the base, but are not uniformly distributed. Approximately 126 square miles (27 percent) of the base were excluded due to lack of desert tortoise habitat (e.g., dry lake beds, cantonment areas, research facilities, graded targets, housing areas, and other operational areas). The Air Force repeated these density surveys from 2006 through 2007 following the same methodology employed during the 1991 to 1994 surveys.

The Air Force used the total corrected sign method to conduct these surveys. In this methodology, surveyors record the amount of desert tortoise sign (e.g., scat, barrows, etc.) observed while walking transects and then develop a density estimate by calibrating the results against densities on long-term study plots, where the density of desert tortoises had been previously estimated using mark-recapture studies. This technique provides an index of relative density only and is no longer used for several reasons.

The following table summarizes results of surveys conducted from 1991 to 1994 and from 2006 to 2007 (Air Force 2008b, Air Force 2010). Although the absolute numbers may be questionable, the comparison of average densities between the two survey periods seems to indicate that the number of desert tortoises on Edwards Air Force Base has declined.

| Survey Period | Density range (individuals per square mile) | Average density (individuals per square mile) |
|---|---|---|
| **1991-1994** | 3 to 69 | 15.9 |
| **2006-2007** | 0 to 58 | 7.8 |

Results of the 2006 to 2007 surveys indicate that the relative density of desert tortoises are approximately twice as high near designated critical habitat and within the eastern portion of the base as they are on the west side. The mean relative density of desert tortoises on the east side of the base was 10.3 per square mile; on the west side, the mean relative density was 5.1 desert tortoises per square mile. Fewer desert tortoises are observed along the lakebeds and in the southwestern portions of the base. We added the densities of the areas surveyed and estimated that approximately 2,643 desert tortoises occurred on Edwards Air Force Base at the time of the 2006 and 2007 surveys; because of the variability associated with this methodology, we emphasize that this number represents a very rough estimate.

As we discussed in the Existing Conditions in the Action Area section, we expect that State Routes 58, which borders a portion of the northern edge of the base, and 395, which crosses its

northeastern tip, have likely resulted in a decrease in the numbers of desert tortoises adjacent to these roads. The number of desert tortoises on base has also likely been affected to a degree by the extensive human activity at Edwards Air Force Base that occurred prior to the listing of the species in 1989 (e.g., development of the main base, housing areas, bombing ranges and training areas, etc.; see Appendix B in Air Force 2008a). Finally, desert tortoises on base likely experienced an overall decrease in density as a result of the same factors that affected desert tortoises throughout the western Mojave Desert as we discussed in the Status of the Species section of this biological opinion.

The following table depicts the numbers of desert tortoises that have been killed or moved from harm's way as a result of the Air Force's activities under its active biological opinions (Mull 2013d). As in every action that covers a large area, we expect that the Air Force did not detect all injuries and mortalities. Because the number of desert tortoise mortalities is lower than the number moved from harm's way and substantially lower than the number of observations, we expect that the Air Force's protective measures are generally functioning well and that few animals have been killed or injured as a result of the activities.

| **Biological opinion** | **Total number of Desert Tortoises** | | |
|---|---|---|---|
| | **Observed** | **Mortalities** | **Moved from harm's way** |
| **1-6-91-F-28** | 3 | 1 | 1 |
| **1-6-92-F-61** | 1 | 0 | 3 |
| **1-8-93-F-5** | 9 | 0 | 2 |
| **1-8-93-F-18** | 0 | 0 | 0 |
| **1-8-93-F-23** | 18 | 0 | 1 |
| **1-8-93-F-32** | 1 | 0 | 1 |
| **1-8-93-F-35** | 0 | 0 | 0 |
| **1-8-94-F-6** | 68 | 2 | 16 |
| **1-8-94-F-19** | 6 | 0 | 0 |
| **1-8-94-F-25** | 0 | 0 | 0 |
| **1-8-95-F-1** | 0 | 0 | 0 |
| **1-8-95-F-6** | 0 | 0 | 0 |
| **1-8-95-F-31** | 1 | 0 | 0 |
| **1-8-96-F-10** | 2 | 0 | 1 |
| **1-8-96-F-45** | 11 | 0 | 0 |
| **1-8-96-F-56** | 0 | 0 | 0 |
| **1-8-97-F-10** | 73 | 2 | 40 |
| **1-8-97-F-38** | 3 | 0 | 0 |
| **1-8-98-F-21R** | 0 | 0 | 0 |
| **1-8-99-F-58** | 0 | 0 | 0 |
| **Total** | 196 | 5 | 65 |

Total number of desert tortoise observations, mortalities, and moved from harm's way under biological opinions for Edwards Air Force Base from January 1, 1997 to May 31, 2013.

The Air Force is unlikely to find every desert tortoise that dies as a result of its activities. Although we expect that the Air Force's activities have killed more than 5 desert tortoises since its listing, we also expect that the overall number of animals that have died is unlikely to be substantially more than that observed by the Air Force. We have reached this conclusion because the generally low density of desert tortoises on base likely decreases the frequency of interactions between the Air Force's activities and desert tortoises. Additionally, the intensity of monitoring employed by the Air Force and the general high level of awareness of desert tortoises by base personnel in general likely add further protection to individuals of this species.

We expect that desert tortoises occur along the proposed easement for the gen-tie line in low numbers; we are aware of a few desert tortoises that have been detected in the area of the wind farms as a result of surveys conducted in that area. Sheep grazing and unauthorized off-road vehicle use have likely degraded the quality of habitat in this area and resulted in the deaths of desert tortoises. Because of the human activity associated with the residences and businesses, we expect that common ravens are common in this area and exert heavy predation pressure on desert tortoises. We also expect that the presence of State Route 14 has caused a local depression in the number of desert tortoises along the easement.

**Status of Critical Habitat of the Desert Tortoise in the Action Area**

Approximately 65,554 acres of the Fremont-Kramer Critical Habitat Unit are generally located on the south central and eastern portions of Edwards Air Force Base (Air Force 2008b); this area includes portions of Air Force research facilities and the Precision Impact Range Area. (See figure 5-7 in Air Force 2008b). The Air Force did not provide information on the overall condition of the primary constituent elements of critical habitat within the boundaries of Edwards Air Force Base. In general, we expect that the condition of the primary constituent elements within the installation is similar to that within the remainder of the Fremont-Kramer Critical Habitat Unit. That is, although we expect that the first, third, fourth, and fifth primary constituent elements have been affected to some degree by the Air Force's activities, these impacts have not, to date, substantially compromised the conservation value and function of the critical habitat. We expect that invasive plants have compromised the conservation value and function of critical habitat to some degree with regard to the second primary constituent element (i.e., sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species). Because most of the critical habitat within Edwards Air Force Base experiences fewer disturbances than public lands off base, we expect that the sixth primary constituent element (i.e., habitat protected from disturbance and human caused mortality) has not been appreciably affected by human activities.

The Air Force's activities contribute to the less-than-prime condition of the second primary constituent element. As previously mentioned in the Environmental Baseline, desert tortoise critical habitat is present within the Precision Impact Range Area on base; this area is divided into three management zones that roughly correspond with mission use in each zone. Zone 1 is a designated 4,681-acre area that experiences the heaviest use within the Precision Impact Range Area and critical habitat. Approximately 27,902 acres of critical habitat fall within the area

designated as Zone 2, this area experiences a moderate level of activity that is expected to continue at its current rate. Zone 3 encompasses 31,254 acres of the Precision Impact Range Area. Very little activity occurs within this area. The remaining critical habitat on base that is not associated with the three management zones is 1,717 acres.

The following table shows the total acres of habitat disturbance and re-vegetation efforts in desert tortoise critical habitat under active biological opinions for Edwards Air Force Base. The total acres of disturbance and re-vegetation comprise approximately 0.16 and 0.09 percent of the amount of critical habitat that lies with the boundaries of Edwards Air Force Base, respectively. We adapted the table from Mull (2013d) to include only biological opinions in which habitat disturbance or re-vegetation efforts occurred in areas designated as critical habitat.

| **Biological opinion** | **Total acres of desert tortoise critical habitat disturbed** | | **Total acres of re-vegetation** |
|---|---|---|---|
| | **Permanent** | **Temporary** | |
| **1-8-93-F-23** | 0.5846 | 1.59 | 0 |
| **1-8-94-F-6** | 12.452 | 79.036 | 55.45 |
| **1-8-94-F-19** | 0 | 1.77 | 0 |
| **Total** | **13.0366** | **82.396** | **55.45** |

Total acres of habitat disturbance and re-vegetation in desert tortoise critical habitat under biological opinions for Edwards Air Force Base from 1 January 1997 – 31 May 2013.

EFFECTS OF THE ACTION

As we described in the Description of the Proposed Action section of this biological opinion, the Air Force and Service evaluated each of the Air Force's proposed activities and listed the aspects of the activity that may affect desert tortoises or their habitat (including critical habitat). In this section of the analysis, we will provide a general description of how these various aspects affect desert tortoises and their habitat (including critical habitat).

After we review the general mechanisms of how the Air Force's activities may affect desert tortoises and their critical habitat, we will analyze the potential effects of the injury or death of up to 5 desert tortoises per year and the loss of up to 5,000 of critical habitat and 15,000 acres outside of critical habitat. The Air Force and Service developed these numbers as thresholds upon which to base the analysis of Future Development in this biological opinion and to provide a trigger for the re-initiation of formal consultation.

Desert tortoises less than 160 millimeters in length (including hatchlings and eggs) are difficult to detect. Surveyors are less likely to detect them than desert tortoises greater than 160 millimeters because hatchlings can take shelter in burrows of all sizes and are difficult to see due to their cryptic nature and their small size. Consequently, we expect that most hatchlings and eggs likely remain in work areas that have been cleared of larger desert tortoises. We anticipate that future activities are likely to result in injury or mortality of small (i.e., less than 160

millimeters in length) desert tortoises because they are more difficult to detect. Because of their cryptic nature and small size, these mortalities have potential to go undetected. We acknowledge that smaller desert tortoises and eggs may be killed during the implementation of the Air Force's activities; however, because they are difficult to detect and because larger individuals are more important for the long-term conservation of the species, we focused our analysis on larger individuals.

**Driving Off Roads**

*Desert Tortoise*

In general, the use of vehicles off of roads (paved or unpaved) can injure or kill desert tortoises; vehicles traveling off road can also crush desert tortoise burrows trapping individuals in their collapsed burrows. In contrast to recreational off-highway vehicle use, where numerous vehicles travel off road at high speeds and with little or no regard to natural resources, the Air Force's use of vehicles off road are prohibited under normal conditions, but limited off-road use may be required in emergencies or to support specific mission requirements. Because the off-road activities associated with range-ground operations and the expenditure of ordnance and energetic materials are expected to be infrequent and these activities would be controlled by the Air Force, we expect that use of vehicles off paved or unpaved roads is likely to injure or kill few desert tortoises.

*Critical Habitat*

In general, the use of vehicles off of roads (paved or unpaved) can destroy plants needed for cover and food, erode and compact substrates, cause proliferation of weeds, and increase in the number and location of wildfires. We do not expect that the use of vehicles off of roads, at the extent likely to be conducted by the Air Force, would have a measurable effect on the first primary constituent element of critical habitat (sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow). We have reached this conclusion because the Air Force's use would be infrequent and monitored to the extent that it would not reduce the amount of habitat within critical habitat and prevent movement, dispersal, and gene flow.

The second through fifth primary constituent elements (sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species; suitable substrates for burrowing, nesting, and overwintering; burrows, caliche caves, and other shelter sites; sufficient vegetation for shelter from temperature extremes and predators) are related to the biological and physical aspects of critical habitat. We expect the low level of use of vehicles off roads, which will be appropriately monitored, would not affect the function of these aspects of the desert tortoise's habitat in a measurable manner.

This aspect of the Air Force's activities would minimally affect the sixth primary constituent element (habitat protected from disturbance and human caused mortality) because it would occur infrequently and be monitored.

**Driving on Roads**

*Desert Tortoise*

Desert tortoises are generally more easily observed on roads, because of their more even surfaces and lack of plant cover. Roads often allow vehicles to travel at higher speeds, which reduce the likelihood of drivers detecting and avoiding desert tortoises. Rises and turns in roads also decrease the ability of drivers to detect desert tortoises. Along heavily used roads, the number of desert tortoises is depressed for some distance from the edge of the road as a result of road-associated mortality; this distance varies with the level of use of the road. In general, vehicle use is likely to result in at least some mortalities of and injuries to desert tortoises; the extent of the loss is related to the condition of the road, the time of the year when vehicle use occurs, the abundance of desert tortoises, and the awareness of the driver. Even the most careful drivers may occasionally strike a desert tortoise.

To date, most of the reported desert tortoise mortalities that have occurred in the action area resulted from vehicles driving over them on roads during permitted activities (Mull 2013c). Additionally, personnel have moved many more from roadways. The Air Force addresses this threat in its protective measures by posting signs for reduced speed limits where appropriate. We expect this threat to persist throughout the action area.

*Critical Habitat*

The use of existing roads will not affect the second through fifth primary constituent elements because these physical and biological aspects of critical habitat are no longer present within roads. Roads that experience high levels of traffic can essentially form a barrier to movement, dispersal, and gene flow (first primary constituent element); we do not expect that any roads within Edwards Air Force Base within desert tortoise habitat experience this level of traffic. High levels of traffic may affect the sixth primary constituent element (habitat protected from disturbance and human caused mortality) by increasing the number of desert tortoises that are injured or killed; we do not anticipate that traffic levels in desert tortoise habitat would rise to such levels.

**Ground Disturbance**

*Desert Tortoise*

We consider ground disturbance to include any activity where the Air Force's activities disrupt vegetation and substrate through the use of heavy equipment and materials. Desert tortoises may be injured or killed or trapped in their burrows during these activities. Some of the Air Force's

activities may cause negligible amounts ground disturbance. Conversely, the construction of a new target or building may result in ground disturbance over a larger area.

Because the Air Force would use standard and successful measures and experienced staff to avoid injuring or killing desert tortoises during ground-disturbing activities, we expect that relatively few individuals are likely to be injured or killed as a result of ground disturbance.

*Critical Habitat*

Ground disturbance has the potential to adversely affect all the primary constituent elements of critical habitat. Small amounts of ground disturbance that are temporary in nature would generally affect critical habitat less than larger areas of permanent disturbance, although some indirect effects of smaller projects (e.g., the proliferation of weeds) can extend well beyond the temporal and spatial footprint of a project.

**Explosions**

*Desert Tortoise*

Ordnance or other materials associated with explosions could strike a desert tortoise directly. Additionally, unforeseen explosions such as an accidental crash of an unmanned aerial vehicle could also strike and injure or kill a desert tortoise. Such events are likely extremely rare, given the large area of the target sites, the sparse distribution of desert tortoises, and the relatively small area that the explosion would affect. Additionally, the Air Force's standard practice is to check areas within desert tortoise habitat before emergency scheduled explosions occur to remove any desert tortoises that may be present. Some potential exists that large explosions can cause over pressure vibrations that would cause nearby burrows to collapse and trap desert tortoises inside.

Desert tortoises may be injured by noise associated with explosions. Bowles et al. (1999) found that subsonic and supersonic aircraft noise did not elicit substantial responses from desert tortoises. If a desert tortoise were close to a large explosion, however, we expect that the noise would have the potential to cause physical damage to the animal. Because the Air Force inspects areas and would remove desert tortoises before explosions occur, few desert tortoises are likely to be injured or killed by explosions.

The Air Force's use of the target sites and open burn/open detonation facilities can reasonably be expected to start fires under the appropriate conditions. Therefore, we will consider these fires as a likely effect of explosions. Desert tortoises may be burned to death from fires started by weapons testing, open burn/open detonation activities in areas containing vegetation, lightning or aircraft crashes (Air Force 2008a). Fires can injure or kill desert tortoises that are away from their burrows; the use of fire equipment to fight fires could also kill desert tortoises. Larger fires during times of the year and day when desert tortoises are active are more likely to injure or kill desert tortoises than smaller fires when desert tortoises are inactive (i.e., in their burrows). Desert tortoises are less likely to be present in areas that have repeatedly burned, where non-

native grasses predominate; to the extent that at least some fires occur in such areas, the risk of desert tortoises being injured or killed by fire is somewhat reduced.
The Air Force's fire management measures are likely to reduce the potential for fires started at target sites. This measure is protective of desert tortoises because fires can kill desert tortoises that may be above ground.

*Critical Habitat*

The Air Force's use of explosives would not directly impair the value and function of critical habitat with regard to the first primary constituent element (sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow). We have reached this conclusion because the explosions occur in relatively small areas that are used repeatedly. Most explosions would likely occur in areas that have been previously used for such work. However, if a large fire spread from target sites, the potential exists that habitat conditions could be altered to the extent that desert tortoises would no longer traverse such areas.

Large explosions would likely alter the quality and quantity of forage species and the soil conditions to provide for the growth of these species in new target areas (the second primary constituent element); target areas that have been used previously likely no longer support these features. Smaller explosions likely have little or no direct effect on this primary constituent element. As we previously discussed, fire spreading from a target area would likely reduce the value and function of this primary constituent element.

Large explosions likely damage substrates for burrowing, nesting, and overwintering (third primary constituent element) and burrows, caliche caves, and other shelter sites (fourth primary constituent element). Because most explosions would occur in previously used, defined target areas, damage to substrates and shelter sites is likely to be minimal. Fire may affect substrates and shelter sites if it removes sufficient plant cover to increase erosion during storm events. Large explosions would remove vegetation that desert tortoises use for shelter from temperature extremes and predators (the fifth primary constituent element), but generally in a limited area. This adverse effect would be reduced by the use of existing target sites. Fire would affect shelter sites provided by shrubs if it spreads beyond the disturbed target site.

The repeated use of target sites would reduce the potential for explosions to have a measurable effect on the sixth primary constituent element (habitat protected from disturbance and human-caused mortality) because the disturbance and potential for mortality of desert tortoises would be limited to a relatively small portion of critical habitat. Conversely, the creation of new bombing targets in critical habitat requires the Air Force to clear additional lands. As with the other primary constituent elements, fire that spreads beyond disturbed areas around the target sites would increase the adverse effect.

The Air Force's fire management measures likely reduce the potential that fires started at target sites would have a measurable effect on the primary constituent elements of critical habitat of the desert tortoise. One of the primary natural resources management goals of the base's integrated

natural resources management plan is to conserve natural resources in a manner consistent with the military mission and the base's wildland fire management plan by implementing effective suppression of wildland fires and minimizing fire and structural damage to biological resources (Air Force 2008b). Although Edwards Air Force Base has over 200,000 acres of unimproved vegetated terrain, the base has not had a history of a severe fire danger hazard over the past 25 years; lightning is the primary cause of fires on base (Air Force 2008b).

**Non-native Plant Species**

*Desert Tortoise*

Vehicles, ground disturbance, fire, and other human activities contribute to the dispersal of non-native plant species. These non-native plants include species that are already present in the California desert and newly introduced species. As we discussed in the Status of the Species and Critical Habitat section of this biological opinion, non-native plants can alter the quality and quantity of plant foods available to desert tortoises and thereby affect their nutritional intake.

*Critical Habitat*

The spread of non-native plant species may impair the value and function of the first primary constituent element (sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow) if they become so widespread and dense that they reduce the ability of desert tortoises to forage over wide areas. This threat is most prominent in the action area where fires have the potential to alter habitat conditions on a large scale.

As we discussed in the Status of Critical Habitat of the Desert Tortoise section of this biological opinion, the function and value of the second primary constituent element (sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species) have been compromised to some degree throughout the range of the desert tortoise. The Air Force's activities, particularly near targets where fires are more likely, may exacerbate this threat.

The spread of non-native plant species is not likely to affect the third and fourth primary constituent element (suitable substrates for burrowing, nesting, and overwintering; burrows, caliche caves, and other shelter sites). We have reached this conclusion because the plants would not generally affect substrates or shelter sites used by desert tortoises.

Non-native plant species can degrade vegetation that desert tortoises use to seek shelter from temperature extremes and predators (the fifth primary constituent element), primarily by supporting larger and more intense fires. Most shrubs in the California desert are not adapted to fire. Once fire kills these shrubs, they are unlikely to return, thus depriving desert tortoises of shelter sites.

Habitat that is degraded by the presence of a large component of non-native species has not been protected from disturbance and human-caused mortality (the sixth primary constituent element). Consequently, spread of non-native plant species has the potential to further degrade the value and function of this primary constituent element.

As we discussed in the Status of the Desert Tortoise section of this biological opinion, current information indicates that invasive species likely affect a large portion of the desert tortoise's range. Non-native species can occur in densities that can increase the risk of fires, which, in turn, destroy native species and may result in future habitat loss. Non-native plant species currently occur throughout Edwards Air Force Base (see Appendix B in 2008b). The Air Force's wildland fire management plan (Appendix H in Air Force 2008b) has potential to reduce the spread of non-native plant species by implementing effective suppression of wildland fires and minimizing fire and structural damage to biological resources. In the event of a wildfire that may affect desert tortoises or their critical habitat, the Air Force and Service would consult under the emergency provisions of section 7(a)(2) of the Endangered Species Act.

**Common Ravens**

*Desert Tortoise*

The Air Force has proposed to manage its trash and debris to reduce the attractiveness of Edwards Air Force Base to common ravens. This protective measure would likely be effective in reducing some level of food subsidies to common ravens. We expect that buildings and other structures on the Edwards Air Force Base would continue to provide common ravens with more perching, roosting, and nesting sites than would be found in a natural setting. We also expect that common ravens also derive at least some food and water from the residential area of the installation. Future development may lead to an increase in the number of people using the residential area, which may, in turn, increase the amount of food and water available to common ravens. Any increase in the number of common ravens would likely result in increased predation of desert tortoises.

*Critical Habitat*

Common ravens do not affect the primary constituent element of critical habitat.

**Moving Desert Tortoises from Harm's Way**

*Desert Tortoise*

Some potential exists that capturing desert tortoises to move them from harm's way may cause elevated levels of stress that may render these animals more susceptible to disease. Because the Air Force will use experienced biologists approved by the Service and approved handling techniques, collected desert tortoises are unlikely to experience elevated stress levels. Information from a translocation project at Fort Irwin indicates that translocation of desert

tortoises in that study did not cause a measurable physiological stress response (Drake et al. 2012). In the case of Fort Irwin, the animals were often moved far from their home ranges. Because the Air Force's activities are of a smaller scale, desert tortoises moved from harm's way would likely remain within their home ranges; therefore, we expect that the potential for these animals to be stressed is even lower.

*Critical Habitat*

Moving desert tortoises from harm's way will not affect critical habitat because this activity primarily involves the transport of individuals a relatively short distance by a biologist who is traveling on foot. Neither the desert tortoises themselves nor the personnel who transport them will affect the primary constituent elements of critical habitat. The construction of artificial burrows would disturb limited areas where annual plants could grow and their supporting substrates; however, this disturbance will not measurably affect the value or function of the primary constituent elements of critical habitat.

**Personnel on Foot**

*Desert Tortoise*

Because of their small size, hatchlings and slightly larger desert tortoises could be trampled by foot traffic. Nests are also vulnerable, but their typical location, near the mouth of a burrow, likely protects them to some degree.

We expect that few desert tortoises would be injured or killed in this manner because most Air Force personnel working in desert tortoise habitat will receive specific training, which would increase their awareness of this potential threat. Additionally, we expect that the likelihood of stepping on desert tortoises would generally be low because most activities involving personnel on foot would occur in a relatively limited area of the base and most frequently in situations where the Air Force has conducted surveys to protect desert tortoises.

*Critical Habitat*

This activity will not affect the primary constituent elements of critical habitat because of the general low level and intensity of use.

**Habitat Conversion**

*Desert Tortoise*

Various activities that the Air Force may undertake have the potential to cause habitat conversion. The act of converting habitat from an area that is suitable for desert tortoises into some other environment has the potential to kill the individuals living in that area. Generally, the

heavy equipment that is involved in the conversion of habitat would crush any desert tortoises that are present.

As we have discussed previously in this biological opinion, other factors, such as fire and an overabundance of non-native species can, either together or separately, covert an area of suitable habitat for desert tortoises into something that is far less able to support them. Over time, desert tortoises that are forced to live in such areas are likely to die as a result of starvation; prior to that, their reproductive output would likely be lower because of their poorer physiological condition.

*Critical Habitat*

Suitable habitat generally is that which contains the primary constituent elements of critical habitat in a functioning condition. In the context of critical habitat, habitat conversion would occur when the amount of disturbance or alteration of a primary constituent element removes its function or value. Any ground-based activity that the Air Force undertakes could potentially disturb or alter, to some degree, the primary constituent elements. As examples, the extensive use of off-road vehicles could decrease the amount of space needed to support a viable population of desert tortoises and to provide for movement, dispersal, and gene flow within the Western Mojave Recovery Unit. Vehicles traveling off roads could decrease the quality and quantity of forage species and the substrate conditions that support the growth of these species and for burrowing; off-road travel could also destroy burrows, caliche caves, and other shelter sites and the perennial vegetation that desert tortoises use for shelter from temperature extremes and predators. Off-road vehicle use would increase the amount of disturbance and human-caused mortality in the area in which it occurred.

**Future Development**

In this biological opinion, we considered future development to be any activity that the Air Force undertakes for which this biological opinion serves as compliance with the Endangered Species Act. Consequently, we consider the future injury or death of any desert tortoise that may result from an otherwise legal activity to have been analyzed in this biological opinion, provided that it is within the parameters proposed by the Air Force. With regard to habitat and critical habitat, we expect the Air Force to track any loss of habitat or critical habitat caused by any otherwise legal activity it conducts or authorizes. Disturbance resulting from activities that occur in previously disturbed areas that do not support the biological or physical attributes of desert tortoise habitat or in undisturbed natural areas that do not support desert tortoise habitat (e.g., dry lake beds) would not be considered to involve the loss of desert tortoise habitat.

*Desert Tortoise*

The regulatory definition of "to jeopardize the continued existence of the species" focuses on assessing the effects of the proposed action on the reproduction, numbers, or distribution of the species being considered in the biological opinion. For that reason, we have used those aspects

of the desert tortoise's status as the basis to assess the overall effect of the proposed action on the species.

In the first portion of the Effects of the Action section of this biological opinion, we provided a general description of how the various activities that the Air Force expects to undertake are likely to affect desert tortoises. In the following sections, we will use the proposed re-initiation threshold of five desert tortoises killed in a year to determine how the future operation of Edwards Air Force Base would affect the reproduction, number, and distribution of the desert tortoise. We will then assess the effects of the proposed action on the recovery of the species and whether it is likely to appreciably reduce the likelihood of both the survival and recovery of the desert tortoise. We reach our conclusion regarding whether an action is likely "to jeopardize the continued existence of the species" through an analysis of how a proposed action affects the listed taxon within the action area in relation to the range of the entire listed taxon. For the desert tortoise, this process involves considering the effects at the level of the action area, then at the level of the recovery unit (in this case, the Western Mojave Recovery Unit), and then finally for the range of the listed taxon. Logically, if an aspect of the proposed action is unlikely to cause a measurable effect within the action area, it is unlikely to affect the recovery unit or the remainder of the range.

Reproduction

The reproductive output of individuals of a species is determined in part by the species' breeding ecology, overall abundance of breeding individuals, and the condition of the habitat in which they live. The reproductive output of the desert tortoise is governed by several aspects of its breeding ecology: the delayed onset of breeding, many years of reproduction, high mortality rates of eggs and young, and low mortality rates among adults. If the population of desert tortoises at Edwards Air Force Base was stable or increasing, the loss of five individuals per year to human activities would be unlikely to have a measurable effect on its overall reproductive capacity. The long reproductive life of female desert tortoises and the normally low mortality rates among adult animals are factors that would protect the reproductive output of a population.

The overall abundance of breeding individuals would also influence how the loss of five desert tortoises per year affects their reproductive output at Edwards Air Force Base. In general, desert tortoises occur at low densities in most areas of the base; the highest density is 58 desert tortoises over one square mile. In some areas, their densities are extremely low. The effects of the mortality of five desert tortoises per year within Edwards Air Force Base may negatively affect the amount of reproduction for several reasons. First, the loss of even a small number of individuals in a low-density population could render finding mates more difficult. Second, desert tortoises require from 13 to 20 years to reach sexual maturity. Third, females produce a relatively small number of eggs per year. Fourth, desert tortoises also experience high mortality early in life (including as eggs). Consequently, even moderate downward fluctuations in adult survival rates can result in rapid population declines; slow reproductive rates and high juvenile mortality limit the capacity of populations to increase rapidly after a decline (Service 2011a).

The desert tortoise possesses two safeguards against the loss of reproduction in areas of low population density. First, female desert tortoises can store sperm for several years; this trait provides some hedge against low densities precluding reproduction because females do not need to encounter males every year to produce young. Second, breeding-age desert tortoises would continue to produce young over their long reproductive life; this reproductive output could replace individuals that are killed by the Air Force's activities.

The amount and timing of rainfall in the desert greatly influences the production of native annual plants upon which desert tortoises feed. A high diversity and abundance of annual plants provide desert tortoises with the appropriate quality and quantity of food to persist and to produce eggs. The widespread invasion of non-native annual plants has likely reduced the desert tortoise's ability to obtain the appropriate quality and quantity of forage plants on a consistent basis. Human disturbance of substrates and increased frequency of fires render desert habitat more susceptible to invasion by non-native annual plants. The Air Force does not implement specific measures to control weed infestations that its activities may cause. Consequently the Air Force's activities have the potential to indirectly affect desert tortoise habitat well outside the footprint of areas that it directly disturbs. Some potential exists that non-native plants are already established at Edwards Air Force Base to the degree that the Air Force's activities would not exacerbate the situation. If the Air Force introduced new species of invasive plants during its activities or expanded the area of infestation of invasive species already on base, the quality of desert tortoise habitat would likely further decrease; such a decrease would negatively affect the ability of Edwards Air Force Base to support the reproduction of desert tortoises at the highest levels of productivity.

Based on these factors, we conclude that the loss of five individuals per year to the Air Force's activities is likely to cause a minor depression of reproduction of desert tortoises at Edwards Air Force Base. We acknowledge that all five individuals may not be of reproductive age; the loss of non-reproductive individuals would not have an immediate effect on reproduction. We also acknowledge that the loss of younger animals would reduce their potential recruitment into breeding age individuals.

Our determination with regard to whether a proposed action is likely to jeopardize the continued existence of a species is based on the status of the listed taxon throughout its range and not just within the action area. Consequently, although the loss of five desert tortoises per year at Edwards Air Force Base is likely to cause a minor depression of reproduction of desert tortoises at Edwards Air Force Base, this loss is unlikely to have a measurable effect on the reproduction of desert tortoises within the Western Mojave Recovery Unit or range wide. We have reached this conclusion because Edwards Air Force Base comprises a small portion of the Western Mojave Recovery Unit and an even smaller portion of the species' range. The next section of this analysis provides insight into the numbers of desert tortoises within Edwards Air Force Base, the Western Mojave Recovery Unit, and range wide.

Number

We used the reports on range-wide sampling for the last 3 years (Service 2012b, 2012c, 2012d) to assess how the loss of 5 individuals per year at Edwards Air Force Base would affect the desert tortoise, first within the Western Mojave Recovery Unit (which is where Edwards Air Force Base is located) and then throughout its range. The numbers in the following table are desert tortoises that are greater than 180 millimeters in length that reside in the sampled areas of critical habitat and other desert tortoise conservation areas; because these numbers do not include smaller individuals and desert tortoises that reside outside the sampled areas, we expect that more desert tortoises occur in the Western Mojave Recovery Unit and throughout the range than are represented in this table. Because of the complexity involved with sampling desert tortoises on such a large scale, the changes in numbers from year to year are more likely from sampling error than actual trends or changes in the number of individuals.

| Year | Area of Estimate | Number of Desert Tortoises | | |
|---|---|---|---|---|
| | | Estimated | Lower 95 Percent CI | Upper 95 Percent CI |
| 2010 | Western Mojave | 20,264 | 13,153 | 31,329 |
| | Range-wide | 95,145 | 77,038 | 117,511 |
| 2011 | Western Mojave | 21,533 | 12,600 | 37,120 |
| | Range-wide | 99,568 | 69,324 | 143,007 |
| 2012 | Western Mojave | 22,260 | 19,894 | 46,735 |
| | Range-wide | 71,827 | 46,685 | 110,509 |

To assume the most conservative approach to this analysis, we assumed that the actual numbers of desert tortoises in the Western Mojave Recovery Unit and range wide were the lowest results from these 3 years (12,600 and 46,685). We also assumed that all five desert tortoises that die would be reproductive. These losses amount to approximately 0.04 and 0.01 percent of the number of desert tortoises over 180 millimeters within sampled areas in Western Mojave Recovery Unit and throughout the range; these percentages would decrease even further if we considered all desert tortoises through the entire recovery unit and range.

Because the Air Force's activities would continue over time, we also calculated how the loss of five individuals over a 20-year period would affect desert tortoise populations. The loss of 100 desert tortoises would comprise approximately 0.79 and 0.21 percent of the Western Mojave Recovery Unit and range-wide populations, respectively.

We acknowledge that we cannot predict whether the numbers of desert tortoises at Edwards Air Force Base, within the Western Mojave Recovery Unit, or range wide would change over the next 20 years. If the number of desert tortoises at Edwards Air Force Base decreases, we expect that the Air Force would encounter fewer individuals while it is implementing actions and, therefore, fewer individuals are likelier to die. If more desert tortoises number occur at Edwards Air Force Base in the future, the risk that desert tortoises would die at any given project would increase but the Air Force's proposed protective measures (including a commitment to re-initiate

formal consultation if five are killed in a year) would prevent an appreciable increase in mortalities.

Consequently, based on the best available information, we conclude that the loss of five desert tortoises per year is not likely to appreciably diminish the number of desert tortoises, either within the Western Mojave Recovery Unit or range wide.
We did not discuss the injury of desert tortoises in this section. The implementing regulations for section 7 of the Endangered Species Act at 50 Code of Federal Regulations 402.14(i)(1)(iv) require the Service to specify the procedures to be used to handle or dispose of any individuals of a species that is killed or injured during the implementation of a proposed action that has undergone formal consultation. Consequently, in the Incidental Take Statement - Disposition of Dead or Injured Specimens section of this biological opinion, we will direct the Air Force to take injured desert tortoises to a qualified veterinarian for treatment and to contact us regarding the final disposition any these animals. If they recover from their injuries to the extent that they can be released to the wild, these animals would not be included in the annual count of dead desert tortoises.

Distribution

Edwards Air Force Base occupies approximately 307,516 acres. Of this total, areas of unsuitable habitat (e.g., Buckhorn, Rogers, and Rosamond dry lakes), cantonment areas; research facilities, fenced operational areas, graded targets, other operational areas, and housing cover approximately 80,640 acres. Consequently, approximately 226,876 acres of desert tortoise habitat occur on base.

The Air Force has proposed to re-initiate formal consultation if 20,000 acres of desert tortoise habitat (15,000 acres outside of critical habitat boundaries and 5,000 within the boundaries of critical habitat) are disturbed by future development. This amount of long-term disturbance would comprise up to approximately 9.09 percent of the desert tortoise habitat on Edwards Air Force Base. Previous consultations with the Air Force generally involved numerous actions that affected scattered, relatively small areas of desert tortoise habitat across Edwards Air Force Base. We expect this general pattern to continue. One exception is the Air Force's proposal to allow for the development and operation of a large solar plant in the northwest corner of Edwards Air Force Base. This solar plant may occupy up to 4,000 acres. We do not have information on the final design of the plant at this time; however, some potential exists that the Air Force and operator would not exclude desert tortoises from the entire project area during its operation.

This future development, including the solar plant in the northwestern corner of the base, would reduce the amount of habitat on base and increase, to some degree, the amount of fragmentation on a local scale. Based on the Nussear et al. (2009, using values of 0.5 to 1) model and our calculations (Waln 2010), the Western Mojave Recovery Unit may support up to 10,316 square miles of desert tortoise habitat. Consequently, the proposed action would result in the loss of approximately 0.30 percent of the habitat in the Western Mojave Recovery Unit. (That is,

20,000 acres of disturbance divided by 640 acres per square mile equals 31.25 square miles. 31.25 square miles divided by 10,316 square miles equals 0.00302. 0.00302 multiplied by 100 equals 0.30 percent.) Because the area that may be disturbed at Edwards Air Force Base is a small proportion of the available habitat in the Western Mojave Recovery Unit and because most of the projects that the Air Force undertakes would be relatively small and scattered throughout

the base, we do not expect this loss of habitat to appreciably reduce the distribution of the desert tortoise with regard to the Western Mojave Recovery Unit.

This loss would comprise approximately 0.11 percent of the range-wide distribution of the desert tortoise, which covers approximately 28,417 square miles, using the values of 0.5 to 1 in the Nussear et al. (2009) model and our calculations (Waln 2010). (That is, 31.25 square miles of disturbance divided by 28,417 square miles equals 0.00109. 0.00109 multiplied by 100 equals 0.11 percent.) This loss of habitat is unlikely to appreciably reduce the distribution of the desert tortoise in relation to the range of the listed taxon.

*Critical Habitat*

We have previously discussed how the various aspects of the Air Force's activities would affect the primary constituent elements of critical habitat, so we will not repeat those analyses here. For the purposes of this analysis, we will assume that any future development within critical habitat is likely to reduce or eliminate the function of the primary constituent elements within the boundaries of that project's area; in terms of the analysis, this assumption likely overstates the effect because some of the primary constituent elements would likely remain after the implementation of at least some of the future actions.

The Air Force anticipates that it may need up to 5,000 acres for the development of new facilities, infrastructure, and new or expanded targets within the approximately 60,800 acres of critical habitat that lie within Edwards Air Force Base. Future development would likely be scattered throughout critical habitat in variously sized parcels. We expect that the Air Force is unlikely to situate larger developments within critical habitat because larger facilities would require more infrastructure support and most of the existing infrastructure is located outside of critical habitat.

The loss or disturbance of 5,000 acres of critical habitat during future development and operations of Edwards Air Force Base has the potential to increase the patchiness of suitable habitat because it could occur in numerous locations. Conversely, we do not expect that scattered development throughout the area of critical habitat within Edwards Air Force Base would measurably affect connectivity, either within or outside of the base. This amount of disturbance would also occupy a relatively small area of the critical habitat on base.

The 5,000 acres comprise approximately 0.96 percent of the Fremont-Kramer Critical Habitat Unit. (That is, 5,000 acres of development divided by 518,000 acres of critical habitat within the Fremont-Kramer Critical Habitat Unit times 100 equals 0.96 percent.) The Service must

consider the effects of a proposed action with regard to the entirety of the 6,446,200 acres of critical habitat that it designated. The 5,000 acres that may be lost or disturbed at Edwards Air Force Base comprise approximately 0.08 percent of critical habitat throughout the range. Because the amount of critical habitat to be lost or disturbed is so small relative to the entire designated area, it is not likely to appreciably diminish the value or function of critical habitat.

**Effects on Recovery**

Edwards Air Force Base occupies a relatively small portion of the Western Mojave Recovery Unit and an even smaller portion of the range of the desert tortoise. Consequently, the activities that the Air Force conducts on base under consideration in this biological opinion are unlikely to have an appreciable direct effect, either positively or negatively, on the recovery of the desert tortoise. The relatively small number of desert tortoises that we expect the Air Force to kill annually is unlikely to appreciably diminish the ability of the desert tortoise to reach stable or increasing population trends in the future. The Air Force's efforts to re-vegetate disturbed areas, close unneeded roads and unused excavations to reduce mortality of desert tortoises, and install exclusion fence and warning signs along roads to reduce mortality on active roads are likely to promote the conservation of the species within Edwards Air Force Base.

We do not consider the maintenance of head starting pens to raise desert tortoises for release to the wild to be an effective tool for recovery of the species at this time. Mortality rates among wild desert tortoises likely remain too high for desert tortoises released from head-starting pens to result in an expanded population; we also suspect that recruitment of reproductive animals from the ranks of juvenile desert tortoises is not occurring at a sustainable rate in at least some areas of the desert. Various studies have shown that protection of reproductive desert tortoises would contribute far more to the stabilization of population trends than the release of smaller individuals. Until we can improve the survival rate of reproductive desert tortoises (and rate of recruitment of juveniles to a reproductive size), the practice of head starting is highly unlikely to affect an increase in wild populations.

The Readiness and Environmental Protection Initiative would implement an important recovery task for the desert tortoise through the Air Force's acquisition in fee title or by easement lands with critical habitat that lie to the east of the base. These acquisitions would preclude the development of the land; such development is generally detrimental, both directly and indirectly, to the long-term conservation of the desert tortoise.

Overall, the operation of Edwards Air Force Base, as described in this biological opinion, including the development of solar energy facilities, is unlikely to adversely affect the recovery of the desert tortoise. We expect the adverse effects of the Air Force's operations to be relatively minor in relation to the range-wide status of the desert tortoise; the Air Force's on-base programs to restore habitat and reduce the mortality of desert tortoises have the potential to offset, to some degree, the adverse effects of its operations. If the Readiness and Environmental Protection Initiative is successfully implemented over time, the removal of the threat of development on

lands important to the long-term conservation of the desert tortoise would constitute an overall positive effect on recovery.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Most of the action area is entirely located within Edwards Air Force Base and is therefore on Federal lands; any future actions will be subject to the consultation requirements of section 7(a)(2) of the Act. A small portion of the action area extends from the northwestern corner of Edwards Air Force Base to the Windhub Substation on Oak Creek Road. We are unaware of any non-federal actions that are reasonably certain to occur in this area. Consequently, the proposed action has no associated cumulative effects.

CONCLUSION

*Desert Tortoise*

After reviewing its current status, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the desert tortoise. We have reached this conclusion for the following reasons. First, the Air Force has proposed measures to reduce the number of desert tortoises that are likely to be injured or killed in the course of its activities. Second, the few desert tortoises that the Air Force is likely to kill is a minor fraction of the number of desert tortoises range-wide; the loss of these animals is unlikely to measurably affect the number of desert tortoises or reproductive capacity of the listed taxon. Third, the Air Force's efforts to reduce hazards to desert tortoises (e.g., fencing roads and closing excavation in which they can become trapped) are likely to reduce the level of ongoing mortality on base. Fourth, the loss of habitat that is likely to occur during future activities at Edwards Air Force Base will not appreciably reduce the distribution of the desert tortoise.

*Critical Habitat of the Desert Tortoise*

After reviewing the current status of critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to result in the destruction or adverse modification of critical habitat of the desert tortoise. We have reached this conclusion because the amount of critical habitat that is likely to be affected comprises a small portion of the total amount of the critical habitat on Edwards Air Force Base, which itself is a small portion of the larger Fremont-Kramer Critical Habitat Unit and an even smaller portion of critical habitat range wide. Therefore, the amount of disturbance is not likely to compromise the conservation function and value of critical habitat for the desert tortoise.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened wildlife species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission which creates 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. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not the purpose of, the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement and the avoidance and minimization measures proposed by the Air Force.

The measures described below are non-discretionary; the Air Force must implement these measures during the conduct of its activities or include them as binding conditions of any grant or permit issued to its customers and contractors, as appropriate, for the exemption in section 7(o)(2) to apply. The Air Force has a continuing duty to regulate the activity covered by this incidental take statement. If the Air Force fails to assume and implement the terms and conditions or fails to require its customers and contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Air Force must report the progress of the actions and its impact on the species to the Service as specified in the incidental take statement (50 Code of Federal Regulations 402.14(i)(3)).

The Service anticipates that five desert tortoises per year are likely to be taken, in the form of mortality, as a result of the operation of Edwards Air Force Base. We derived this number through discussions with the Air Force and used it as the basis of our section 7(a)(2) analysis in this biological opinion. This number also serves as a basis for the re-initiation of formal consultation.

We do not expect removing desert tortoises from harm's way during the implementation of the Air Force's activities to result in their injury or mortality. Therefore, we are not including an anticipated amount or extent of this form of take (i.e., capture).

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

The Air Force and Service agreed to several revisions to the proposed action during the course of formal consultation. Because these revisions have been incorporated into the proposed action of

this biological opinion, we have no additional reasonable and prudent measures or terms and conditions.

As described at the beginning of this section, the protective coverage of section 7(o)(2) may lapse if the Air Force does not abide by the protective measures described in this biological opinion. Additionally, the Air Force remains responsible for complying with the provisions of

Reporting Requirements and Disposition of Dead or Injured Specimens sections of this biological opinion.

REPORTING REQUIREMENTS

Pursuant to 50 Code of Federal Regulations 402.14(i)(3), the Air Force must provide a report to the Service that provides details on each desert tortoise that is killed or injured by its activities. In addition to the information that the Air Force will provide to the Service in its annual report, as described in the Administration of the Consultation section of this biological opinion, the report must also include information on any instances when desert tortoises were killed, injured, or handled, the circumstances of such incidents, and any actions undertaken to prevent similar instances from re-occurring. The report must also include a description of the monitoring efforts that occurred during implementation of actions that occur with desert tortoise habitat.

DISPOSITION OF DEAD OR INJURED SPECIMENS

Within 3 days of locating any dead or injured desert tortoises, the Air Force must notify the Ventura Fish and Wildlife Office by telephone (805 644-1766) and by facsimile or electronic mail. The report must include the date, time, and location of the carcass, a photograph, cause of death, if known, and any other pertinent information.

The Air Force must take any injured desert tortoises to a qualified veterinarian for treatment. If any injured desert tortoises survive, the Air Force must contact the Service regarding their final disposition.

Care must be taken in handling dead specimens to preserve biological material in the best possible state for later analysis, if such analysis is needed. The Service will make this determination when the Air Force provides notice that a desert tortoise has been killed by project activities.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recognizes the effort that the Air Force's undertakes to conserve desert tortoises and their habitat. To meet its obligations under section 7(a)(1) of the Act, the Air Force has implemented several actions. For example, the Air Force has provided funds or personnel to conduct line-distance sampling within the Fremont-Kramer Critical Habitat Unit; the data generated by this sampling effort assists the Service in determining population trends across the range of the desert tortoise.

The Air Force is also working in conjunction with nongovernment conservation organizations to acquire lands through the Readiness and Environmental Protection Initiative program. This program supports cost-sharing partnerships authorized by Congress between the military, private conservation groups, and state and local governments to protect military test and training capabilities and conserve land. In the case of Edwards Air Force Base, the Air Force's goal of maintaining open space under the test flight corridors to the north of the base coincides with the Service's goal of conserving critical habitat of the desert tortoise.

The Air Force plans to continue to close and rehabilitate off-highway vehicle routes near the base and within the Fremont-Kramer Critical Habitat Unit to protect regional desert tortoise populations. Within Edwards Air Force Base, the Air Force plans to continue efforts to install desert tortoise barrier fencing and culverts along heavily traveled roads crossing desert tortoise habitat. The Air Force will prioritize the fencing of areas with high densities of desert tortoises or critical habitat; implementation of these actions is contingent upon available funding. To date, the Air Force has installed approximately 13 miles of desert tortoise exclusionary fencing along roads within Edwards Air Force Base.

In addition to these actions, we also recommend that the Air Force:

1. Assist the Service in implementation of the management plan for the common raven, control of feral dogs, management of subsidies for coyotes (*Canis latrans*), and numerous other activities that are intended to reduce the mortality levels of desert tortoises and improve habitat conditions.

2. Mark small desert tortoises from within project sites prior to their movement from harm's way or translocation. This marking would provide some information on their post-project status if they are encountered during future surveys or monitoring efforts. If the Air Force determines that it will include this requirement, we suggest that the authorized biologist contact the Desert Tortoise Recovery Office to ascertain the most appropriate means of marking the animals.

The Service requests notification of the implementation of any conservation recommendations so we may be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats.

RE-INITIATION NOTICE

This concludes formal consultation on operations at Edwards Air Force Base. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) if the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the exemption issued pursuant to section 7(o)(2) will have lapsed and any further take would be a violation of section 4(d) or 9. Consequently, we recommend that any operations causing such take cease pending re-initiation.

If you have any questions, please contact Rachel Henry or Ray Bransfield of my staff at (805) 644-1766, extension 333 and 317.

Sincerely,

Stephen P. Henry
Acting Field Supervisor

Appendices

1. Mojave population of the desert tortoise (*Gopherus agassizii*). 5-year review: summary and evaluation. Available on disk or hard copy by request or at http://ecos.fws.gov/docs/five_year_review/doc3572.DT%205Year%20Review_FINAL.pdf.
2. Solar projects for which the U.S. Fish and Wildlife Service has issued biological opinions or incidental take permits.

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Appendix 2. Solar projects for which the U.S. Fish and Wildlife Service has issued biological opinions or incidental take permits.

The following table summarizes information regarding the proposed solar projects that have undergone formal consultation with regard to the desert tortoise. In the Citations column, a single reference indicates that the acres of desert tortoise habitat and number of desert tortoises are estimates from the biological opinion; when the column includes two citations, the first is for the acres of desert tortoise habitat from the biological opinion and the second is for number of desert tortoises that are known to have been translocated or killed during construction.

| Project and Recovery Unit | Acres of Desert Tortoise Habitat | Desert Tortoises Estimated[1] | Desert Tortoises Observed[2] | Citations[3] |
|---|---|---|---|---|
| **Eastern Mojave** | | | | |
| Ivanpah Solar Electric Generating System | 3,582 | 1,136 | 173 | Service 2011a, 2013d |
| Stateline Solar | 1,685 | 94 | - | Service 2013a |
| Silver State North – NV | 685 | 14 | 4 | Service 2010a, Cota 2013 |
| Silver State South – NV | 2,427[4] | 122[4] | - | Service 2013a |
| Amargosa Farm Road – NV | 4,350 | 4 | - | Burroughs 2012 |
| **Western Mojave** | | | | |
| Abengoa Harper Lake | Primarily in abandoned agricultural fields | 4 | - | Service 2011b |
| Chevron Lucerne Valley | 516 | 10 | - | Service 2010b |
| **Northeastern Mojave** | | | | |
| Nevada Solar One - NV | 400 | [5] | [5] | Burroughs 2012, 2014 |
| Copper Mountain North - NV | 1,400 | 30[5] | 30[5] | Burroughs 2012, 2014 |
| Copper Mountain - NV | 380 | [5] | [5] | Burroughs 2012, 2014 |
| Moapa K Road Solar - NV | 2,141 | 186 | 157 | Service 2012, Burroughs 2013 |
| **Colorado** | | | | |
| Genesis | 1,774 | 8 | 0 | Service 2010c, Fraser 2014 |
| Blythe | 6,958 | 30 | - | Service 2010d |
| Desert Sunlight | 4,004 | 56 | 7 | Service 2011c, Fraser 2014 |
| McCoy | 4,533 | 15 | - | Service 2013b |
| Desert Harvest | 1,300 | 5 | - | Service 2013c |
| Rice | 1,368 | 18 | 1 | Service 2011d, Fraser 2014 |
| **Total** | **37,503** | **1,732** | **372** | |

1. The numbers in this column are not necessarily comparable because the methodologies for estimating the numbers of desert tortoises occasionally vary between projects.
2. This column reflects the numbers of desert tortoises observed within project areas. It includes translocated animals and those that were killed by project activities. Project activities may result in the deaths of more desert tortoises than are found.
3. The first citation in this column is for the biological opinion or incidental take permit and is the source of the information for both acreage and the estimate of the number of desert tortoises. The second is for the number of desert tortoises observed during construction of the project; where only one citation is present, construction has not begun or data are unavailable at this time.
4. These numbers include Southern California Edison's Primm Substation and its ancillary facilities.
5. These projects occurred under the Clark County Multi-species Habitat Conservation Plan; the provisions of the habitat conservation plan do not require the removal of desert tortoises. We estimate that all three projects combined will affect fewer than 30 desert tortoises.

The Service completed consultation on the Calico and Palen projects. The applicant for the Calico project, which was located in the Western Mojave Recovery Unit, has abandoned the project and the Bureau has withdrawn the request for consultation (Bureau 2013). For the Palen project, which is located in the Colorado Desert, BrightSource Energy acquired the project from its former owner and proposed to use power tower technology. The California Energy Commission denied the application but will allow BrightSource Energy to re-apply if it can resolve the issues the California Energy Commission raised. Because of the change in technology, the Bureau re-initiated formal consultation with the Service. As of the March 7, 2014, the Service and Bureau have not completed formal consultation on this project; consequently, we have removed it from the table.

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# Appendix E - Emissions Calculations

Emission calculations were done using a combination of Air Emissions Guide for *Air Force Mobile Sources Methods For Estimating Emissions Of Air Pollutants For Mobile Sources At United States Air Force Installations* (June 2020), and AP-42: Compilation of Air Emissions Factors the Air Emissions Guide For Air Force Mobile Sources. The below calculations include the vehicles needed to bring Boeing recovery gear to/from EAFB to recovery the CM, vehicles rented locally by the Boeing team, and heavy equipment (crane, generator, two forklifts) provided by EAFB. It does not include other EAFB support vehicles and emissions sources provided from base assets as the proposed use would be comparable to daily operations.

For the vehicles that travel through multiple states (for non-California emissions) or counties (for California emissions) the worst case emissions factors were utilized in the calculations. For the particulate matter calculations for California the worst case factors were also adjusted to take into account the possibility of no yearly precipitation in those counties.

**Semi-Truck Mileage KSC to EAFB**

| State | One Way Miles | Round Trip Miles | |
|---|---|---|---|
| Florida | 535 | | |
| Alabama | 80 | | |
| Mississippi | 205 | | |
| Louisiana | 190 | | |
| Texas | 600 | | |
| New Mexico | 380 | | |
| Arizona | 360 | | |
| Total Non-California | 1545 | 3090 | |
| | | | |
| San Bernardino County | 200 | | |
| Kern County | 25 | | |
| Total California | 225 | 450 | |

Source: Google Maps

**Semi-Truck Mileage WSMR to EAFB**

| State | One Way Miles | Round Trip Miles | |
|---|---|---|---|
| New Mexico | 215 | | |
| Arizona | 400 | | |
| Total Non-California | 615 | 1230 | |
| | | | |
| Riverside | 160 | | |
| San Bernardino County | 45 | | |
| Los Angeles County | 50 | | |
| Kern County | 25 | | |
| Total California | 280 | 560 | |

Source: Google Maps

**Rental Car Mileage Lancaster to EAFB**

| # vehicles | Round Trip Miles | # of days | Total Miles |
|---|---|---|---|
| 4 | 60 | 12 | 2880 |

**Emissions Factors Non-California**

Vehicle Types:

HDDV: Heavy-Duty Vehicles (8,501 + lbs.)

| State | Fuel | Vehicle Type | Emissions Factors (g/mi) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Critical Pollutants and Ozone Precursors | | | | | | | |
| | | | CO | VOC | $NO_X$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_{2e}$ | $NH_3$ |
| FL | Diesel | HDDV | 1.532 | 0.34 | 3.79 | 0.013 | 0.151 | 0.139 | 1546.1 | 0.03 |
| AL | Diesel | HDDV | 1.563 | 0.38 | 4.18 | 0.013 | 0.144 | 0.133 | 1485.87 | 0.03 |
| MS | Diesel | HDDV | 1.533 | 0.37 | 4.1 | 0.012 | 0.141 | 0.129 | 1472.57 | 0.03 |
| LA | Diesel | HDDV | 1.641 | 0.41 | 4.27 | 0.013 | 0.145 | 0.134 | 1513.29 | 0.03 |
| TX | Diesel | HDDV | 1.525 | 0.36 | 4.07 | 0.013 | 0.143 | 0.131 | 1499.18 | 0.03 |
| NM | Diesel | HDDV | 1.803 | 0.49 | 5.22 | 0.013 | 0.147 | 0.135 | 1492.81 | 0.03 |
| AZ | Diesel | HDDV | 1.706 | 0.43 | 4.86 | 0.013 | 0.15 | 0.138 | 1540.1 | 0.03 |
| | | | | | | | | | | |
| Worst Case | Diesel | HDDV | 1.803 | 0.49 | 5.22 | 0.013 | 0.151 | 0.139 | 1546.1 | 0.03 |

Source:

AIR EMISSIONS GUIDE FOR AIR FORCE MOBILE SOURCES

METHODS FOR ESTIMATING EMISSIONS OF AIR POLLUTANTS FOR MOBILE SOURCES AT UNITED STATES AIR FORCE INSTALLATIONS (June 2020)

Table 5-20. On-Road Vehicle Emission Factors – 2021

**Semi-Truck Calculations Non-California**

Total Miles Driven: 3090 + 1230 = 4320 miles

| | CO | VOC | $NO_X$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_{2e}$ | $NH_3$ |
|---|---|---|---|---|---|---|---|---|
| Emission Factor g/mi | 1.803 | 0.488 | 5.215 | 0.01 | 0.15 | 0.139 | 1546.1 | 0.029 |
| X 4320 mi = grams | 7789 | 2108 | 22529 | 56 | 652 | 600 | 6679135 | 125 |
| X.0022 lbs./g = lbs. | 17.1 | 4.6 | 49.6 | 0.1 | 1.4 | 1.3 | 14694.1 | 0.3 |

**Semi-Truck Calculations California**

Total Miles Driven: 450 + 560 = 1010 miles

| | CO | VOC | $NO_X$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_{2e}$ | $NH_3$ |
|---|---|---|---|---|---|---|---|---|
| Emission Factor g/mi | 1.803 | 0.488 | 5.215 | 0.01 | 0.15 | 0.139 | 1546.1 | 0.029 |
| X 1010 mi = grams | 1821 | 493 | 5267 | 13 | 153 | 140 | 1561557 | 29 |
| X.0022 lbs./g = lbs. | 4.0 | 1.1 | 11.6 | 0.0 | 0.3 | 0.3 | 3435.4 | 0.1 |

**Rental Car / POV Emissions Factors California**

| County | Vehicle Type | Emissions Factors (g/mi) Critical Pollutants and Ozone Precursors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | NOx | $SO_2$ | CO | ROG | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ | $NH_3$ |
| Kern | All | 0.27 | 0.004 | 2.19 | 0.31 | 0.053 | 0.023 | 382.72 | 0.024 |
| Los Angeles | All | 0.247 | 0.004 | 2.22 | 0.31 | 0.055 | 0.024 | 383.84 | 0.024 |
| San Bernardino | All | 0.257 | 0.004 | 2.18 | 0.32 | 0.052 | 0.023 | 370.41 | 0.024 |
| Riverside | All | 0.24 | 0.004 | 2.04 | 0.29 | 0.053 | 0.023 | 364.19 | 0.024 |
| | | | | | | | | | |
| Worst Case | All | 0.27 | 0.004 | 2.22 | 0.32 | 0.055 | 0.024 | 383.84 | 0.024 |

Source:

AIR EMISSIONS GUIDE FOR AIR FORCE MOBILE SOURCES

METHODS FOR ESTIMATING EMISSIONS OF AIR POLLUTANTS FOR MOBILE SOURCES AT UNITED STATES AIR FORCE INSTALLATIONS (June 2020)

Table 5-25. EMFAC County-Specific On-Road Vehicle Composite EFs – 2021 POV

**Rental Car POV Calculations California**

Total Miles Driven: 2880 miles

| | NOx | $SO_2$ | CO | ROG | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ | $NH_3$ |
|---|---|---|---|---|---|---|---|---|
| Emission Factor g/mi | 0.27 | 0.004 | 2.216 | 0.32 | 0.06 | 0.024 | 383.835 | 0.024 |
| X 2880 mi = grams | 778 | 12 | 6382 | 907 | 158 | 69 | 1105445 | 69 |
| X.0022 lbs./g = lbs. | 1.71 | 0.03 | 14.04 | 2.00 | 0.35 | 0.15 | 2431.98 | 0.15 |

**Total Vehicle Exhaust Emissions per Landing (lbs.)**

| | NOx | $SO_2$ | CO | ROG | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ | $NH_3$ |
|---|---|---|---|---|---|---|---|---|
| California | 5.72 | 1.11 | 25.63 | 2.02 | 0.68 | 0.46 | 5867.40 | 0.22 |
| Non-California | 17.1 | 4.6 | 49.6 | 0.1 | 1.4 | 1.3 | 14694.1 | 0.3 |

**Paved Road Emissions Factors**

Vehicle Types:

2 HDDV: Heavy-Duty Vehicles (8,501 + lbs.) + 4 LDDT: Light Duty Trucks

| State | Silt Loading ($g/m^2$) | Vehicle Weight Average (ton) | Traffic Category | Annual Precipitation Days | Emissions Factors (g/mi) Fugitive Dust | | |
|---|---|---|---|---|---|---|---|
| | | | | | PM | $PM_{10}$ | $PM_{2.5}$ |
| FL | 0.03 | 2.33 | >10,000 | 120 | 0.469 | 0.090 | 0.022 |
| AL | 0.03 | 2.33 | >10,000 | 120 | 0.469 | 0.090 | 0.022 |
| MS | 0.03 | 2.33 | >10,000 | 110 | 0.473 | 0.090 | 0.023 |
| LA | 0.03 | 2.33 | >10,000 | 110 | 0.473 | 0.090 | 0.023 |
| TX | 0.03 | 2.33 | >10,000 | 80 | 0.483 | 0.092 | 0.023 |
| NM | 0.03 | 2.33 | >10,000 | 60 | 0.490 | 0.094 | 0.023 |
| AZ | 0.03 | 2.33 | >10,000 | 40 | 0.497 | 0.095 | 0.024 |
| CA (Southern) | 0.03 | 2.33 | >10,000 | 30 | 0.501 | 0.096 | 0.024 |
| Worst Case | 0.03 | 2.33 | >10,000 | 0 | 0.512 | 0.098 | 0.024 |

Source:

AP-42

13.2.1 Paved Roads

Table 13.2.1-1 Particle Size Multipliers for Paved Road Equation

Table 13.2.1-2 Ubiquitous Silt Loading Default Values with Hot Spot Contributions from Anti-Skid Abrasives

**Paved Roads Dust Calculations Non-California**

Total Miles Driven: 3090 + 1230 = 4320 miles

| | PM | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| Emission Factor g/mi | 0.512 | 0.098 | 0.024 |
| X 4320 mi = grams | 2210 | 422 | 105 |
| X.0022 lbs./g = lbs. | 4.9 | 0.9 | 0.2 |

**Paved Roads Dust Calculations California**

Total Miles Driven: 450 + 560 + 2880 = 3890 miles

| | PM | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| Emission Factor g/mi | 0.501 | 0.096 | 0.024 |
| X 4320 mi = grams | 1949 | 372 | 93 |
| X.0022 lbs./g = lbs. | 4.3 | 0.8 | 0.2 |

**Unpaved Road Emissions Factors**

Vehicle Types:

2 HDDV: Heavy-Duty Vehicles (8,501 + lbs.) + 4 LDDT: Light Duty Trucks

| CA County | Silt Content % | Vehicle Weight Average (ton) | Annual Precipitation Days | Emissions Factors (lb/mi) Fugitive Dust | | |
|---|---|---|---|---|---|---|
| | | | | PM | $PM_{10}$ | $PM_{2.5}$ |
| San Bernardino County | 8.5 | 2.33 | 30 | 3.16 | 0.90 | 0.09 |
| Kern County | 8.5 | 2.33 | 30 | 3.16 | 0.90 | 0.09 |
| Worst Case | 8.5 | 2.33 | 0 | 3.44 | 0.98 | 0.10 |

Source:

AP-42

13.2.2 Unpaved Roads Equation 1a

Table 13.2.2-2 Constants for Equations 1a and 1b

**Unpaved Road Calculations California**

Total Miles Driven: 20 + 20 + 80 = 120 miles

| | PM | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| Emission Factor g/mi | 3.44 | 0.98 | 0.10 |
| X 1000 mi = grams | 413 | 118 | 12 |
| X.0022 lbs./g = lbs. | 0.91 | 0.26 | 0.03 |

**Total Fugitive Dust Emissions per Landing (lbs.)**

| | PM | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| California | 5.20 | 1.08 | 0.23 |
| Non-California | 4.9 | 0.9 | 0.2 |

**Recovery Equipment (EAFB provided)**

| Equipment Type | No of Equipment | Fuel | Hours per Day | Total Days | Total Hours |
|---|---|---|---|---|---|
| Crane | 1 | Diesel | 4 | 3 | 12 |
| Generator | 1 | Diesel | 24 | 4 | 96 |
| Forklift | 2 | Diesel | 2 | 3 | 6 |

**Emission Factors for Equipment California**

| VehClass | MdlYr | HP_Bin | Fuel | HC EF lb/hr per vehicle | ROG EF lb/hr per vehicle | TOG EF lb/hr per vehicle | CO EF lb/hr per vehicle | NOx EF lb/hr per vehicle | CO2 EF lb/hr per vehicle | PM10 EF lb/hr per vehicle | PM2.5 EF lb/hr per vehicle | PM EF lb/hr per vehicle | SOx EF lb/hr per vehicle | NH3 EF lb/hr per vehicle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ConstMin - Cranes | Aggregated | Aggregated | Diesel | 3.14E-04 | 3.80E-04 | 4.52E-04 | 2.58E-03 | 4.17E-03 | 5.41E-01 | 1.91E-04 | 1.76E-04 | 1.91E-04 | 5.00E-06 | 4.42E-06 |
| Portable Equipment - Non-Rental Generator | Aggregated | Aggregated | Diesel | 2.33E-04 | 2.82E-04 | 3.36E-04 | 1.82E-03 | 2.76E-03 | 5.72E-01 | 1.08E-04 | 9.98E-05 | 1.08E-04 | 5.28E-06 | 4.67E-06 |
| Industrial - Forklifts | Aggregated | Aggregated | Diesel | 3.80E-05 | 4.60E-05 | 5.48E-05 | 4.01E-04 | 3.98E-04 | 5.96E-02 | 2.65E-05 | 2.44E-05 | 2.65E-05 | 5.50E-07 | 4.86E-07 |

Source:
OFFROAD2017 (v1.0.1) Emissions Inventory
Region Type: Air Basin
Region: Mojave Desert
Calendar Year: 2021
Scenario: All Adopted Rules - Exhaust
Vehicle Classification: OFFROAD2017 Equipment Types
https://www.arb.ca.gov/orion/
EF (lb/hr) = Emissions (ton/day) / Population / Activity (hours/yr) * 2000 lb/ton

**Equipment Calculations California**

| **Crane** | **NOx** | **$SO_2$** | **CO** | **ROG** | **PM** | **$PM_{10}$** | **$PM_{2.5}$** | **$CO_2$** | **$NH_3$** |
|---|---|---|---|---|---|---|---|---|---|
| Emission Factor (lb/hr) | 4.17E-03 | 5.00E-06 | 2.58E-03 | 3.80E-04 | 1.91E-04 | 1.91E-04 | 1.76E-04 | 5.41E-01 | 4.42E-06 |
| X Total Hours = lb | 0.050 | 5.99E-05 | 0.031 | 0.005 | 0.002 | 0.0023 | 0.0021 | 6.496 | 5.30E-05 |
| | | | | | | | | | |
| **Generator** | 2.76E-03 | 5.28E-06 | 1.82E-03 | 2.82E-04 | 1.08E-04 | 1.08E-04 | 9.98E-05 | 5.72E-01 | 4.67E-06 |
| X Total Hours = lb | 0.265 | 0.001 | 0.174 | 0.027 | 0.010 | 0.010 | 0.010 | 54.905 | 0.000 |
| | | | | | | | | | |
| **Forklift** | 3.98E-04 | 5.50E-07 | 4.01E-04 | 4.60E-05 | 2.65E-05 | 2.65E-05 | 2.44E-05 | 5.96E-02 | 4.86E-07 |
| X Total Hours = lb | 0.002 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.358 | 0.000 |
| | | | | | | | | | |
| **Total emissions (lb) from equipment** | 0.32 | 0.001 | 0.21 | 0.03 | 0.01 | 0.01 | 0.01 | 61.76 | 0.001 |

# Appendix F – Jettisoned Items Containment Evaluator (JICE) Model

Boeing developed to JICE model to determine the landing locations for the various parts that jettison from the Starliner during the landing sequence. The model was developed for use both in determining the impacted areas for the Starliner EAs and for inclusion in the analysis done to meet NASA and FAA public risk requirements.

The list of parts is shown in Table G-1. The deployment sequence begins with the FHS chute doors at 30,000 feet and ends with the main chutes that detach from the Starliner at landing.

**Table G- 1: Jettisoned Parts Information**

| Quantity | Description | Shape | Dimensions | | | | Mass | Terminal Velocity |
|---|---|---|---|---|---|---|---|---|
| | | | radius ft. | length ft. | width ft. | height ft. | lb. | mph |
| 2 | FHS Chute Doors | plate | | 0.8 | 1.00 | | 1.00 | 33 |
| 2 | FHS Mortar Lids | disk | 0.3 | | | | 0.25 | 29 |
| 2 | FHS Chute Sabots | cylinder | 0.3 | | | 0.3 | 0.75 | 59 |
| 1 | FHS With Chutes | | | | | | 329.00 | 42 |
| 2 | Drogue Mortar Lids | disk | 0.7 | | | | 0.75 | 31 |
| 2 | Drogue Chute Sabots | cylinder | 0.7 | | | 0.3 | 3.00 | 68 |
| 2 | Drogue Chutes | | 12.0 | | | | 67.50 | 11 |
| 3 | Pilot Mortar Lids | disk | 0.3 | | | | 0.25 | 29 |
| 3 | Pilot Chute Sabots | cylinder | 0.3 | | | 0.3 | 0.75 | 47 |
| 3 | Pilot Chutes | | 4.9 | | | | 10.00 | 17 |
| 1 | BHS | disk | 7.3 | | | 3.0 | 1682.0 | 72 |
| 3 | Main Chutes | | 52.0 | | | | 180.00 | 3 |

The model was developed with the following assumptions and limitations:

- Flat terrain
- 1 second uncertainty on the following nominal event timeline
  - 0.7s after 30,000 ft. geodetic altitude: FHS deploy items
  - 5s after 30,000 ft. geodetic altitude: Drogue deploy items
  - 0.8s after 8000 ft. AGL altitude: Drogue chutes, pilot chutes, and pilot chute deploy items
- Jettison items trajectories were modelled using tumbling area and drag coefficients with +/- 10% uncertainty
- Wind persistence uncertainty was not considered

The model was run utilizing 3000 historical wind cases at EAFB, 250 cases for each month. It was determined during these runs that the orbital approach direction (ascending vs descending) and the cross range needed to get to the landing site did not affect jettison item impact locations. It was also compared against the landing location during various Starliner parachute drop tests and updated based on those results. Results from future missions will be compared against the

actual landing locations to determine if additional modifications are required. Both the NASA Commercial Crew Program Office and the FAA reviewed the tool methods.

# Appendix G - Results of Consultations

SHPO Consultation

State of California • Natural Resources Agency
Gavin Newsom, *Governor*

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July 21, 2021

Reply in Reference to: USAF_2021_0301_001

Rhena Lynn Shreve
Cultural Resources Manager
412 CEG/CEVA
120 North Rosamond Boulevard, Suite A
Edwards AFB, CA 93524-8600

VIA ELECTRONIC MAIL

Re: Section 106 Consultation for Boeing Starliner Landing and Recovery, Rodgers Dry Lake Area, Edwards Air Force Base, Kern County

Dear Ms. Shreve:

The United States Air Force (USAF) is continuing consultation with the State Historic Preservation Officer (SHPO) in compliance with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. §306108), as amended, and its implementing regulation found at 36 CFR Part 800.

Having previously received the SHPO's April 1, 2021 comments on the proposed undertaking, the USAF responded with additional information in its July 1, 2021 letter. The USAF specifically addressed historic property identification efforts and provided an analysis of the undertaking's effects on the Rodgers Dry Lake, a National Historic Landmark, stating that:

- The Boeing Starliner Undertaking is a continuation of the critical, historic role played by the dry lake.
- No known NRHP eligible cultural resources are within the 4km radius landing zone of the Starliner.
- There are no identified Traditional Cultural Properties or resource gathering areas in the APE. There are no mapped historic districts within the APE. The hard dry lake surface, clear air, and long, unobstructed sight distances are characteristics of the NHL that will not be altered or affected.

- Tribal consultation with the Tejon Indian Tribe, the San Manuel Band of Mission Indians, the Colorado River Indian Tribe, the Morongo Band of Mission Indians, and the Chemehuevi Indian Tribe resulted in comments received from the San Manuel Band of Mission Indians expressing concerns over the culture history and the characterization of sites CA-KER-2017/EAFB-574 and CA-KER-4722/EAFB2081. The USAF's documentation confirms that the tribe's concerns were adequately addressed and that there are no remaining issues regarding site eligibility.

Upon review of the supplemental information provided, the SHPO offers the following comments:

1) Pursuant to 36 CFR Part 800.4(a)(1), the SHPO has no objection to the USAF's revised APE defined as Rogers Dry Lake NHL in its entirety.

2) The SHPO concurs with the USAF's finding of no adverse effect. Be advised that that under certain circumstances, such as an unanticipated discovery or a change in project description, the USAF may have future responsibilities for this undertaking under 36 CFR Part 800.

Please notify Historian Ed Carroll at (916) 445-7006 or Ed.Carroll@parks.ca.gov if there are any questions or concerns.

Sincerely,

Julianne Polanco
State Historic Preservation Officer

# Appendix H - EAFB Biological Resources

Table H-1 contains the list of both federal and state species of concern located within EAFB.

Table H-2 contains information on animal species listed in the USF&W IPaC database for EAFB.

Table H-3 lists the animal species listed in the USF&W IPaC database and which have critical habitat within the sonic boom footprint.

**Table H- 1: EAFB Species of Concern**

| Scientific Name[a] | Common Name[a] | Federal Status | California Status | NatureServe Ranks | CRPR | Presence on EAFB[b] | Presence at Piute Ponds[b] |
|---|---|---|---|---|---|---|---|
| **Plants** | | | | | | | |
| *Calochortus striatus* | Alkali mariposa lily | | | G3? S2S3 | 1B.2 | Occurs | Occurs |
| *Eriophyllum mohavense* | Barstow woolly sunflower | | | G3 S2 | 1B.2 | Occurs | Unknown |
| *Puccinellia simplex* | California alkaligrass | | | G5 S3 | 2B.2 | Occurs | Unknown |
| *Senna covesii* | Coues' cassia | | | G3 S3 | 4.2 | Occurs | Unknown |
| *Muilla coronata* | Crowned muilla | | | G2 S2 | 1B.2 | Occurs | Unknown |
| *Cymopterus deserticola* | Desert cymopterus | | | G2G3 S2S3 | 1B.3 | Occurs | Unknown |
| *Gilmania luteola* | Golden-carpet gilmania | | | G3 S3 | 4.2 | Occurs | Occurs |
| *Goodmania luteola* | Goodmania luteola | | | G3 S4 | 4.2 | Occurs | Occurs |
| *Eriastrum hooveri* | Hoover's eriastrum | | | G2 S2 | 1B.2 | Occurs | Unknown |
| *Astragalus preussii var. laxiflorus* | Lancaster milkvetch | | | G5T3T4 S3 | 4.2 | Occurs | Unknown |
| *Chorizanthe spinosa* | Mojave spineflower | | | G4T2 S1 | 1B.1 | Occurs | Unknown |
| *Trifolium gracilentum var. palmeri* | Palmer's clover | | | G2? S2? | 1B.2 | Occurs[1] | Unknown |
| *Delphinium recurvatum* | Recurved larkspur | | | G5T2 S2 | 1B.2 | Occurs | Unknown |
| *Eschscholzia minutiflora ssp. twisselmannii* | Red Rock poppy | | | G1? S1? | 1B.1 | Occurs | Occurs |

| Scientific Name[a] | Common Name[a] | Federal Status | California Status | NatureServe Ranks | CRPR | Presence on EAFB[b] | Presence at Piute Ponds[b] |
|---|---|---|---|---|---|---|---|
| *Eriastrum rosamondense* | Rosamond eriastrum | | | G4 S4 | 4.3 | Occurs | Unknown |
| *Nemacladus gracilis* | Slender nemacladus | | | G5T3 S2 | 2B.2 | Occurs | Occurs |
| *Loeflingia squarrosa var. lartemisiarum* | Spreading pygmyleaf | | | G3G4 S3S4 | 4.2 | Occurs[1] | Unknown |
| *Canbya candida* | White pygmy-poppy | | | G3 S3 | 4.2 | Occurs | Occurs |
| *Calochortus striatus* | Alkali mariposa lily | | | G3? S2S3 | 1B.2 | Occurs | Occurs |
| **Reptiles** | | | | | | | |
| *Gopherus agassizii* | Mohave desert tortoise | FT | ST | G3 S2S3 | | Occurs | Occurs |
| *Uma scoparia* | Mojave fringe-toed lizard | | SSC | G3G4 S3S4 | | Unknown | Unknown |
| *Anniella pulchra* | Northern legless lizard | | SSC | G3 S3 | | Occurs[1] | Occurs[1] |
| *Actinemys marmorata* | Western pond turtle[5] | 12M FY21 | SSC | G3G4 S3 | | Occurs | Occurs |
| **Birds** | | | | | | | |
| *Pelecanus erythrorhynchos* | American white pelican | | SSC | G4 S1S2 | | Occurs | Occurs |
| *Haliaeetus leucocephalus* | Bald eagle | BCC | SE/FP | G5 S3 | | Occurs | Occurs |
| *Riparia riparia* | Bank swallow | | ST | G5 S2 | | Occurs | Occurs |
| *Cypseloides niger* | Black swift[2] | BCC | SSC | G4 S2 | | Unknown | Unknown |
| *Chlidonias niger* | Black tern[2] | BCC | SSC | G4 S2 | | Occurs | Occurs |

| Scientific Name[a] | Common Name[a] | Federal Status | California Status | NatureServe Ranks | CRPR | Presence on EAFB[b] | Presence at Piute Ponds[b] |
|---|---|---|---|---|---|---|---|
| *Spizella atrogularis* | Black-chinned sparrow[4] | BCC | | G5 S4 | | Unknown | Unknown |
| *Branta bernicla* | Brant | | SSC | G5 S2? | | Occurs | Occurs |
| *Pelecanus occidentalis* | Brown pelican | | FP | G4 | | Occurs | Unknown |
| *Athene cunicularia* | Burrowing owl[2 3] | BCC | SSC | G4 S3 | | Occurs | Occurs |
| *Sternula antillarum browni* | California least tern | FE | SE/FP | G4T2T3Q S2 | | Occurs | Occurs |
| *Gavia immer* | Common loon[2] | | SSC | G5 S1 | | Occurs | Occurs |
| *Calypte costae* | Costa's hummingbird [2] | BCC | | G5 S4 | | Occurs | Occurs |
| *Dendrocygna bicolor* | Fulvous whistling-duck[2] | | SSC | G5 S1 | | Unknown | Unknown |
| *Aquila chrysaetos* | Golden eagle[4] | BCC | FP/WL | G5 S3 | | Occurs | Occurs |
| *Ammodramus savannarum* | Grasshopper sparrow[2 4] | BCC | SSC | G5 S3 | | Occurs | Unknown |
| *Vireo vicinior* | Gray vireo[2 4] | BCC | SSC | G4 S2 | | Occurs | Unknown |
| *Gelochelidon nilotica* | Gull-billed tern[2] | BCC | SSC | G5 S1 | | Unknown | Unknown |
| *Spinus lawrencei* | Lawrence's goldfinch[4] | BCC | | G3G4 S3S4 | | Unknown | Unknown |
| Vireo bellii pusillus | Least Bell's vireo | FE | SE | G5T2 S2 | | Occurs | Occurs |
| *Ixobrychus exilis* | Least bittern[2] | BCC | SSC | G4G5 S2 | | Occurs | Occurs |
| *Toxostoma lecontei* | LeConte's thrasher[4] | BCC | SSC | G4 S3 | | Unknown | Unknown |

| Scientific Name[a] | Common Name[a] | Federal Status | California Status | NatureServe Ranks | CRPR | Presence on EAFB[b] | Presence at Piute Ponds[b] |
|---|---|---|---|---|---|---|---|
| *Lanius ludovicianus* | Loggerhead shrike[2 4] | BCC | SSC | G4 S4 | | Unknown | Unknown |
| *Numenius americanus* | Long-billed curlew[2 4] | BCC | WL | G5 S2 | | Occurs | Occurs |
| *Asio otus* | Long-eared owl[2] | | SSC | G5 S3? | | Occurs | Occurs |
| *Leiothlypis luciae* | Lucy's warbler[2] | BCC | SSC | G5 S2S3 | | Occurs | Unknown |
| *Limosa fedoa* | Marbled godwit | BCC | | G5 | | Occurs | Unknown |
| *Charadrius montanus* | Mountain plover[3] | BCC | SSC | G3 S2S3 | | Occurs | Occurs |
| *Circus hudsonius* | Northern harrier[2] | | SSC | G5 S3 | | Occurs | Occurs |
| *Contopus cooperi* | Olive-sided flycatcher[2 4] | BCC | SSC | G4 S4 | | Occurs | Occurs |
| *Falco peregrinus* | Peregrine falcon | BCC | FP | G4T4 S3S4 | | Unknown | Unknown |
| *Falco mexicanus* | Prairie falcon | BCC | WL | G5 S4 | | Occurs | Occurs |
| *Progne subis* | Purple martin[2] | | SSC | G5 S3 | | Occurs | Occurs |
| *Aythya americana* | Redhead[2] | | SSC | G5 S3S4 | | Occurs | Occurs |
| *Asio flammeus* | Short-eared owl[2] | | SSC | G5 S3 | | Occurs | Unknown |
| *Charadrius nivosus* | Snowy plover[2] | BCC | SSC | G3T3 S2S3 | | Occurs | Occurs |
| *Piranga rubra* | Summer tanager[2] | | SSC | G5 S1 | | Unknown | Unknown |
| *Buteo swainsoni* | Swainson's hawk | BCC | ST | G5 S3 | | Occurs | Occurs |
| *Agelaius tricolor* | Tricolored blackbird[2 3] | BCC | ST/SSC | G2G3 S1S2 | | Occurs | Occurs |

| Scientific Name[a] | Common Name[a] | Federal Status | California Status | NatureServe Ranks | CRPR | Presence on EAFB[b] | Presence at Piute Ponds[b] |
|---|---|---|---|---|---|---|---|
| *Cygnus buccinator* | Trumpeter swan | | FP | G4 | | Unknown | Unknown |
| *Chaetura vauxi* | Vaux's swift[2] | | SSC | G5 S2S3 | | Occurs | Occurs |
| *Pyrocephalus rubinus* | Vermilion flycatcher[2] | | SSC | G5 S2S3 | | Occurs | Occurs |
| *Numenius phaeopus* | Whimbrel | BCC | | G5 | | Occurs | Occurs |
| *Elanus leucurus* | White-tailed kite | | FP | G5 S3S4 | | Occurs | Occurs |
| *Empidonax traillii* | Willow flycatcher | BCC | SE | G5 S1S2 | | Occurs | Occurs |
| *Setophaga petechia* | Yellow warbler[2] | BCC | SSC | G5 S3S4 | | Occurs | Occurs |
| *Coccyzus americanus* | Yellow-billed cuckoo | FT/BCC | SE | G5T2T3 S1 | | Occurs | Occurs |
| *Icteria virens* | Yellow-breasted chat[2] | | SSC | G5 S3 | | Occurs | Occurs |
| *Xanthocephalus xanthocephalus* | Yellow-headed blackbird[2] | | SSC | G5 S3 | | Occurs | Occurs |
| **Mammals** | | | | | | | |
| *Taxidea taxus* | American badger | | SSC | G5 S3 | | Occurs | Unknown |
| *Eumops perotis californicus* | California mastiff bat | | SSC | G5T4 S3S4 | | Unknown | Unknown |
| *Xerospermophilus mohavensis* | Mohave ground squirrel | | ST | G2G3 S2S3 | | Occurs | Unknown |
| *Antrozous pallidus* | Pallid bat | | SSC | G5 S3 | | Occurs | Unknown |
| *Bassariscus astutus* | Ringtail | | FP | G5 | | Occurs | Unknown |
| *Corynorhinus townsendii* | Townsends's big-eared bat | | SSC | G3G4 S2 | | Unknown | Unknown |

| Scientific Name[a] | Common Name[a] | Federal Status | California Status | NatureServe Ranks | CRPR | Presence on EAFB[b] | Presence at Piute Ponds[b] |
|---|---|---|---|---|---|---|---|
| *Lasiurus frantzii* | Western red bat | | SSC | G5 S3 | | Occurs | Occurs |
| **Invertebrates** | | | | | | | |
| *Bombus crotchii* | Crotch's bumble bee | | SCE | G3G4 S1S2 | | Occurs[1] | Unknown |
| *Helminthoglypta greggi* | Mohave shoulderband snail | | | G1 S1 | | Unknown | Unknown |
| *Danaus plexipus* | Monarch butterfly | FPT | | G4 SNR | | Unknown | Unknown |

[a] Species nomenclature according to the American Ornithological Union (AOS; 2020), American Society of Mammalogists (ASM; 2020), Bat Conservation International (2020), California Invasive Spcies Council (CalIPC; 2020), Integrated Taxonomic Information System (ITIS; 2020), Jepson Flora, (Jepson; 2020), NatureServe (2020), Society for the Study of Amphibians and Reptiles (SSAR; 2020), and U.S. Department of Agriculture Plants (USDA; 2020).

[b] Presence Source: Edwards AFB Geographic Information System. ([1] Denotes a source other than the Edwards AFB GIS database.)

Species Additional Notes:

[2]These avian special status species have the potential to nest on EAFB.
[3]DoD Partners in Flight (PIF) Mission-Sensitive Species
[4]DoD PIF Tier 2 Species
[5]DoD At-Risk Herpetofaunal Priority Species

Status Source: NatureServe (2020), U.S. Fish and Wildlife Service (USFWS), National Listing Workplan, 7-Year Workplan (September 2016); California Native Plant Society, Rare Plant Program (October 2017); Inventory of Rare and Endangered Plants of California; CDFW (2017), Natural Diversity Database (October); Special Animals List, USFWS, Birds of Conservation Concern in Bird Conservation Region 33 (USFWS 2008a)

***Federal Status***

FE = Federally endangered

FT = Federally threatened

FC = Federal candidate species

FPE = Federally proposed for listing as endangered

FPT = Federally proposed for listing as threatened

FPD = Federally proposed for delisting

12-MO = 12-month finding on a petition to list a species; FY = fiscal year of anticipated completion

***Federal Status: USFWS Special Status***

BCC = Birds of Conservation Concern

***Callifornia Status: CEQA***

SE = Listed as state of California endangered

ST = Listed as state of California threatened

SCE = State candidate for listing as endangered
SCT = State candidate for listing as threatened
SCD = State candidate for delisting

***California Status: CDFW***

FP = Fully Protected
SSC = Species of Special Concern
B = Breeding
W = Wintering
Y = Year round
WL = Watch List

***NatureServe Ranks***

Global Ranking (Entire Species)
G1 = Critically Imperiled
G2 = Imperiled
G3 = Vulnerable
G4 = Apparently Secure
G5 = Secure
Taxon Ranking (Subspecies)
T1 = Critically imperiled
T2 = Imperiled
T3 = Vulnerable
T4 = Apparently secure
T5 = Secure

***State Ranking (California)***

S1 = Critically imperiled
S2 = Imperiled
S3 = Vulnerable
S4 = Apparently secure
S5 = Secure
SNR = Unranked

***California Native Plant Society (CNPS), California Rare Plant Ranking (CRPR)***

1B = Plants rare, threatened, or endangered in California and elsewhere
2B = Plants rare, threatened, or endangered in California but more common elsewhere
3B = Plants about which more information is needed—a review list
4 = Plants of limited distribution—a watch list
CBR = Considered but rejected
Threat Ranking
0.1 = Seriously threatened in California
0.2 = Moderately threatened in California
0.3 = Not very threatened in California

**Table H- 2: IPaC Species Information for EAFB**

| **Threatened Species** | **IPaC Description** |
|---|---|
| Desert Tortoise (Gopherus agassizii) | Gopherus agassizii is terrestrial, with a domed shell and round, stumpy elephantine hind legs. The front limbs are flattened for digging and heavily scaled without webbed toes. The carapace (upper shell) is oblong and domed with the sides round due to joining of the carapace and plastron (lower shell). The scute centers are often yellowish which have grooved concentric rings. The plastron is also yellowish, with brown along the scute margins. The head is small and rounded in front with reddish-tan coloring and the iris being greenish-yellow. The front and hind feet are about equal in size and the tail is of short length. |
| | |
| **Migratory Birds** | |
| Allen's Hummingbird (Selasphorus sasin) | Allen's Hummingbird is a small and compact hummingbird. It is extensively rusty in most plumages. Immature Allen's Hummingbirds are similar to adult females, but have both less spotting on the throat and rufous on flanks. Males have an iridescent red throat and shiny green back. |
| Burrowing Owl (Athene cunicularia) | In general, Burrowing Owls have a distinct oval facial ruff, framed by a broad, buffy-white eyebrow-to-malar stripe on the interior part. The Iris is usually bright, lemon yellow. Wings are relatively long and rounded, with 10 brown and buffy-white barred primaries, and tails are short with 12 brown and buffy-white barred rectrices. They have a brown dorsum, profusely spotted back, scapulars, and crown, white throat and undertail coverts. Sexes are not reliably distinguishable by general plumage or size, although during the breeding season, females are generally darker than males. The most apparent differences of juveniles from adults are a solid buff-colored chest (as opposed to mottled) and an obvious buff-colored patch across the dorsal surface of the wings. |
| Clark's Grebe (Aechmophorus clarkia) | No description available |
| Costa's Hummingbird (Calypte costae) | The Costa's Hummingbird is small with green upperparts. Males have an iridescent violet crown and throat patch, also called a gorget, which extends out the sides of the throat. Females have a white throat and underparts, sometimes with violet feathers. Juveniles resemble adult females; have a gray-buff edging on feathers of upperparts, and a doubly-rounded tail instead of singly-rounded. |
| Golden Eagle (Aquila chrysaetos) | No description available<br><br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential |

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| | susceptibilities in offshore areas from certain types of development or activities. |
| Lawrence's Goldfinch (Carduelis lawrencei) | The Lawrence's Goldfinch is a small songbird with a gray back and sides, yellow patch on the chest, yellow wingbars and a dusky or black face. Adult males have a black face, gray nape and mantle, black wings with broad yellow bars, yellow edges on primary feathers and a yellow patch on the breast. Adult females are gray overall and have subtle yellow wing bars, edges of primary feathers, and breast patch. Juveniles are similar to adult females, but have even less yellow, and sometimes appear all brownish gray. |
| Le Conte's Thrasher (toxostoma lecontei) | Le Conte's Thrashers are large, long-tailed songbird that are pale sandy gray all over. They have a down-curved bill, dark tail and pale reddish undertail. Juveniles are similar to adults, but are slightly paler, with a paler undertail. |
| Long-billed Curlew (Numenius americanus) | The Long-billed curlew is a large, long-legged shorebird with a very long, decurved bill. Body plumage is rich buff throughout tinged with cinnamon or pink, and with upperparts streaked and barred with dark brown; underwing-lining contrasting cinnamon, and upper surface of remiges contrasting orange-brown. Sexes similar in appearance, but female averages larger with longer bill than male. Juvenile distinguished from adult by wing-coverts, which have dark-brown centers but lack dark-brown barring and pale notches. Juvenal tertials also more brightly marked than in adult, with darker, wider central stripes and cinnamon-buff versus grayish-buff ground color; underparts may also be less prominently streaked than in adults, and bill distinctly shorter, especially in newly fledged birds. |
| Marbled Godwit (Limosa fedoa) | Marbled Godwits are large shorebirds that have a slightly upturned bill with a dark tip and pinkish base, long legs, and are rich buff-brown all over. In addition to having cinnamon wing linings and an orangish stripe in their wings, their breeding plumage consists of barring across their chest. Nonbreeding plumage consists of a plain breast, and juveniles look similar to nonbreeding adults. |
| Mountain Plover (Charadrius montanus) | The Mountain Plover is about the size of a Killdeer (Charadrius vocierus) but with longer legs and more erect posture. Sexes are similar in both size and plumage coloration, remaining drably colored most of the year and lacking black breast bands typical of many other plovers. |
| Rufous Hummingbird (selasphorus rufus) | A fairly small hummingbird with a slender, nearly straight bill, a tail that tapers to a point when folded, and fairly short wings. In good light, males glow like coals: bright orange on the back and belly, with a vivid iridescent-red throat. Females are green above |

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| | with rufous-washed flanks, rufous patches in the green tail, and often a spot of orange on the throat. |
| Whimbrel (Numenius phaeopus) | The Whimbrel is a large shorebird with a long neck, legs and down-curved bills. They are streaked, buffy, crown dark and have a distinct light stripe in the middle. Juveniles are similar to adults, but have light spots on their back, a less distinct crown stripe, more buff breast, and finer streaking on the neck and chest. |
| Willet (Tringa semipalmata) | No description available |

**Table H- 3: IPaC Listed Species Within the Sonic Boom Footprint**

| Species | Status | Critical Habitat in Sonic Boom Footprint |
|---|---|---|
| **Mammals** | | |
| San Joaquin Kit Fox (Vulpes macrotis mutica) | Endangered | No |
| Sierra Nevada Bighorn Sheep (Ovis canadensis sierra) | Endangered | No |
| Fresno Kangaroo Rat (Dipodomys nitratoides exilis) | Endangered | No |
| Fisher (Pekania pennanti) | Endangered | No |
| Giant Kangaroo Rat (Dipodomys ingens) | Endangered | No |
| Tipton Kangaroo Rat (Dipodomys nitratoides nitratoides) | Endangered | No |
| Southern Sea Otter (Enhydra lutris nereis) | Threatened | No |
| **Birds** | | |
| California Condor (Gymnogyps californianus) | Endangered | Yes |
| California Least Tern (Sterna antillarum browni) | Endangered | No |
| Coastal California Gnatcatcher (Polioptila californica californica) | Threatened | Yes |
| Least Bell's Vireo (Vireo bellii pusillus) | Endangered | Yes |
| Southwestern Willow Flycatcher (Empidonax traillii extimus) | Endangered | Yes |
| Western Snowy Plover (Charadrius alexandrinus nivosus) | Threatened | Yes |
| Yellow-billed Cuckoo (Coccyzus americanus) | Threatened | Yes |
| Light-footed Clapper Rail | Endangered | No |

| | | |
|---|---|---|
| (Rallus longirostris levipes) | | |
| Marbled Murrelet (Brachyramphus marmoratus) | Threatened | No |
| **Reptiles** | | |
| Blunt-nosed Leopard Lizard (Gambelia silus) | Endangered | No |
| Desert Tortoise (Gopherus agassizii) | Threatened | Yes |
| Giant Garter Snake (Thamnophis gigas) | Threatened | No |
| **Amphibians** | | |
| California Red-legged Frog (Rana draytonii) | Threatened | Yes |
| California Tiger Salamander (Ambystoma californiense) | Threatened | Yes |
| Arroyo (=arroyo Southwestern) Toad (Anaxyrus californicus) | Endangered | Yes |
| Mountain Yellow-legged Frog (Rana muscosa) | Endangered | Yes |
| **Insects** | | |
| Kern Primrose Sphinx Moth (Euproserpinus Euterpe) | Threatened | No |
| Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus) | Threatened | No |
| El Segundo Blue Butterfly (Euphilotes battoides allyni) | Endangered | No |
| Fishes | | |
| Mohave Tui Chub (Gila bicolor ssp. Mohavensis) | Endangered | No |
| Santa Ana Sucker (Catostomus santaanae) | Threatened | Yes |
| Tidewater Goby (Eucyclogobius newberryi) | Endangered | Yes |
| Unarmored Threespine Stickleback (Gasterosteus aculeatus williamsoni) | Endangered | No |
| Delta Smelt (Hypomesus transpacificus) | Threatened | No |
| Little Kern Golden Trout (Oncorhynchus aguabonita whitei) | Threatened | No |
| Crustaceans | | |
| Riverside Fairy Shrimp (Streptocephalus woottoni) | Endangered | Yes |
| Vernal Pool Fairy Shrimp | Threatened | No |

| | | |
|---|---|---|
| (Branchinecta lynchi) | | |
| Conservancy Fairy Shrimp (Branchinecta conservation) | Endangered | Yes |
| Vernal Pool Tadpole Shrimp (Lepidurus packardi) | Endangered | Yes |

# Appendix I - Agencies Consulted

National Aeronautics and Space Administration
Federal Aviation Administration
Department of the Air Force
California State Historic Preservation Officer
Tejon Indian Tribe
The San Manuel Band of Mission Indians
The Colorado River Indian Tribe
The Morongo Band of Mission Indian
The Chemehuevi Indian Tribe

# Appendix J – Licenses and Permits Required

FAA

- Launch License for United Space Alliance Atlas V Rocket
  - Issued
- Re-entry License for Boeing Starliner Spacecraft
  - Application in process
  - Required before the first operational mission after CFT

- Department of the Air Force
  - Below is the EAFB portable equipment registration.

CALIFORNIA AIR RESOURCES BOARD



# Statewide Portable Equipment Registration

**Registration No: 101854**

| | |
|---|---|
| Military Installation: | Edwards Air Force Base |
| Mailing Address: | Environ. Management Div. 412 CEG/CEVC BLDG. 3735<br>120 N. Rosamond Blvd.<br>Edwards Air Force Base, CA 93524-8600 |
| Equipment Description: | see attached |
| Conditions: | see attached |

**Expiration Date: June 30, 2022**

David J. Mallory
Manager, Equipment Registration Program
Enforcement Division

**Statewide Portable Equipment Registration**

**The following operating conditions apply for registration 101854**

**General Requirements**

1. The tactical support equipment shall be properly maintained and kept in good operating condition at all times.
2. Any change in the number or type of tactical support equipment in any calendar year is allowable, provided the military installation includes the increased units in the annual report to the Executive Officer within 60 days after the end of each calendar year. TSE registration issuance will be contingent on payment of the billing invoice.
3. The military tactical support equipment shall continue to meet the definition of military tactical support equipment. Military tactical support equipment is defined as equipment using a portable engine, including turbines, that meets military specifications, owned by the United States Department of Defense and/or the United States military services, and used in combat, combat support, combat service support, tactical or relief operations, or training for such operations. Examples include, but are not limited to, internal combustion engines associated with portable generators, aircraft start carts, heaters, and lighting carts.

**Emission Limitations**

4. No air contaminant shall be discharged into the atmosphere for a period or periods aggregating more than 3 minutes in any one hour which is as dark or darker than Ringelmann 2 or equivalent to 40% opacity.

**Reporting**

5. Within 60 days after the end of each calendar year, the military installation shall provide the Executive Officer, in a format approved by the Executive Officer, the number, type, and brake horsepower or equivalent rating of registered military tactical support equipment at each installation as of December 31 of that year. Any variation of registered military tactical support equipment to actual military tactical support equipment shall be accounted for in this annual report. TSE registration issuance will be contingent on payment of the billing invoice.

CALIFORNIA
AIR RESOURCES BOARD



June 18, 2021

Herbert Roraback
Edwards Air Force Base
Environ. Management Div. 412 CEG/CEVC BLDG. 3735
120 N. Rosamond Blvd.
Edwards Air Force Base, CA 93524-8600

Dear Herbert Roraback:

**RE:** Application # 1319 **Action(s):** Annual TSE Update
**CARB Staff Contact:** Jenny Vong **Phone:** 916-229-0971 **Email:** jenny.vong@arb.ca.gov

We have received your annual inventory report for tactical support equipment (TSE) to be registered in the Statewide Portable Equipment Registration Program. Based on our evaluation, an updated equipment list of Registration 101854 will be issued.

Enclosed with this letter is a registration certificate, which includes your updated TSE inventory listed on the attachment. Please replace your current registration certificate with the new registration certificate. The registration certificate contains the registration and operating conditions under which operation of the TSE is valid. Any violation of the conditions may result in legal action by either local air quality management or air pollution control districts or the California Air Resources Board.

As a condition of registration, a copy of the registration certificate must be maintained at the following address at all times:

Edwards Air Force Base, CA
Environ. Management Div.
412 CEG/CEVC BLDG. 3735
Edwards Air Force Base, CA. 93524-8600

Please indicate your registration certificate number on any future correspondence with us regarding the TSE listed on the attachment provided. If you have any questions regarding your registration, please contact portable@arb.ca.gov.

Sincerely,

David J. Mallory, Manager
Equipment Registration Section
Enforcement Division

Attachment
Enclosures

# Attachment 1

## Portable Equipment Registration - Tactical Support Equipment Summary

Application #: 1319 Registration #: 101854

Total # of Units: 262 TSE Registration Fee: $5890.00

| Equipment Identification | Max BHP Rating | Fuel Type | General Use of Equipment | Number of Units |
|---|---|---|---|---|
| A/M32A-103 | 425 | Jet-A | Generator | 4 |
| ACE 410-927 | 262 | Jet-A | Coolant Cart | 1 |
| MC-5 | 100 | Jet-A | Air Compressor | 4 |
| P-250 | 80 | Diesel | air compressor | 1 |
| 4045T | 113 | Diesel | generator | 1 |
| 6BG1 | 55 | Diesel | generator | 1 |
| 6BG1 | 77 | Diesel | generator | 3 |
| DPAO | 200 | Jet-A | Coolant Cart | 6 |
| 4045T | 100 | Diesel | generator | 1 |
| MC-5 | 61 | Jet-A | Air Compressor | 1 |
| D00378 | 85 | Diesel | water truck | 1 |
| D00379 | 85 | Diesel | water truck | 1 |
| ACE 802-329S | 255 | Jet-A | Air Conditioner | 8 |
| B809B | 185 | Jet-A | Generator | 2 |
| PAO | 90 | Jet-A | Coolant Cart | 2 |
| PAO | 97 | Jet-A | Coolant Cart | 1 |

| | | | | |
|---|---|---|---|---|
| FX60 | 60 | Diesel | Vacuum Ditch Witch | 1 |
| VAC CON | 131 | Diesel | Vacuum Pump | 1 |
| D00380 | 85 | Diesel | water truck | 1 |
| A/M32A-86D | 148 | Jet-A | Generator | 32 |
| AF/M32T-1 | 51 | Jet-A | Cabin Leak Tester | 4 |
| MA-3D | 110 | Jet-A | Air Conditioner | 14 |
| DPAO | 105 | Jet-A | Coolant Cart | 1 |
| ACU-802-CUP | 340 | Jet-A | Air Conditioner | 7 |
| ACU-808-DUP-USAF | 449 | Jet-A | Air Conditioner | 11 |
| CGACC | 250 | Jet-A | Combined Generation Air Conditioned cart | 10 |
| ACE 410-927 | 195 | Jet-A | Coolant Cart | 1 |
| A/M32A-95 | 160 | Jet-A | Turbine Generator (air start cart) | 19 |
| P185WJD | 66 | Diesel | Air Compressor | 1 |
| RJ150 | 126 | Jet-A | Air Conditioner | 1 |
| AF/M27M-1 | 115 | Gasoline | Water Truck (emergency) | 1 |
| B809D | 155 | Jet-A | Generator | 6 |
| B809D | 185 | Jet-A | Generator | 2 |
| BF4M | 100 | Diesel | Generator (supporting Volumetric Mixer) | 1 |
| EAID | 755 | Diesel | Generator | 5 |
| EAID | 535 | Diesel | Generator | 2 |
| EAID | 380 | Diesel | Generator | 3 |

| | | | | |
|---|---|---|---|---|
| EAID | 216 | Diesel | Generator | 1 |
| Hobart | 100 | Jet-A | Generator | 1 |
| MEP-805B | 100 | Diesel | Generator | 2 |
| MEP-809A | 290 | Diesel | Generator | 1 |
| Hobart 90CU20 | 170 | Jet-A | Generator | 1 |
| A/M27T-17 | 275 | Jet-A | Hydraulic Test Stand | 10 |
| HIP-200D-2Z-30 | 197 | Jet-A | Hydraulic Test Stand | 1 |
| MJ-1 | 110 | Jet-A | Hydraulic Test Stand | 2 |
| MJ2A-1 | 200 | Jet-A | Hydraulic Test Stand | 4 |
| TTU-228/E-1B | 130 | Jet-A | Hydraulic Test Stand | 5 |
| TTU-228/E-B1 | 130 | Jet-A | Hydraulic Test Stand | 4 |
| J41002D | 250 | Jet-A | Liquid Cooling Unit | 2 |
| LCU-025-CUP | 250 | Jet-A | Liquid Cooling Unit | 1 |
| DPC | 250 | Jet-A | Power cart (provides electrical power) | 5 |
| A/M32A-60A | 160 | Jet-A | Turbine Generator (Air start cart) | 34 |
| Hobart 180CU20 | 325 | Jet-A | Generator | 2 |
| DHC | 110 | Jet-A | Hydraulic Test Cart | 5 |
| P260 HP220 | 79 | Diesel | Air Compressor | 1 |
| 6068T | 135 | Diesel | Generator | 1 |
| HPSGNSC | 165 | Jet-A | Nitrogen Servicing Cart (High Purity Self Generating) | 3 |
| PAO | 234 | Jet-A | Coolant Cart | 3 |

| | | | | |
|---|---|---|---|---|
| A/M32A-86D | 151 | Jet-A | Generator | 1 |
| B809E | 165 | Jet-A | Generator | 6 |
| SDG45 | 57 | Diesel | Generator | 1 |
| Tornado | 115 | Diesel | Street Sweeper | 3 |