

**Commercial Crew Transportation System (CCTS)
Draft Environmental Assessment
For the Boeing Starliner Launch from Cape Canaveral
Air Force Station and
Landing and Recovery at the
U.S. Army Willcox Range**

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



**Prepared by:
The Boeing Company**



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Commercial Crew Transportation System
(CCTS)
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1.0 Executive Summary

1.1 Introduction

This Environmental Assessment (EA) has been prepared to evaluate the potential environmental impacts from the proposed launch of the Boeing Commercial Crew Transportation System (CCTS) Starliner spacecraft, utilizing the United Launch Alliance's (ULA) Atlas V rocket, from the Cape Canaveral Air Force Station (CCAFS) in Florida and landing and recovery of the Starliner crew module (CM) at the U.S. Army's Willcox Range (referred to as the Willcox Playa throughout this document), in Arizona. The range consists of land controlled by Ft. Huachuca that include two parcels controlled by the State of Arizona. An additional area outside the range consisting of State of Arizona, Bureau of Land Management (BLM) and private land would also be utilized when the winds are strong enough and in the right direction to cause up to six small parts jettisoned from the Starliner during the parachute deployment process to be blown outside the boundaries of the Ft. Huachuca controlled land. These consist of small aluminum plates weighing up to 1 pound. 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 Edwards Air Force Base (EAFB) in California (one site), White Sands Missile Range (WSMR) in New Mexico (two sites), and Dugway Proving Grounds in Utah (one site). Separate EAs are being developed for those locations. Other sites were evaluated but failed to meet one or more of the criteria required for a landing site.

The Commercial Space Launch Act of 1984, as amended and re-codified at 51 U.S.C. 50901 - 50923 (the Act), authorizes the Department of Transportation and, through delegations, the Federal Aviation Administration's (FAA's) Office of Commercial Space Transportation, to oversee, authorize, and regulate both launches and reentries of launch and reentry vehicles, and the operation of launch and reentry sites when carried out by U.S. citizens or within the United States. The Act directs the FAA 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. The Act also directs the FAA to encourage, facilitate, and promote commercial space launches and reentries by the private sector, including those involving space flight participants.

NASA is acting as the lead agency for this EA, with the Federal Aviation Administration (FAA) and the U.S. Army Garrison Fort Huachuca acting as cooperating agencies. The first two test missions of the Starliner spacecraft would be under oversight of NASA. An FAA-issued commercial space launch and re-entry license is expected to be granted for the follow-on operational missions.

This EA has been prepared in compliance with the following:

- National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. §§ 4321-4370d)
- 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, Code of Federal Regulations (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 CFR Title 32, Part 651 *Environmental Analysis of Army Actions*.

The EA assesses impacts of the proposed action, discusses alternatives, and provides this information to the decision maker to make an informed decision to proceed or not to proceed with the proposed action. NEPA requires the preparation of an EA for Federal actions that do not qualify for a Categorical Exclusion and may not require an Environmental Impact Statement (EIS). If this EA determines that the environmental effects of the proposed action are not significant, a Finding of No Significant Impact (FONSI) would be issued by the agencies. In addition, because the proposed action takes place within a floodplain, a Finding of No Practical Alternatives (FONPA) would be issued. If this action appears to have significant impact, a Notice of Intent (NOI) to prepare an EIS would be published.

The following NEPA documents analyze the potential environmental consequences of launching the Starliner atop the ULS Atlas V from Space Launch Complex (LC) 41 at CCAFS. These contain the affected environments and environmental impacts for the ULA Atlas V rocket operations at CCAFS. Only those impacts unique to the integration of the Starliner are included in this EA.

- *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (April 1998)
- *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (March 2000)

A number of related environmental documents have been prepared and approved that address activities performed at Willcox Playa. These documents contain information about the affected environment that was used in the preparation of this EA. Even though several of these are fairly old, the information is still accurate. These documents also contain a general discussion of the affected environments present. A listing of these documents follows:

- *Environmental Assessment, U.S. Army Electronic Proving Ground Communication-Electronic Testing and Use of Test Sites in Southern Arizona and Fort Huachuca.* Department of the Army, Ft. Huachuca Garrison, Fort Huachuca, Arizona, June 1992.
- *Environmental Assessment, Renewal of Leases on Sands Ranch and Two Properties on Willcox Playa to Support USAEPG Test Mission.* Department of the Army, Ft. Huachuca Garrison, Fort Huachuca, Arizona, November 1992.
- *Environmental Assessment, Renewal of Six Joint-Use Property Leases in Support of the U.S. Army Electronic Proving Ground,* Directorate of Engineering and Housing, U.S. Army Garrison, Fort Huachuca, Arizona, March, 1997
- *Final Environmental Assessment for the Aerodynamic Stability Testing of Battle Damage Assessment Vehicles in the Vicinity of Willcox, Arizona.* US Army TACOM-ARDEC, Picatinny Arsenal, NJ, February 2000.

1.2 Background

NASA's CCDev initiative is working with the American aerospace industry as companies develop and operate a new generation of spacecraft and launch systems capable of carrying crews to low-Earth orbit and the ISS. Boeing is one of the companies developing this capability via its CCTS Starliner spacecraft.

Commercial transportation to and from the ISS will provide expanded utility, additional research time and broader opportunities of discovery on the orbiting laboratory. The ISS is critical for NASA to understand and overcome the challenges of long-duration spaceflight necessary for the journey to Mars. By encouraging industry to provide human transportation services to and from low-Earth orbit, NASA can expand its focus on building spacecraft and rockets for deep space missions.

Boeing will build, integrate, test and service the Starliner in the Commercial Crew and Cargo Processing Facility (C3PF) at Kennedy Space Center (KSC) before transporting it to the CCAFS for integration onto the Atlas V rocket. The Starliner launches flight crew and cargo on an Atlas V rocket from LC 41 at the CCAFS, 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 or, in an emergency that does not allow time for targeting one of the five landing sites, lands at sea, and is recovered and potentially refurbished for reuse. A ground-based mission control center controls orbital operations. Ground-based facilities provide prelaunch operations and manufacturing support. A combination of Boeing and DoD vehicles and personnel perform recovery operations at the primary and backup landing sites. In the event of an emergency water landing, caused by either a launch abort or an emergency return from orbit, the mission control center would coordinate a combination of Coast Guard and DoD Search and Rescue vehicles and personnel to locate and recover the Starliner and its crew. The Boeing CCTS system consists of three segments: the Starliner spacecraft, the Atlas V rocket, and the ground support infrastructure. The Starliner segment includes the Crew Module (CM), and Service Module (SM), which has a Launch Abort System (LAS). This segment supports the flight crew through launch, on-orbit, and return operations. The CM is the only portion of the Starliner that is recovered. It is returned to the C3PF for possible refurbishment and processing for a future mission. The expended launch vehicle lands in the Atlantic. The parts of the SM that do not burn up during entry land in the Pacific. The Boeing Landing Recovery Team (LRT) convoy would be based at the White Sands Missile Range in New Mexico and deploy to the designated primary and backup landing sites for each Starliner landing. Figure 1-1 shows the overall concept of operations for the Starliner missions to the ISS.

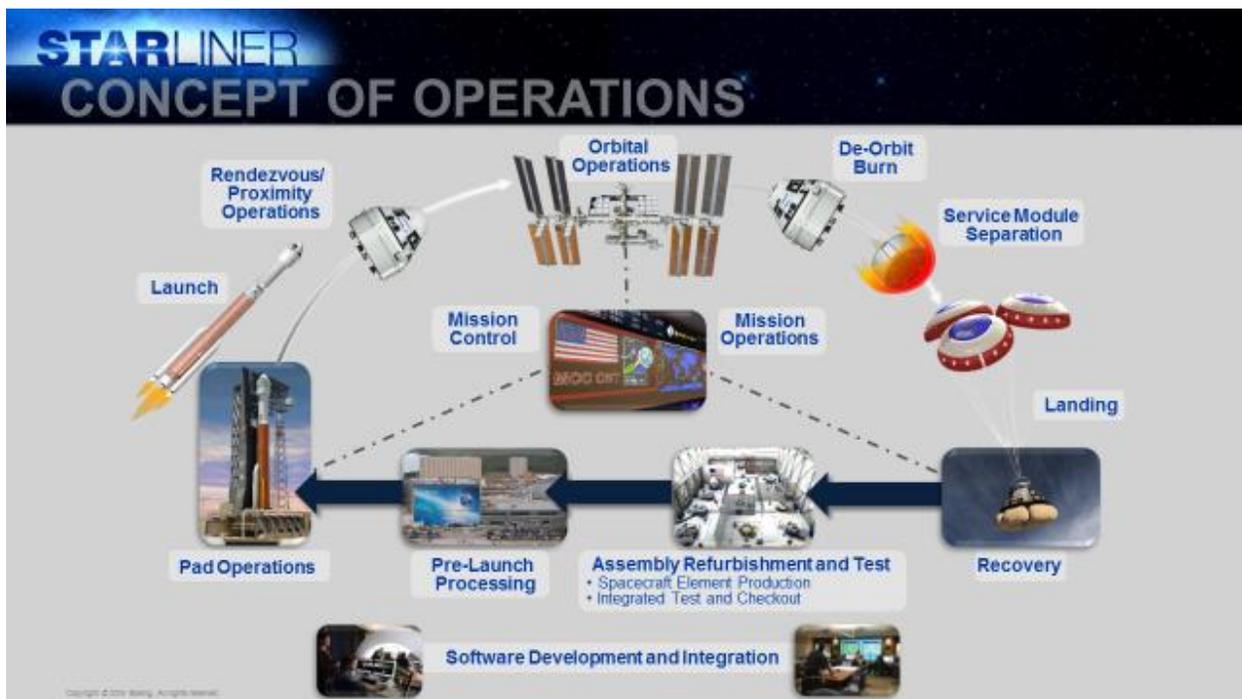


Figure 1-1: Starliner Concept of Operations

Ft. Huachuca, at the request of NASA and the Boeing Corporation, is proposing to support the development of the CCTS as part of NASA's CCDev initiative by providing a landing site for the Starliner CM.

The playa is located within an area characterized by mountain ranges on a northwest-southeast axis, separated by broad alluvial valleys. Mountains surrounding the area include the Winchester Mountains, approximately 15 miles (mi) to the northwest, the Chiricahua Mountains approximately 9 mi to the east (with the greater Chiricahua range approximately 25 mi to the southeast), and the Dragoon Mountains approximately 10 mi to the southwest. The San Pedro River is located approximately 25 mi to the west and the Gila River is approximately 45 mi north of the playa. The landing site is on a DoD range and test facility located on the Willcox Playa south of Willcox, Arizona (Figure 1-2). The Bureau of Land

Management (BLM) owns the land but it has been withdrawn to the Army for military use. The Army manages the playa from Ft. Huachuca. The playa was used as a bombing and strafing training area during World War II and was later used as the Electronic Proving Ground (EPG) Radar Geometric Fidelity Facility (RGFF) and Radar Geology Test Area (RGTA). The Willcox Playa consists of 52 square miles (28,667 acres); including 50 square miles (27,387 acres) managed by Ft. Huachuca and two, 1 square mile State of Arizona managed parcels (1,280 acres) (Figure 1-2).

Two flight tests support the design and development of the CCTS: the Orbital Flight Test (OFT) and the Crewed Flight Test (CFT). The OFT would demonstrate the ability to launch the spacecraft with cargo to orbit and safely land. The CFT would demonstrate the ability to launch crew to orbit and safely land. Ft. Huachuca is being asked to support beginning with the OFT. In addition, the same support would also be required for NASA's follow-on Service Missions to the ISS. Willcox, along with two sites at WSMR, EAFB, and Dugway, would act either as the Primary Landing Site (PLS) or as a Back-up Landing Site (BLS). In the case of a wave-off of a nominal landing both a PLS and a BLS would be active for each landing. The LRT would generate the necessary requirements and procedures to support the mission landings.

This document will describe the Starliner spacecraft, the launch operations, and the desired support from Ft. Huachuca to prepare Willcox Playa for the landings as well as to augment the Boeing LRT, and an overview of the planned landing and recovery operations for all potential phases of the CFT and follow-on missions.

Figure 1-3 depicts the landing zone at Willcox Playa (red circle plus red wedge-shaped extension) and shows the location of the remains of the RGFF (consisting of concrete pillars and dilapidated wood framing, numbered black dots) that would be removed as part of the proposed action to clear the landing zone of obstacles. The CM and all large jettisoned parts would land within a cleared circle with a radius of approximately 4 km on the playa. Depending on the strength of the winds on landing day, up to six small parts jettisoned as part of the parachute deployment system could land in the extension shown out to 8 km. White silt and clay cover the area with very little in the way of vegetation (Figure 1-4). Figure 1-5 shows the Starliner spacecraft in its landing configuration. Impacts for this infrastructure removal are included as part of this EA.

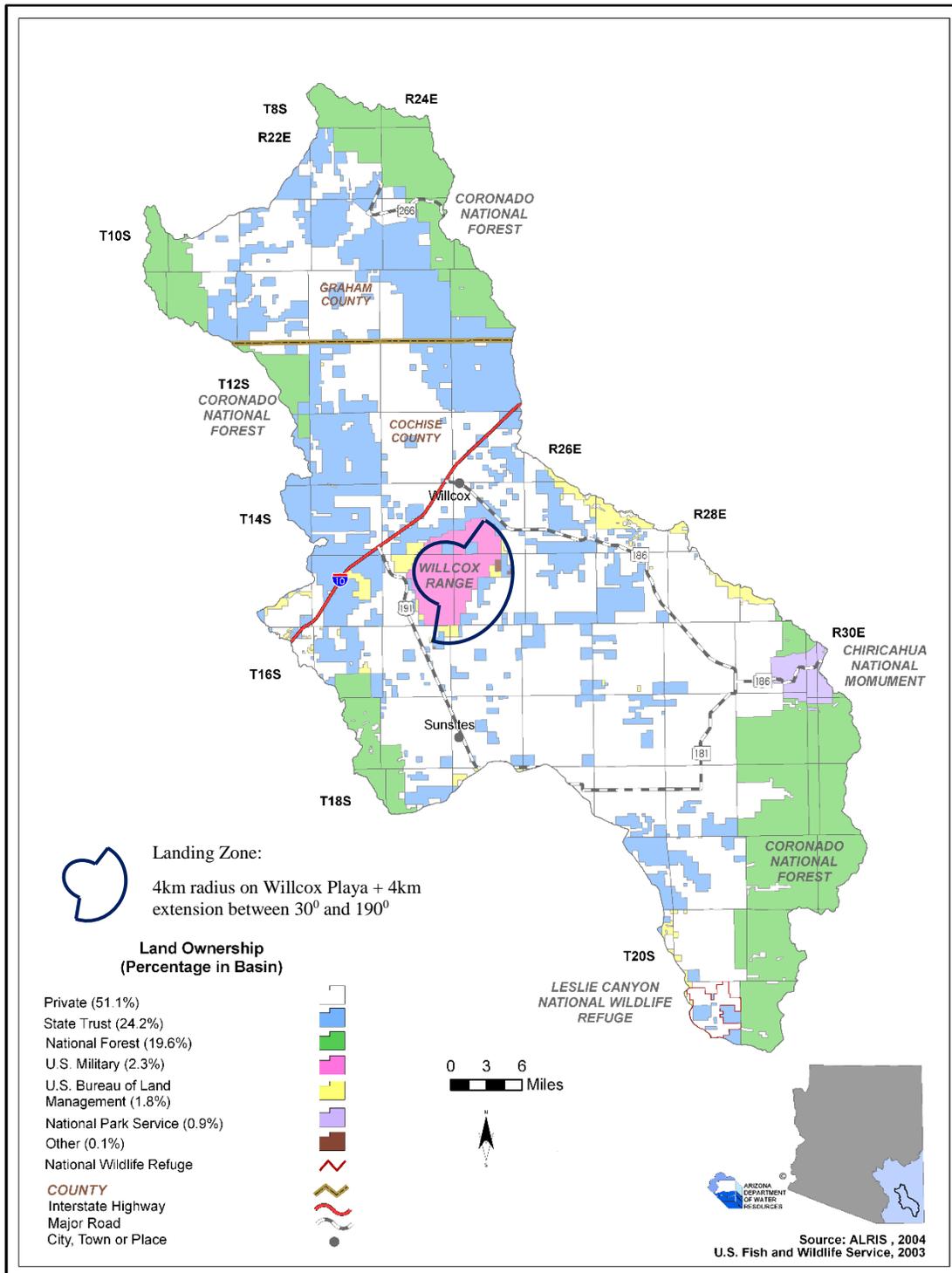


Figure 1-2: Willcox Range Location

(Source: U.S. Fish and Wildlife Service)

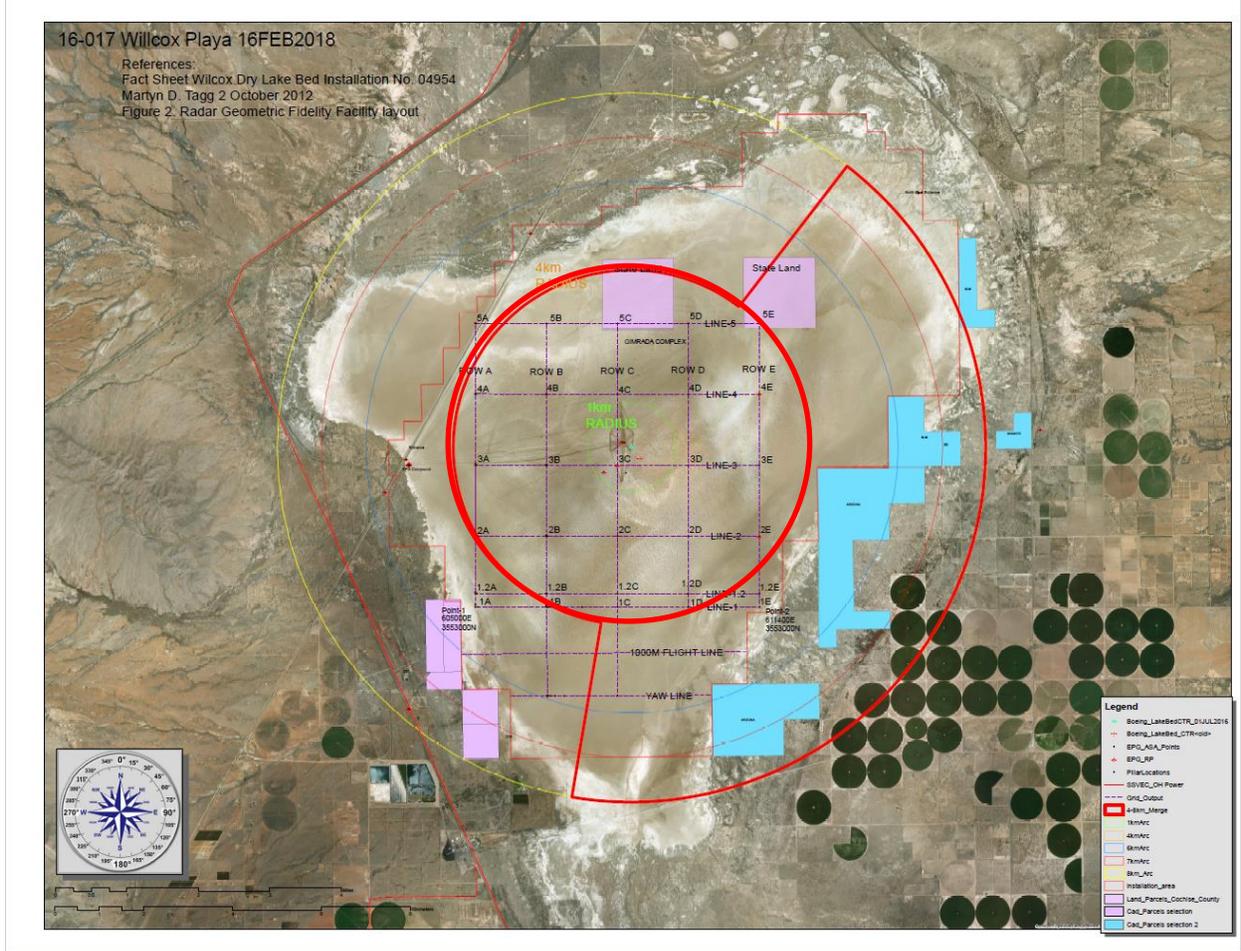


Figure 1-3: Willcox Range EPG RGFF Pillar Locations and Starliner Landing Zone

(Source: Directorate of Public Works Engineering Plans and Services Division, Ft. Huachuca)



Figure 1-4: Willcox Landing Area

(Source: Cultural Resources Report)



Figure 1-5: Boeing Starliner

1.3 Proposed Action

For NASA and the DoD, the proposed action is to prepare the landing site by removing the remnants of the RGFF and allowing the CCTS initiative to launch from CCAFS and to perform landing and recovery operations for the Boeing Starliner at Willcox Playa for the CFT, OFT, and subsequent missions. At CCAFS, existing launch processing infrastructure would be utilized for integration and launch on the Atlas V. At Willcox, demolition of the remaining RGFF infrastructure is required in order to clear the necessary terrain within the 4 km radius to allow for an adequate landing zone for the crew module.

As mentioned at the beginning of Section 1.1, in order for Boeing to conduct commercial Starliner missions, Boeing would have to obtain a launch and reentry license from the FAA. The FAA's anticipated action of issuing Boeing a license for Starliner launch, reentry, and landing is considered part of the proposed action analyzed in this EA.

1.4 Process

Three federal agencies (NASA, DoD, and FAA) are directly involved in the EA for this proposed action, with NASA acting as the lead agency.

1.4.1 Role of NASA

NASA provides oversight for current commercial space and technology development-related activities, and is responsible for establishing and coordinating activities outlined in the proposed action. NASA is the lead agency for the proposed action and is responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

1.4.2 Role of FAA

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 EO 12465, *Commercial Expendable Launch Vehicle Activities*, and chapter 509 of Title 51 of the U.S. Code covering commercial space launch activities. The mission of the FAA's Office of Commercial Space Transportation is to ensure protection of the public, property, and the national security and foreign policy interests of the United States during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation. The FAA expects to receive a launch and reentry license application from Boeing for launching from CCAFS and reentering and landing the Starliner at Willcox. The FAA would be required to review the application and determine whether to issue a license.

1.4.3 Role of DoD

As the owner of the Eastern Test Range, the Air Force is responsible for its real property assets and infrastructure in support of launching of the Starliner spacecraft at CCAFS. A support contract between Boeing and ULA for launch services is in development.

As the landowner of the landing site, the Army is responsible for its real property assets and infrastructure in support of the landing and recovery of the Starliner spacecraft at the Willcox Playa. A support contract has been established between Boeing and Ft. Huachuca for Army support to the proposed action.

1.5 Environmental Effects

The environmental effects for launching the Atlas V have been well documented in the EELV EIS and Supplement referenced in section 1.1. Only those impacts unique to the launching the Starliner on the Atlas V were assessed for this EA.

The Proposed Action incorporates several measures and practices to minimize potential impacts on the physical resources at Willcox. An evaluation was made of the following environmental resources to assess the significance of potential impacts for the Proposed Action:

- Air Quality
- Biological Resources (fish, wildlife, plants, threatened and endangered species, and critical habitat)
- Climate
- Department of Transportation Act, Section 4(f)
- Land Use and Airspace, including Farm Land
- Physical Resources (including water, floodplains, topography, geology, and soils)
- Cultural Resources (Architectural, Archaeological, and Area of Tribal Interest)
- Noise and Noise Compatible Land Use
- Socioeconomics
- Environmental Justice and Children’s Environmental Health and Safety Risks
- Visual Effects
- Infrastructure and Utilities
- Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention
- Human Health and Safety

Natural resources¹ were not analyzed in detail in this EA because the proposed action would not result in the development of new facilities or result in consumption of natural resources other than the fuel used by the launch operations and by the demolition and LRT vehicles.

Each environmental resource was evaluated based on a list of activities determined necessary to accomplish the Proposed Action. The primary areas of concern for landing and recovery operations are potential loss of soil and/or vegetation, dust generation, impacts to cultural heritage, and ensuring human safety. As discussed in chapter 3, the assessment identified no significant impacts.

¹ Per FAA Order 1050.1F, the FAA is required to consider the potential impacts on “natural resources and energy supply.” Energy supply is discussed under “Infrastructure and Utilities” in this EA. In the context of FAA’s NEPA impact assessment, the FAA must consider the amount of natural resources—such as water, asphalt, aggregate, and wood—a project would use in the construction, operation, and maintenance of a project.

1.6 Alternatives Considered but Not Carried Forward

The CCAFS LC 41 is the only launch complex that has been customized to allow required access to load crew and cargo aboard the Starliner and is therefore the only viable launch site. No other launch sites were considered for this action.

The LRT evaluated several landing sites in the U.S. using criteria that included having an adequate landing zone, preferably in a controlled environment like a military range, near a level 1 trauma center, with favorable weather and landing surface, and in the western U.S. to allow SM disposal in the Pacific.

Due to the limited cross-range capability of the Starliner, multiple, geographically separated, landing sites are required for landing opportunities as the orbit of the ISS progresses across the US during any given day. This also provides for a backup option in the case of inclement weather at the primary landing site on the scheduled day of landing. Several of the landing sites also have seasonal standing water that prevent landings during a few months of the year. Boeing's assessment determined five landing sites were required. Based on the assessment, the following were identified as potential landing sites for the Starliner; two at the White Sands Missile Range (WSMR) in New Mexico, Dugway Proving Grounds in Utah, the Willcox Range in Arizona, and Edwards Air Force Base (Figure 1-6). Other landing sites failed to meet one or more of the selection criteria. These included several sites in Oregon, Nevada, California, Utah, Arizona and alternate locations within WSMR and Edwards. The site at Willcox met all requirements for providing an adequate landing area. Due to the unique aspects of each location, a decision was made to generate multiple EAs rather than include all impacts to all areas in a single EA. In addition to this EA, three separate EAs are being prepared for the selected landing sites at Edwards, and Dugway, and WSMR (covering both landing sites).

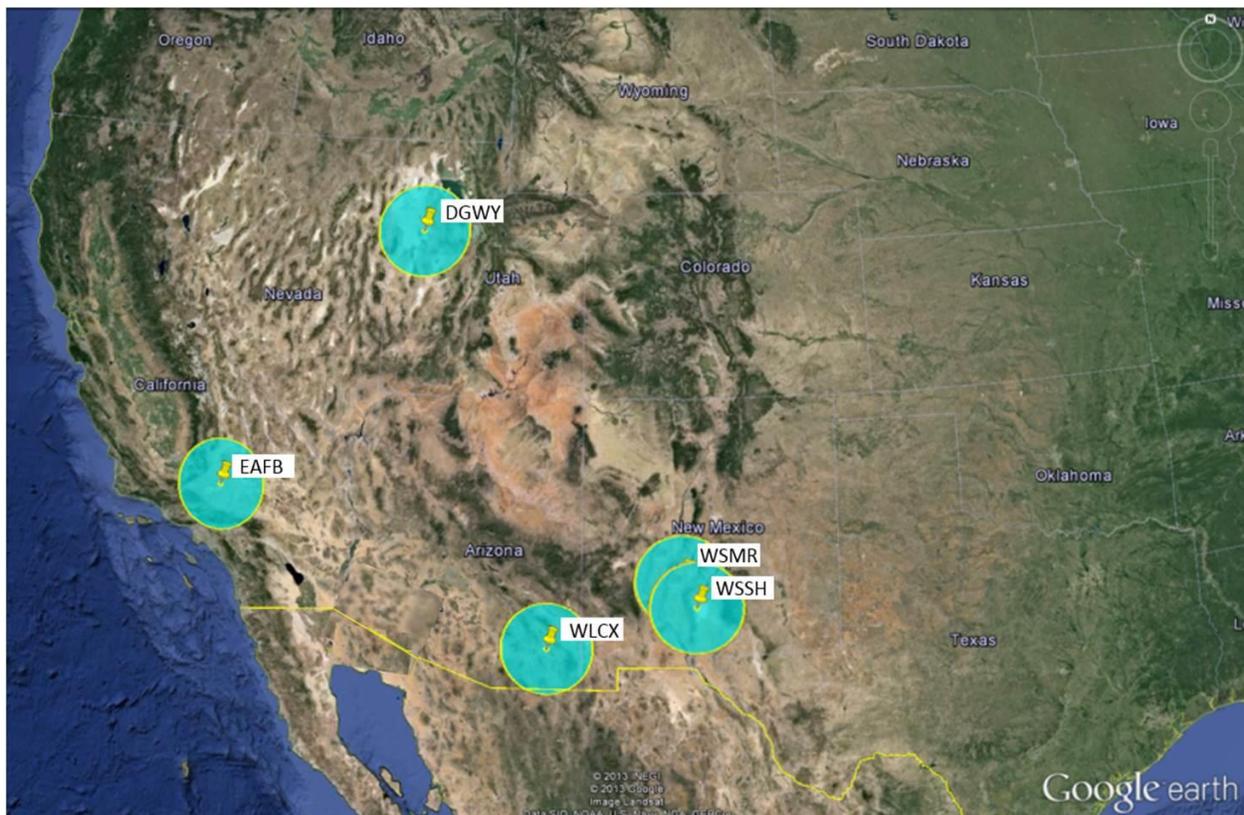


Figure 1-6: Starliner Landing Sites

1.7 No Action Alternative

Under the No Action Alternative, there would be no Proposed Action activities at CCAFS nor Willcox and no environmental impacts from the Proposed Action. Not launching these mandatory test flights and subsequent missions would severely impact the future of the U.S. manned spaceflight program by delaying it until the Space Launch System (SLS) currently under development is designed, built and tested. Under this alternative, the FAA would not issue Boeing a launch and reentry license for Starliner operations.

1.8 Conclusion

This EA provides NASA, the DoD, and the FAA with the documentation of environmental impacts associated with the removal of the RGFF and the Starliner launch from CCAFS and landing and recovery at Willcox. The decision to be made is either: (1) Approve a FONSI and FONPA based upon the proposed analysis contained within the EA; or (2) Determine a FONSI is not applicable, resulting in the need for an EIS.

2.0 Description of the Proposed Action and Alternatives

2.1 Purpose and Need for Proposed Action

The purpose of the proposed action is to allow for the launch of the Boeing Starliner from the CCAFS and the landing recovery at Willcox Playa beginning in 2019. The completion of the ISS and retirement of the Space Shuttle necessitate an innovative plan and program to fulfill the goal of returning the human launch capability to U.S. soil. The Starliner is one of the replacement transport Crew Vehicles for access to the ISS to replace the retired Space Shuttle capability. The proposed action of this EA is to integrate and launch the Starliner at CCAFS and clear the necessary terrain and to support Starliner mission landing and recovery requirements at Willcox. The OFT is scheduled for the first half of 2019 with the CFT scheduled for the second half of 2019. Routine missions would begin upon completion of these two tests and take place 1-2 times per year.

The purpose of the FAA's anticipated action in connection with Boeing's expected request for a launch and reentry license is to fulfill the FAA's responsibilities as authorized by Executive Order 12465, Commercial Expendable Launch Vehicle Activities (49 Federal Register 7099, 3 CFR, 1984 Comp., p. 163), and chapter 509 of Title 51 of the U.S. Code for oversight of commercial space launch activities, including licensing launch and reentry activities. The need for FAA's Proposed Action results from the statutory direction from Congress under the U.S. Commercial Space Launch Competitiveness Act of 2015 to, in part, "promote commercial space launches and reentries by the private sector; facilitate Government, State, and private sector involvement in enhancing U.S. launch sites and facilities; [and] protect public health and safety, safety of property, national security interests, and foreign policy interests of the United States." Pub. L. 114-90, §113(b). Additionally, Congress has determined the Federal Government is to "facilitate the strengthening and expansion of the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities." 51 U.S.C. § 50901(b)(4).

2.2 Proposed Action Details

The Proposed Action for NASA and the DoD is to clear the necessary terrain and perform launch and landing and recovery operations of the Starliner and its flight crew. These operations would take place in the following phases:

- A. Removal of the remnants of the RGFF infrastructure within the playa.
- B. Integration and launch of the Starliner from CCAFS.
- C. Staging of the landing recovery personnel and equipment at Willcox, Arizona
- D. Simulation of landing and recovery operations within the landing zone two days before the scheduled landing of the Starliner
- E. Landing and recovery of the Starliner and its crew.

As part of the certification process to establish Willcox as a landing location for the Starliner, A, C and D above would also be performed before the scheduled OFT.

For a commercial (i.e., non-NASA) mission, Boeing would be required to apply to the FAA for a launch and reentry license. Therefore, the FAA action of issuing Boeing a license for Starliner launch from CCAFS and reentry and landing at the Willcox site is considered part of the proposed action analyzed in this EA.

2.3 Launch Operations

All processing of the Boeing Starliner will occur at facilities located outside of Cape Canaveral Air Force Station. Boeing will build, integrate, test and service the Starliner in the C3PF at KSC. The Starliner will be prepared for transport and loaded aboard the ULA transport vehicle at the C3PF. The Starliner will

then be transferred by road from this facility to LC 41, as is done with commercial payloads. The transportation route does not involve public roads and will be controlled by KSC and/or CCAFS security personnel. Any regulatory reporting, air emissions, waste generated at CCAFS, associated with processing the Starliner at the C3PF is the responsibility of Boeing. The Starliner will then be integrated and launched from LC 41 on an Atlas V in the same fashion as current and previous payloads have been launched.

ULA currently launches Commercial, DoD, and NASA payloads from LC 37 and LC 41 utilizing Delta IV and Atlas V launch vehicles in a multitude of configurations. The Starliner covered in this action is proposed to be launched from LC 41 on an Atlas V Launch Vehicle. Figure 2-1 shows the location LC 41 at CCAFS. Figure 2-2 shows the launch configuration of the Starliner on the Atlas V.

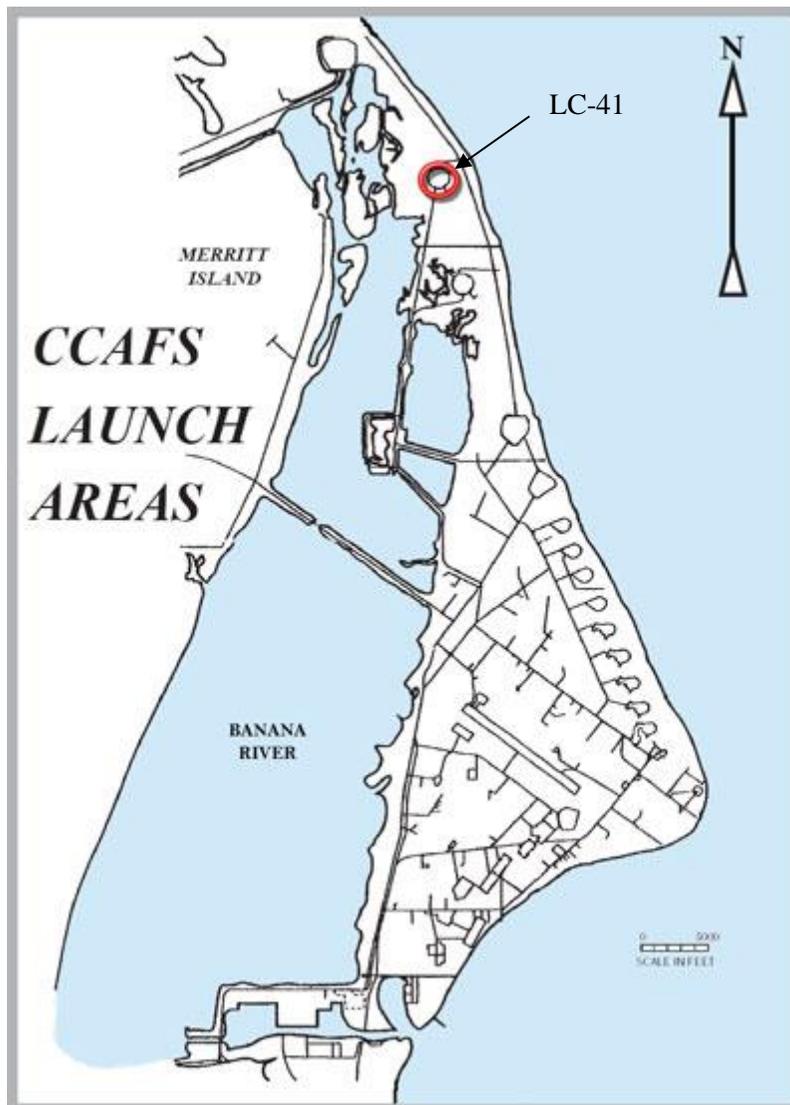


Figure 2-1: Launch Complex 41 Location

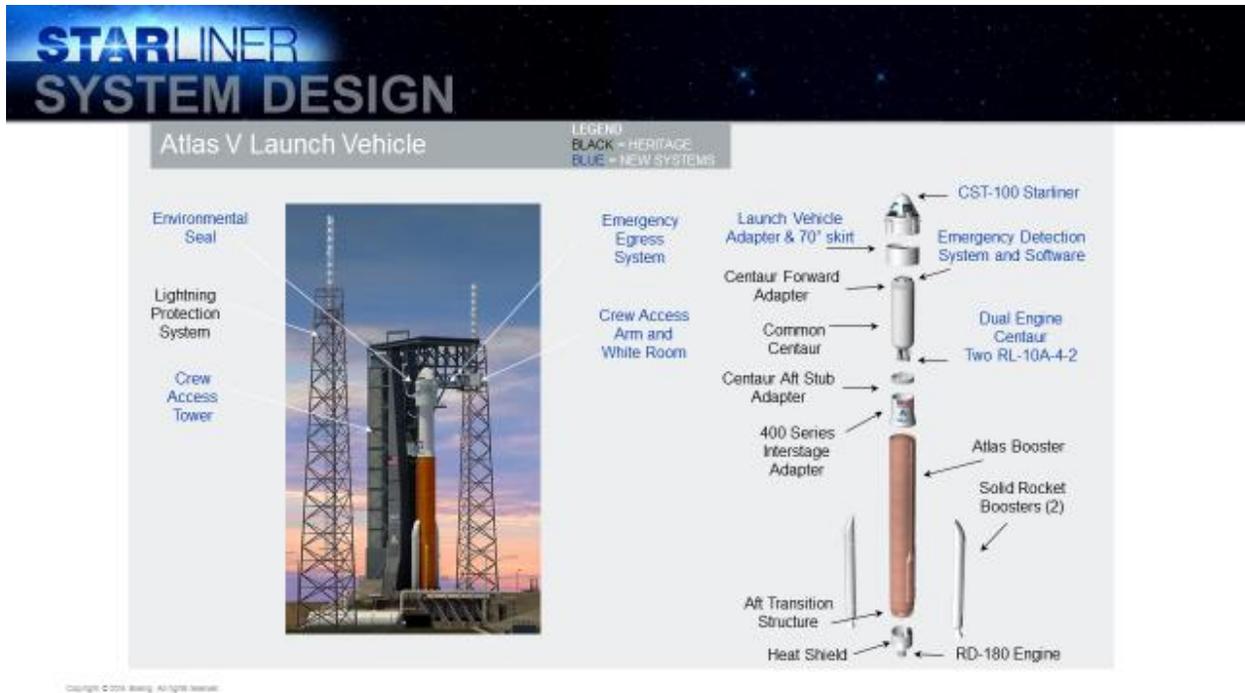


Figure 2-2: Starliner and Atlas Launch Configuration

2.4 Willcox Landing Location

The Willcox landing zone is a 4km radius circle centered at latitude of 32.140 degrees North and a longitude of 109.850 degrees West (Figure 2-3) plus an extension out to 8 km from this center point between 38⁰ and 190⁰ from true north. The spacecraft and all large jettisoned pieces would land within the 4 km radius circle with the Starliner CM landing target being a 1 km radius circle around this center point. Up to six small jettisoned parts could land in the extension depending on the strength of the winds on the day of landing.

On the planned day of landing, weather data would be evaluated at both the PLS and BLS. In order to ensure all the pieces of the Starliner land within the approved landing zone, weather limits would be established for the landing sites. Should the data show an exceedance of the weather limits at the PLS, a decision would be made whether to land at the BLS (assuming it has favorable weather) or wave off the landing to a later opportunity when conditions are favorable. Should the data show an exceedance at both the PLS and BLS, the landing would be waved off to a later opportunity. These controls would ensure the Starliner and jettisoned pieces would stay within the landing zone.

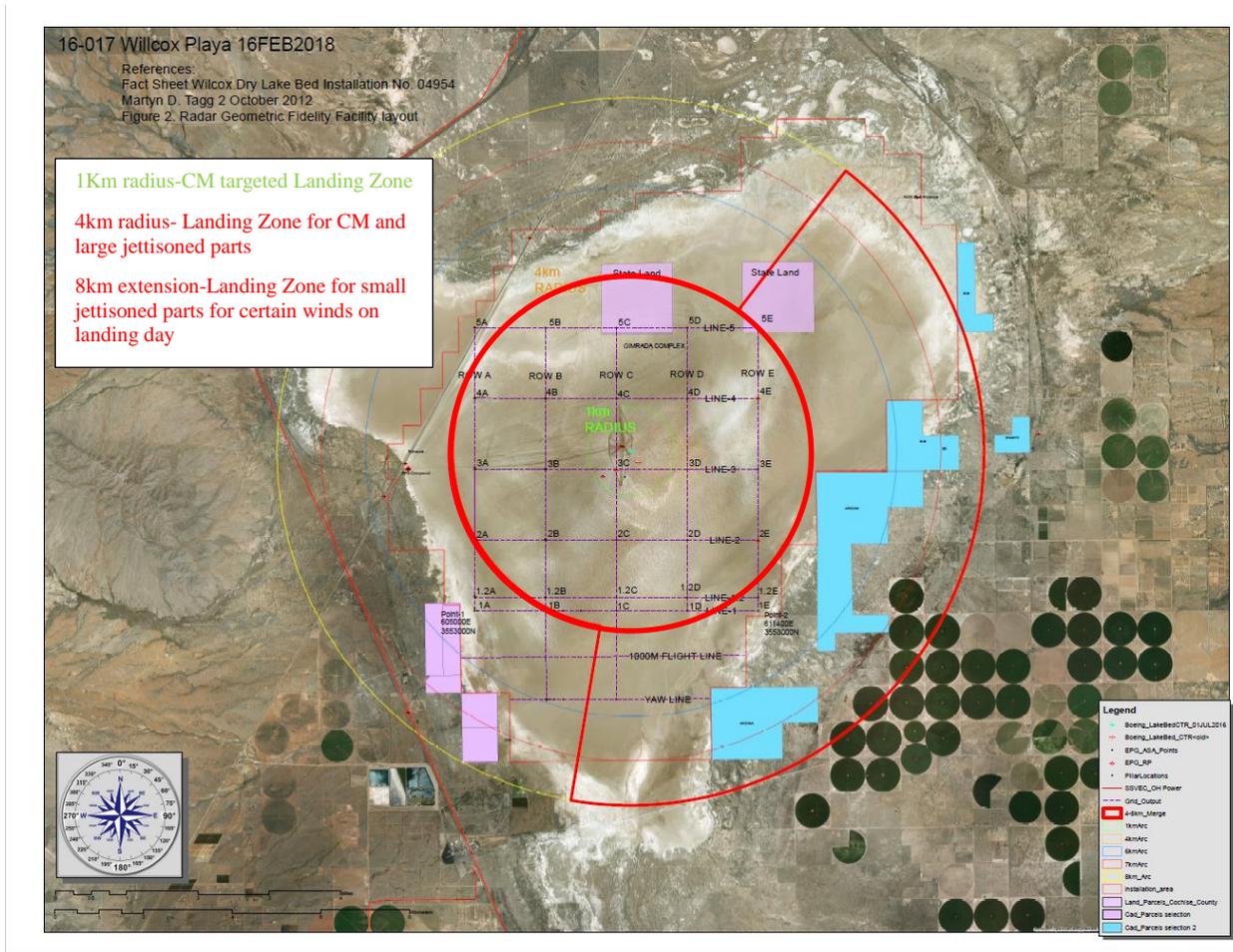


Figure 2-3: Willcox Landing Area Details

(Source: Directorate of Public Works Engineering Plans and Services Division, Ft. Huachuca)

2.5 Electronic Proving Ground Radar Geometric Fidelity Facility Description

The RGFF, constructed in 1962, consisted of 65 concrete pillars arranged in an approximately 4 by 5-mile grid pattern. The pillars are approximately 4 feet in diameter and extend approximately 5 feet above ground level. Each pillar originally had a radar reflector mounted to the top but these are no longer present. All the remaining pillars and attached infrastructure located on the playa would be removed as part of this action. The facility measured spatial fidelity, range accuracy, and range and azimuth resolution of airborne surveillance and mapping radars. Figure 2-4 shows some of the remaining pillars and infrastructure.

The removal of the remnants of the facility would require the use of construction vehicles and machinery to remove and haul away the debris generated.



Figure 2-4: RGFF Concrete Pillars and Infrastructure Examples

2.6 Starliner Description

Boeing's Crew Space Transportation 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 crewmembers and time-critical scientific research. The Starliner is reusable up to 10 times with a six-month turnaround time. The Starliner includes the CM and SM and supports the flight crew and cargo through launch, on-orbit, and return operations. The CM is the only recovered portion of the Starliner that is lands and is recovered.

The Starliner spacecraft jettisons several pieces of hardware during the landing phase of the mission (Figure 2-5). The FHS (less than 10 feet 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 less than 75 pounds) would jettison at approximately 8000 feet altitude just before deploying 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 several mortar sabots (less than 18 inches and weighing less than 5 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 feet in diameter, less than 4 feet tall and weighing less than 1700 pounds) would jettison at approximately 4000 feet altitude and would free fall until ground impact. The three main landing parachutes (less than 110 feet in diameter) would jettison at CM landing. The CM and all large jettisoned pieces would land within the 4 km radius circle. Depending on the winds on landing day, up to six small jettisoned parts could land in the 8km extension. These parts consist of up to two FHS composite doors that are 10 in. by 12 in. and weigh 1 lb. each, up to two round aluminum mortar lids 7.4 in. in diameter and weighing 0.25 lb. each, and up to two round aluminum mortar lids 16 in. in diameter and weighing 0.75 lb. each. Boeing performed a public risk assessment, concurred by NASA and the FAA, which concluded the risk to the public for these items is below federal requirements. Despite this, Boeing will take that added precaution of notifying homeowners when a landing is planned to take place at Willcox and establish roadblocks to ensure there is not a population increase in this area due to public interest in witnessing a landing.

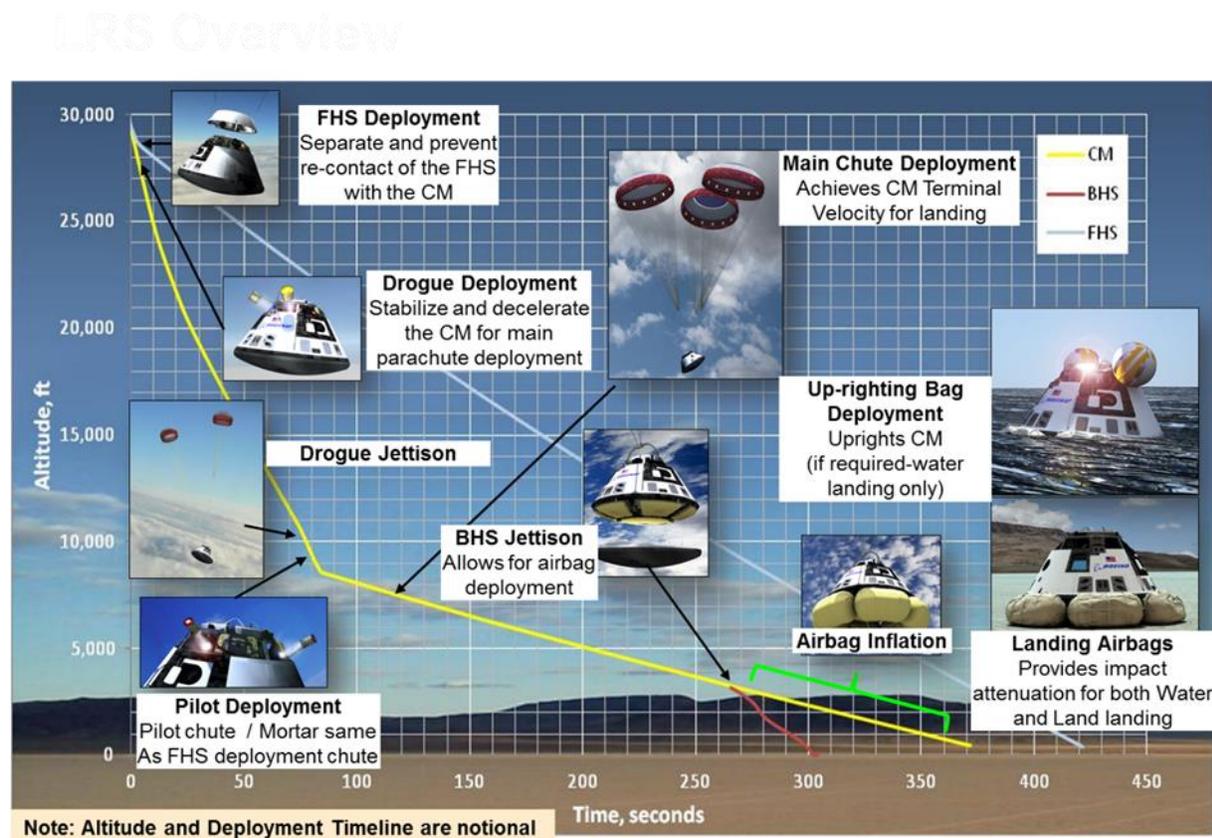
All items that land on the playa would be located and recovered, if possible. It may not be possible to find and recover all of the mortar lids and sabots due to their small size. These are similar in size and material to other debris currently located on the playa so they would not cause any impacts or hazards. Any small jettisoned items that land off the playa would not be retrieved to avoid the impacts of driving ATVs

across the terrain looking for them. The composition of these items would not cause any environmental concerns.

The CM would land 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.

The landing sequence is controlled by automated sequences with the required redundancy built into the systems. The crew can also take over and control the sequence manually if necessary.



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Figure 2-5: Starliner Landing Sequence

2.7 Landing Recovery Forces Description

The landing and recovery convoy would consist of Boeing owned, Boeing contracted, and Ft. Huachuca provided vehicles and equipment. The Boeing owned vehicles and equipment will be based at White Sands Missile Range in New Mexico would arrive at Willcox one week prior to the planned landing date, parking at a secured staging area. These include the Mobile Landing Control Center and Mobile Data Tracking Vehicle trucks, each a four wheel-drive self-contained mobile unit, and the trucks, trailers, and other vehicles needed to carry the Boeing owned landing and recovery personnel, equipment, and portable buildings to the landing site. All other equipment and services needed for the Starliner recovery will be contracted for locally by Boeing or provided by Ft. Huachuca. These include cranes for Starliner and BHS recovery, a semi with flatbed for transporting the Starliner CM from the landing site to the staging area,

fire, rescue, security, and emergency medical vehicles and personnel, and portable water, toilets, lights, and generators.

Two days before the planned landing a simulation would take place involving movement of all vehicles, equipment, and personnel to the landing zone to practice crew and Starliner recovery operations.

On landing day, the recovery convoy would move to a holding area just outside the 4km radius-landing zone approximately 5 hours before the planned landing. Upon landing, the convoy 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 two-person safety assessment team (donned in Propellant Handlers Ensemble or Breathing Air Packs), would perform the initial safety assessment. If hazardous conditions are detected due to a leak of hydrazine caused by a spacecraft failure the safety assessment team would determine the source and mitigate the hazard, if possible. If unable to mitigate the hazard, the Fire Crash Rescue team would assist in mitigating the hazard by performing toxic spill or contamination cleanup. The convoy would reposition near the spacecraft and commence recovery operations once the area is deemed safe. The estimated time needed to complete recovery operations is six hours.

Figure 2-6 is a notional, post-landing configuration showing the portable shelters used to house personnel, provide initial medical evaluation for the returning crew, and processing of any time critical cargo. Also shown are the tent put over the Starliner to protect from dust, the crane and flatbed used to transport the crew module, and other support vehicles.

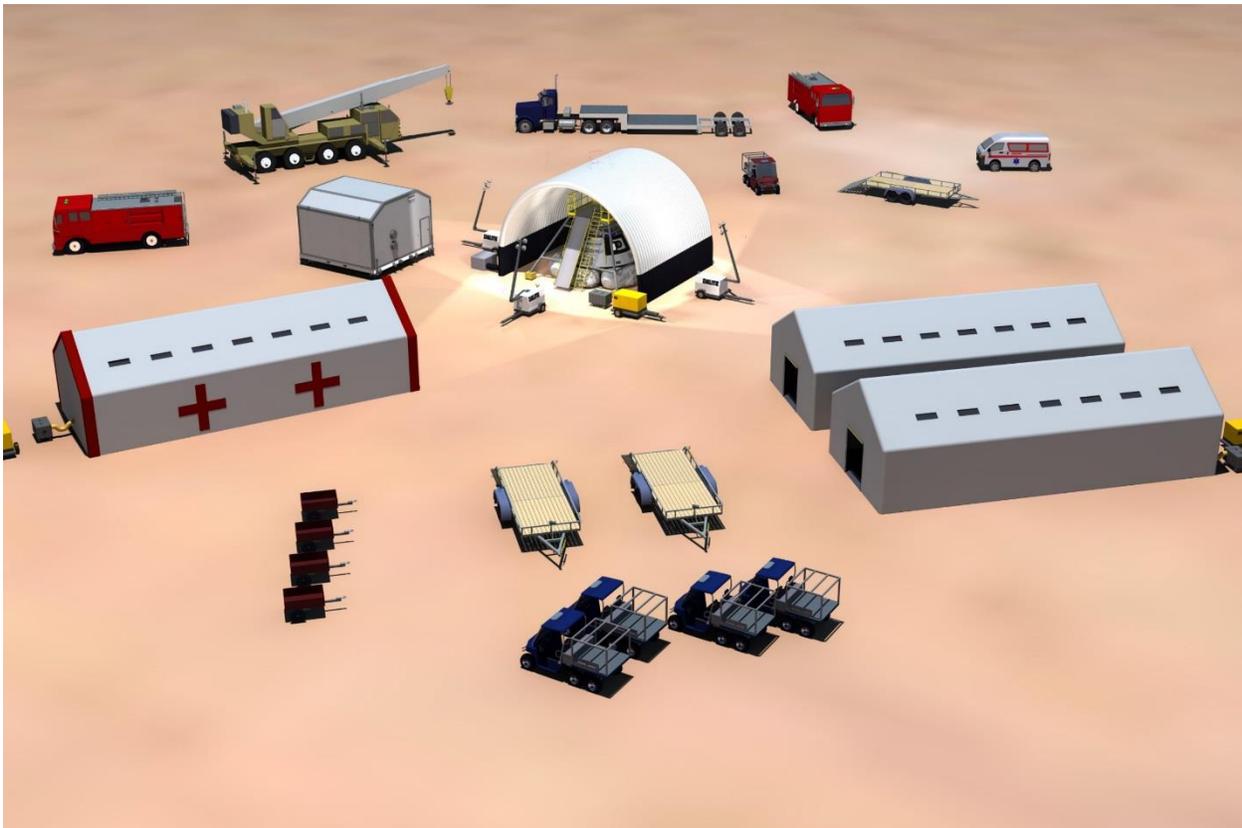


Figure 2-6: Landing Site Post Landing Configuration (notional)

2.8 No Action Alternative

Under the No Action Alternative, there would be no Proposed Action activities at CCAFS or Willcox and no environmental impacts from the Proposed Action. Not launching these mandatory test flights and subsequent missions would severely impact the future of the U.S. manned spaceflight program by delaying it until the SLS currently under development is designed, built and tested. Under this alternative, the FAA would not issue Boeing a launch and reentry license for Starliner operations.

2.9 Alternatives Considered but Not Carried Forward

As mentioned in section 1.6, CCAFS LC 41 is the only launch complex that has been customized to allow required access to load crew and cargo aboard the Starliner and is therefore the only viable launch site for this action. No other launch sites were evaluated.

The LRT completed a review of potential landing sites at multiple locations throughout the southwest 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 and rollout.
2. Preferably, in a controlled environment like a military range for ease of establishing protected keep-out zones and to allow use of DoD personnel and equipment during landing and recovery operations. Also for the ease of negotiations with one owner familiar with the NASA Human Space Flight Program.
3. Near a Level 1 Trauma Center, within a one-hour MEDEVAC capability to provide the best possible care for and injured astronaut.
4. Access for recovery – no standing water or extremely muddy/soft soil for large portions of the year to maximize the number of landing opportunities.
5. Good weather/winds, that fit within the wind restrictions established for safely landing the CM, for a large portion of the year.
6. Geographic location for a 51.6-degree inclination mission, allowing for the Service Module disposal in the Pacific and between the latitude trajectory limits of the Space Station.

This assessment resulted in selection of Willcox as one of the five areas (along with the two sites at the White Sands Missile Range, Dugway, and Edwards) for designation as a prime and backup landing site due to the suitability of the landing site and the availability of the supporting capabilities needed. Landing and recovery activities at WSMR, Edwards, and Dugway are being assessed in separate EAs.

The following sites failed to meet one or more of the above criteria.

Big Sand Gap, OR (Alvord Desert) due to: weather concerns, lack of wind knowledge, and lack of available support assets

Carson Sink, NV due to: high moisture content of the soil on a year round basis and unexploded ordnance (UXO)

China Lake, CA due to: site obstructions

Catlow Valley, OR due to: site obstructions

Edwards Air Force Base, CA –alternate sites on Edwards range were assessed but eliminated due to size and site obstructions

Mojave Desert, CA due to being a conservation/preservation area

Peter's Lake, OR due to: site size and obstructions

Redmond, OR due to: site size and obstructions

Salt Water Springs (Black Rock Desert) due to: being a conservation/preservation area

Tonopah, NV (Nellis AFB) due to: its continued use as an active bombing range and scheduling concerns

Utah Test and Training Range, UT due to: the Dugway Proving Ground being determined to be the better site in the area

Yuma Region, AR (Barry Goldwater Air Force Range) due to: UXO, including the high cost of conducting UXO inspections, and pristine desert concerns

White Sands, NM—alternate sites on WSMR range were assessed in addition to the two selected but failed due to: terrain or vegetation making clearing costs prohibitive

Within Willcox, there is only one area within the playa with sufficient open area to provide a suitable landing site; therefore, no alternate locations at Willcox were assessed.

2.10 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 at 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, consistent with the CEQ Regulations, the FAA has identified factors that should be considered in evaluating the context and intensity of potential environmental impacts (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 Summary of Affected Environment and Environmental Consequences

Sections 4 (for CCAFS) and 5 (for Willcox) describes the affected environments and the potential environmental consequences of the proposed activities by comparing these activities with the potentially affected environmental components for the CCAFS launch site and the Willcox landing site. To assess the potential for and significance of environmental impacts from the proposed activities, a list of activities was developed (section 2.0) 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. Table 3-1 summarizes the results of the environmental analyses for each resource considered.

The region of influence for all affected environments for section 4 of this EA is the area within the boundaries of CCAFS and potentially affected adjacent lands, including off-station lands within launch safety clear zones or land uses that may be affected by activities on the station as well as transportation corridors and utilities supporting CCAFS and the surrounding county. These are described in detail in the *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (April 1998) and the *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (March 2000).

The region of influence for all affected environments for section 5 this EA is the area within the boundaries of Willcox Playa 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 areas within the sonic boom footprints shown in Appendix D. For Socioeconomics, Environmental Justice, and Children’s Environmental Health and Safety Risks, the region of influence also includes the surrounding area of Arizona’s Cochise County.

Table 3-1: Summary of Environmental Analyses for the CCAFS Launch Site and the Willcox Landing Site

Environment (EA Section)	Proposed Action	Proposed Action Impact
Air Quality (3.1)	<p>CCAFS: A small amount of Hydro-fluorocarbon (HFC) 134a would be released during Starliner umbilical separation at launch but it is not categorized as an ozone depleting substance. This and other air quality impacts for processing and launching the Starliner would be insignificant.</p> <p>Willcox: Combustion emissions from generators and vehicles and dust would be generated by the landing recovery operations. However, only small quantities would be generated during these short events. The proposed action would not be a major source of greenhouse gas (GHG) emissions. Dust control measures would be used as necessary. Due to the short duration of the demolition and landing recovery activities, no significant air quality impacts are anticipated.</p>	Insignificant Impact
Biological Resources (3.2)	<p>CCAFS: There are no impacts on biological resources from the integration and launch of the Starliner.</p> <p>Willcox: A small area of vegetation (if present) would be disturbed by the RGFF infrastructure demolition and Starliner landing recovery operations. Jettisoned hardware would be collected as efficiently as</p>	Insignificant Impact

Environment (EA Section)	Proposed Action	Proposed Action Impact
	possible to minimize the impact to vegetation and wildlife. Wildlife, if present, could be affected by demolition and Starliner landing and recovery activities and noise. Wildlife populations would not be significantly impacted due to lack of available habitat on Willcox Playa and the short-term nature of these activities. Starliner landings would not take place when the playa is covered by water, which is the primary time for migratory birds to use the site. No threatened, endangered, or sensitive species occur at the landing site. There are TES species and some critical habitat within the sonic boom footprint but the length and intensity of the boom is low so will not have any long-term effects. There would be no significant impacts to vegetation or wildlife.	
Climate (3.3)	<p>CCAFS: The Starliner integration and launch activities would have no impact on the climate.</p> <p>Willcox: The demolition and landing recovery operations are very short term in nature. The landing recovery operations happen infrequently. The proposed action would not be a major source of GHG emissions. The climate at Willcox Playa would not be affected.</p>	No Impact
Department of Transportation Act, Sec 4(f) (3.4)	<p>CCAFS: There are no Section 4(f) properties affected by the Starliner during integration and launch operations.</p> <p>Willcox: There are no Section 4(f) properties within the demolition and landing zone. Direct impacts are not anticipated to extend outside the boundaries of Willcox Playa to the surrounding communities, with the exception of the potential for small jettisoned parts to land in Arizona and BLM land in the landing zone extension and the sonic boom. The Arizona and BLM land would be closed off via roadblocks for a few hours during a Starliner landing but these only happen at most twice per year. There are many potential Section 4(f) properties under the footprint of the sonic boom; however, the boom is very short term in nature and the maximum overpressure is 0.5 psf. (which equates to less than a clap of thunder) so none will be impacted. There would be no impacts to any Department of Transportation Act Section 4(f) properties.</p>	Insignificant Impact
Land Use and Airspace (3.5)	<p>CCAFS: The launch of the Starliner on the expendable launch vehicle will not increase the launch rate at CCAFS above existing or previously approved and documented levels; therefore, there would be no impact to land use and airspace in the Cape Canaveral area.</p> <p>Willcox: The playa is currently used for occasional classified electronics testing. Removal of the RGFF infrastructure would help return the Playa to its natural state. Depending on the winds on landing day, up to six small jettisoned parts could land outside the playa and impact on State of Arizona, BLM, or private farmland. Boeing would be required to obtain a land use permit from the State of Arizona. BLM determined a Right-of-Way/Permit is not required for use of their land.</p>	Insignificant Impact

Environment (EA Section)	Proposed Action	Proposed Action Impact
	<p>Airspace closure during landing would be coordinated with Albuquerque Center and would be short term in nature and infrequent. All parts of the Starliner spacecraft would be removed, if found, and the landscape left in its original condition to the extent possible with the exception of any parts that land outside the playa. These would left in place to avoid any impacts from driving ATVs across the terrain to retrieve them. Their size and composition would not affect the use of the land. No significant land use, farmland, or airspace impacts are expected. The proposed action would not change the existing use of the land.</p>	
<p>Physical Resources (3.6)</p>	<p>CCAFS: The Starliner transportation, integration, and launch would have negligible impacts on physical resources.</p> <p>Willcox: The surface and ground water resources should not be impacted. The potential for soil contamination exists, should a failure cause a leak from the spacecraft or a demolition or recovery vehicle, but processes are in place to mitigate contamination and appropriately clean up any contamination that may occur. Willcox Playa is in a floodplain; however, demolition activities and landings would not occur during the months the playa is flooded. Damage to the playa during landings at other times of the year would be repaired, if necessary. Overall, the topography, soil, and soil quality would not be significantly affected. The proposed action would have a positive impact by removing obstacles currently in the floodplain.</p>	<p>Insignificant Impact</p>
<p>Cultural Resources (3.7)</p>	<p>CCAFS: The Starliner would have no impacts on cultural resources during launch integration and processing.</p> <p>Willcox: Previous cultural surveys around the proposed landing site were reviewed and additional surveys were conducted as part of the development of this EA to document the remaining RGFF infrastructure and the RGTA, which were recommended as not eligible for National Register of Historic Places (NRHP). In addition, Ft. Huachuca documented a WWII bombing target and an old fence line that are in the landing zone extension. The target was determined to be eligible for the NRHP. It could be impacted by one of the small jettisoned parts but this would not impact the integrity of the target should one land on it. The fence line was determined to be ineligible. No additional cultural surveys were performed on the playa as it is unlikely that archaeological sites would be present within the playa environment. Neither BLM, the State of Arizona, nor the SHPO required cultural surveys of the areas that could be impacted by the jettisoned parts as the chance of hitting an unknown cultural resource is small and these will be left in the field so no damage would be done by vehicle or foot traffic looking for them. No additional cultural survey work was done to identify resources under the sonic boom footprint due to the low magnitude of the sonic boom (0.5psf) which will have no impact on cultural resources. The landing recovery</p>	<p>No Impact</p>

Environment (EA Section)	Proposed Action	Proposed Action Impact
	convoy will access the playa via existing roads. The proposed action would have no impact on significant cultural resources.	
Noise, Noise Compatible Land Use, and Vibration (3.8)	<p>CCAFS: The launch of the Starliner on the expendable launch vehicle will not increase the launch rate at CCAFS above existing or previously approved and documented levels; therefore, there would be no impacts to noise and noise-compatible land use during launch integration and processing.</p> <p>Willcox: Noise generated by vehicle traffic during landing and recovery operations would be consistent with that generated by traffic on the roads and interstates around Willcox Playa. A sonic boom would be generated (maximum overpressure 0.5 psf) prior to landing that is short term in duration and, while possibly noticeable, would not cause any impacts. Any other loud noise or vibration generated by the demolition and LRT vehicles and activities would be infrequent, very short in duration, and not expected to affect the local wildlife. The proposed activities would have no significant impact on conditions that currently exist.</p>	Insignificant Impact
Socio-economics (3.9)	<p>CCAFS: The Starliner activities would not have an appreciable impact to the socioeconomics of the Cape Canaveral area.</p> <p>Willcox: No significant increase or decrease to employment, population, or economic activity is expected from the landing and recovery operations. The current level of socioeconomic activity would not significantly change or be adversely affected.</p>	Insignificant Impact
Environmental Justice and Children's Health and Safety Risks (3.10)	<p>CCAFS: The Starliner activities would not impact environmental justice or children's environmental health and safety risks in the Cape Canaveral area.</p> <p>Willcox: Direct impacts are not anticipated to extend outside the boundaries of Willcox Playa to the surrounding communities, with the exception of the potential for up to six small jettisoned parts impacting in the landing zone extension and the sonic boom that may be noticeable by the people under the boom footprint but would not cause any impacts. There would be no impact, nor a potential for disproportionately high and adverse effects, on minority and low-income populations or children.</p>	No impact
Visual Effects (3.11)	<p>CCAFS: The Starliner will not cause any visual effects impacts at Cape Canaveral above those caused as a result of launching the Atlas V.</p> <p>Willcox: Portable lighting would only be used when Starliner landing recovery operations take place after sunset and then only for the duration of the recovery operations. All parts of the spacecraft will be recovered and removed from the sites if found. Therefore, the long-term visual impacts would be insignificant.</p>	Insignificant Impact

Environment (EA Section)	Proposed Action	Proposed Action Impact
Infrastructure and Utilities (3.12)	<p>CCAFS: The Starliner integration and launch will cause a minor increase in the use of infrastructure and utilities in addition to those needed for the Atlas V.</p> <p>Willcox: Demand on public infrastructure or services are not expected to increase such that the quality of service for persons living in the region is negatively affected. No significant impact on infrastructure or utilities is expected.</p>	Insignificant Impact
Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention (3.13)	<p>CCAFS: Hazardous materials would be present on the Starliner during launch integration and launch. Hazardous waste would only be generated if a failure occurs on the Starliner spacecraft or the launch vehicle that allows release of the hazardous material to the environment. Contingency plans would be in place for cleanup should this happen. Personnel would be trained prior to launch and comply with applicable Air Force procedures and protocols. No significant impact relative to the use of hazardous materials or disposal of waste is anticipated.</p> <p>Willcox: Hazardous materials would be present on the Starliner and in the ground cooling units that are part of the landing recovery convoy. Hazardous waste would only be generated if a failure occurs on the Starliner spacecraft or a recovery vehicle that allows release of the hazardous material to the environment. Contingency plans would be in place for cleanup should this happen. Biohazard waste could be generated during the astronaut post-landing medical evaluation. This would be removed by the medical team for disposal. Solid waste would be generated during both the RGFF infrastructure removal and landing recovery activities and would be removed from the site. Personnel would be trained prior to launch and landing and recovery operations and comply with applicable Army procedures and protocols. No significant impact relative to the use of hazardous materials or disposal of waste is anticipated.</p>	Insignificant Impact
Human Health and Safety(3.14)	<p>CCAFS: Personnel would be trained prior to launch integration operations and comply with applicable procedures and protocols. No significant impact on human health and safety is expected.</p> <p>Willcox: The risk to the public caused by the potential impact of small jettisoned parts in the landing zone extension is below federal regulations. Boeing would take the additional precautions of notifying landowners to vacate the area and establishing roadblocks to prevent an increase in the population when Willcox is planned to be used for a Starliner landing. Personnel would be trained prior to these activities and comply with applicable procedures and protocols. Protective gear would be used at the landing until the Starliner is determined to be safe for recovery operations. No significant impact on human health and safety is expected.</p>	Insignificant Impact

4.0 CCAFS Affected Environments and Environmental Impacts

4.1 Affected Environments

The affected environments include those areas in and around KSC and the CCAFS located in Brevard County, Florida. KSC is a NASA controlled industrial complex utilized to process and launch human missions to outer space. KSC also includes open space associated with the Merritt Island National Wildlife Refuge. CCAFS is a DoD controlled industrial complex utilized to launch scientific, communication, and military satellites. CCAFS is also being modified to support human missions as part of the CCDev Program.

For this action, the only activities taking place at KSC are the buildup and testing of the Starliner vehicle and transportation to the CCAFS.

For this action, the activities taking place at CCAFS include transportation of the Starliner to LC 41, integration and testing of the Starliner on the Atlas V rocket, and launch operations for both.

The affected environment for integrating a payload and launching the Atlas V from CCAFS, as well as the ongoing activities taking place there, are described in detail in the *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (April 1998) and the *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (March 2000). Only those items unique to the Starliner spacecraft are included here.

4.2 Environmental Impacts

The environmental impacts for integrating a payload and launching the Atlas V from CCAFS, as well as the ongoing activities taking place there, are described in detail in the *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (April 1998) and the *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (March 2000).

The proposed action will not significantly impact environmental attributes and therefore qualifies for Categorical Exclusion (CATEX) A2.3.7. This is defined in 32 CFR 989, Environmental Impact Analysis Process (EIAP), Appendix B, as “Continuation or resumption of pre-existing actions, where there is no substantial change in existing conditions or existing land uses and where the actions were originally evaluated in accordance with applicable law and regulations, and surrounding circumstances have not changed.”

The proposed action also qualifies for CATEX A2.3.11, which is defined in 32 CFR 989, EIAP, Appendix B, as “Actions similar to other actions which have been determined to have an insignificant impact in a similar setting as established in an EIS or an EA resulting in a FONSI.

The environmental impact documentation supporting CATEX A2.3.11 are as follows: The environmental impacts of the launch portion of the mission are addressed in the above referenced EELV 1998 EIS and 2000 supplement, the Programmatic Constellation Environmental Impact Statement, and the NASA Routine Payloads Environmental Assessment of June 2002, currently being updated.

The EELV Final EIS and Supplemental EIS assessed the impacts from all expected EELV launches through 2020. The 1998 EIS resulted in the issuance of a Record of Decision (RoD) on 8 June 1998 by the Air Force/DoD. Additional reviews also considered various configurations of the Atlas and Delta launch vehicles and those were further addressed in the 2000 Supplemental EIS addendum to the original RoD.

A Finding of No Significant Impact (FONSI) resulted from the EA for the proposed Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station (CCAFS), Florida, and Vandenberg Air Force Base (VAFB), California, during the period 2002 through 2012.

The Constellation Programmatic EIS (which resulted in a RoD on February 28, 2008) addressed NASA's proposed plan for implementing the, at that time, Congressional and Presidential direction for human spaceflight (the Constellation Program) and was based on the analysis contained in the January 2008 Final Constellation Programmatic EIS. The EIS addressed program-wide changes to the human spaceflight program including operations such as manufacturing, testing integration, construction, test flights, launching/launch vehicle, landing and recovery, etc. at various locations.

During June 2011, NASA issued a Modified Record of Decision (MRoD) to address changes made to the human spaceflight program (i.e., cancellation of the Constellation Program) and new direction that it was moving. NASA determined in the MRoD that it would continue to use the same general technologies and facilities used for the Constellation program that were analyzed in the 2008 PEIS. NASA addressed this change by revising the original RoD and issuing the MRoD during June 2011.

As a result of the above, only those impacts unique to the Starliner spacecraft are included in this EA.

4.3 Air Quality

All Air Force properties are located in areas that are in attainment for all criteria air pollutants; therefore, a conformity determination is not required.

The primary exhaust emissions produced by the solid propellant and first stage include carbon monoxide, hydrochloric acid, aluminum oxide in soluble and insoluble forms, carbon dioxide, and deluge water mixed with propellant byproducts. The primary emission products from the liquid engines include carbon dioxide, carbon monoxide, water vapor, oxides of nitrogen, and carbon particulates. Air impacts will be short-term and not substantial.

For the Starliner, ground support equipment providing the pre-flight cooling for the CM uses HFC 134a as a refrigerant. HFC 134a is not categorized as an F and is not affected by the ODS phase out requirements implemented through the Clean Air Act. It is widely used today in coolant systems as a substitute for ODS refrigerants. At lift-off, during T-0 umbilical disconnect, approximately 5 lbs. of HFC 134a contained within the CM will be released from the spacecraft. This release is by design, and is required because the refrigerant cannot safely remain on board during flight since it will undergo thermal expansion, causing a threat to the environmental control / life support system, and possibly to mission success. There is no technically feasible method to capture this minor amount of material without adding risk and weight to the spacecraft. Environmental regulations prohibiting the release of HFC 134a do not strictly apply to this application, as they are intended for operation and maintenance of household and commercial refrigeration units, and the majority of the refrigerant in the overall ground support system will be retained, in accordance with the intent of the environmental regulations.

The air quality impacts for the Starliner during launch integration and processing would be insignificant.

4.4 Biological Resources

Short-term effects on plants and animals will occur in the vicinity of LC- 41, mainly due to the noise involved with launch site operations and the launch itself. These short-term impacts are of a self-correcting nature, and none of these effects will be substantial. There would be no impacts on threatened or endangered species or critical habitat.

The activities unique to integrating the Starliner would have no additional impacts to those already documented for the Atlas V.

There would be no impact to biological resources from the Starliner during launch integration and processing.

4.5 Climate

All emissions that could affect the atmosphere and climate are produced by the Atlas V rocket except for the 5 lbs. of HFC 134a identified in Section 4.2.1. As a result, the Starliner will have no effect on the climate.

4.6 Department of Transportation Act, Section 4(f)

There are no Section 4(f) properties affected by the Starliner during integration and launch activities.

4.7 Land Use and Airspace

The launch of the Starliner on the expendable launch vehicle will not increase the launch rate at CCAFS above existing or previously approved and documented levels. The proposed Starliner spacecraft is compatible with the mission of the CCAFS.

There would be no impact to land use and airspace from the Starliner during launch integration and processing.

4.8 Physical Resources (including Water, Topography, Geology, and Soil)

The Starliner transportation, integration, and launch would have negligible impacts on physical resources.

4.9 Cultural Resources (Architectural, Archaeological, and Area of Tribal Interest)

The Starliner would have no impacts on cultural resources during launch integration and processing.

4.10 Noise and Noise-Compatible Land Use

The launch of the Starliner on the expendable launch vehicle will not increase the launch rate at CCAFS above existing or previously approved and documented levels; therefore, there would be no impacts to noise and noise-compatible land use during launch integration and processing.

4.11 Socioeconomics

The Starliner activities would not have an appreciable impact to the socioeconomics of the area.

4.12 Environmental Justice and Children's Environmental Health and Safety Risks

The Starliner activities would not impact environmental justice or children's environmental health and safety risks in the area.

4.13 Visual Effects

The Starliner will not cause any visual effects impacts above those caused as a result of launching the Atlas V.

4.14 Infrastructure and Utilities

The Starliner integration and launch will cause a minor increase in the use of infrastructure and utilities in addition to those needed for the Atlas V. However, the launch of the Starliner on the expendable launch vehicle will not increase the launch rate at CCAFS above existing or previously approved and documented levels. The Starliner transport from the C3PF to LC 41 will take place on NASA or Air Force controlled roads. No new facilities are being built for this action.

The Starliner would have insignificant impacts to utilities and infrastructure.

4.15 Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention

The Starliner spacecraft contains the following hazardous materials:

CM Fuel: Hydrazine (N₂H₄) – less than 200 pounds

SM Fuel: Mono-Methyl Hydrazine (CH₃(NH)NH₂) – less than 2000 pounds

SM Oxidizer: Dinitrogen Tetroxide (N₂O₄) – less than 3000 pounds

Lithium Ion Batteries: approximately less than 1000 pounds

Ammonia- less than 0.5 pounds

Perfluoropolyether heat transfer fluid (Galden HT) – CM: less than 110 pounds, SM: less than 100 pounds

HFC-134a coolant – less than 2 pounds

Pyro material –less than 70 pounds

Typical safety data sheets for these materials is included in Appendix B of this EA.

There are no ionizing radiation sources on the Starliner.

If there are any hazardous material releases from the Starliner at CCAFS, Boeing will comply with all Air Force Hazardous Material Emergency Response Plan (10-2), requirements while on CCAFS properties and NASA requirements while on KSC premises as well as all local, state, and federal rules and regulations associated with the clean-up, management, and disposal of all materials/wastes. All pyros would be in a safe configuration until reconfigured just before launch.

The impacts to hazardous materials, waste, and pollution prevention would be minimal.

4.16 Human Health and Environment

A Starliner Missile System Prelaunch Safety Package (MSPSP) will be submitted to the Air Force 45th Space Wing Range Safety Office for review and approval prior to launch. This package will identify a list of hazardous materials that are present on the Starliner and the chemical characteristics of these materials, health hazards, identification of material incompatibility problems in the event of a spill, recommended methods and techniques for decontamination of areas affected by spills and vapor clouds and hazardous waste disposal procedures for any materials generated during the final processing of the Starliner at LC 41. As referenced in section 4.2.13, for any hazardous material releases from the Starliner at CCAFS or KSC, Boeing will comply with all Air Force and/or NASA emergency response requirements.

The impacts to human health and the environment would be minimal.

4.17 No Action Alternatives

The no action alternative would consist of not launching the Starliner. Not launching the mandatory test flights and subsequent missions would severely impact the future of the manned spaceflight program by delaying it until the Space Launch System (SLS) currently under development is designed, built and tested. The proposed date for the initial test flight for the Starliner is currently 2018 and data gained from the proposed test flight would not be available until sometime after this date. The data is critical for completing the final design as well as to obtaining final human rating of the Starliner through NASA.

4.18 Mitigation Measures

The only mitigation measures that would be necessary for the Starliner would be a case where a failure occurred causing a leak of a hazardous material from the spacecraft. Should this happen Boeing will comply with all Air Force and/or NASA emergency response requirements.

5.0 Willcox Affected Environments and Environmental Impacts

A number of related environmental documents have been prepared and approved that address activities performed at Willcox Playa. These documents contain information about the affected environment that was used in the preparation of this EA. Even though several of these are fairly old, the information is still accurate. These documents also contain a general discussion of the affected environments present. A listing of these documents follows:

- *Environmental Assessment, U.S. Army Electronic Proving Ground Communication-Electronic Testing and Use of Test Sites in Southern Arizona and Fort Huachuca.* Department of the Army, Ft. Huachuca Garrison, Fort Huachuca, Arizona, June 1992.
- *Environmental Assessment, Renewal of Leases on Sands Ranch and Two Properties on Willcox Playa to Support USAEPG Test Mission.* Department of the Army, Ft. Huachuca Garrison, Fort Huachuca, Arizona, November 1992.
- *Environmental Assessment, Renewal of Six Joint-Use Property Leases in Support of the U.S. Army Electronic Proving Ground,* Directorate of Engineering and Housing, U.S. Army Garrison, Fort Huachuca, Arizona, March, 1997
- *Final Environmental Assessment for the Aerodynamic Stability Testing of Battle Damage Assessment Vehicles in the Vicinity of Willcox, Arizona.* US Army TACOM-ARDEC, Picatinny Arsenal, NJ, February 2000.

5.1 Air Quality

5.1.1 Affected Environments

The U.S. Environmental Protection Agency (EPA) regulates air quality through National Ambient Air Quality Standards (NAAQS). Air quality is assessed according to six criteria pollutants: carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, respirable particulate matter (PM), and lead (EPA 2011).

Cochise County, which includes Willcox Playa, is within the Southeastern Arizona Air Quality Control Region and is designated as a non-attainment area for particulate matter less than 10 microns in size (PM-10). Occasional elevated concentrations of particulate matter occur in the area because of high winds that blow large amounts of dust from unpaved roads and bare (fallow) agricultural fields.

Air quality at the landing site is excellent. The area's breezy conditions are not conducive to the buildup of pollutant concentrations. Daily winds tend to disperse adverse air emissions. The major sources of air pollution in the area are aircraft, private vehicles, military vehicles, and gas heating emissions. Training exercises involving military and/or private vehicles and aircraft may also produce fugitive dust.

5.1.2 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 includes removal of the remnants of the Radar Geometric Fidelity Facility and one landing test followed by regularly scheduled missions anticipated to take place 1-2 times/per year, all of short duration. Only a portion of Starliner landings would take place at Willcox.

During the RGFF demolition, air emissions would be generated from vehicle and portable generator combustion, man-made dust, and, should a failure occur, fluid release from the construction vehicles (coolant, diesel or gasoline). To minimize dust during these activities, dust control measures, such as water trucks or dust suppressants, would be used as necessary. Impacts to air quality from dust would be negligible due to the short duration of these activities.

The Starliner spacecraft lands under parachutes. No propulsion jet firings take place below approximately 30,000 feet altitude so no fuel residues are added to the atmosphere over Willcox playa.

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

Dust or soil particulate matter disturbance would occur from vehicle and foot traffic accessing the RGFF infrastructure for removal and from the breakup and removal of that infrastructure. However, only small quantities of dust would be generated over the short period needed for removal. Dust or soil particulate matter disturbance would also 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, these short events would only generate small quantities of dust. To minimize dust during these activities, dust control measures, such as water trucks or dust suppressants, would be used as necessary. Based on the soil type present, convoy vehicle drivers will also be instructed to spread out when transiting the playa (vs. following a single track) to minimize dust generation. Impacts to air quality from dust would be negligible.

The demolition and landing recovery activities would require the use of portable generators to supply appropriate power at the landing site. The generators would operate in accordance with the applicable regulations and operating restrictions and as such, no impact to air quality is anticipated.

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 dispersion model of potential hydrazine releases has been performed to establish the worst-case hazard scenarios assuming all of the hydrazine remaining on the spacecraft following a nominal mission to the ISS is released in the atmosphere due to a leak at landing. (Details of the dispersion models are available in Appendix C.) The model uses average atmospheric conditions. Should a leak take place, the model can be run with actual day of landing conditions to determine the area affected. Standard Operating Procedures (SOPs) would be developed, including having personnel in personal protection equipment approach the spacecraft with sniffers to determine the presence of any free hydrazine. The procedures would 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 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. A typical Material Safety Data Sheet (MSDS) for hydrazine is located in Appendix B.

The ground cooling units (GCU) (two total) used by the LRT contain ethylene glycol (less than 30 gallons each), hydrofluorocarbons (HFC) 134a refrigerant (less than 5 gallons each), and halocarbon Rf-404A (less than 3 gallons each). Unless a failure occurs that would allow release, all hazardous material would remain in the GCUs and be transported back to the Boeing facility at WSMR after recovery operations are complete. Any hazardous material that escapes would be collected and disposed of by the emergency response team in accordance with applicable regulations.

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 a heat pipe. The maximum amount of ammonia in any heat pipe is just under 12 grams.

In the event of a fluid leak from a vehicle or generator, SOPs will be utilized to contain and clean up the spill.

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

Based in the size of the LRT convoy and an estimate of the number of vehicles that will be involved in the demolition activities, emissions are estimated at a few tens to a few hundred pounds per year, depending on the pollutant. This is below the de minimis levels set by the EPA of 50-100 tons per year, depending on the pollutant, for a non-containment area. (EPA, De Minimis Tables)

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.

5.1.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in air quality impacts at the Willcox landing site or the surrounding area.

5.1.4 Mitigation Measures

Normal dust suppression methods would be employed as necessary. Vehicles and generators will be inspected frequently to ensure none are leaking fuel. 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. The proposed action requires that hazardous materials-related response plans and standard safety operating plans be completed and approved before beginning the proposed action.

5.2 Biological Resources

5.2.1 Affected Environment

The landing zone is located within the Basin and Range physiographic province, characterized by mountain ranges on a northwest-southeast axis separated by broad alluvial valleys. The project vicinity includes the Dragoon Mountains approximately 10 miles to the southwest, the Winchester Mountains approximately 15 miles to the northwest, the Dos Cabezas Mountains approximately 7 miles to the east, and the large Chiricahua Mountain range approximately 25 mi to the southeast (Figure 5-1). The San Pedro River approximately 25 miles to the west and the Gila River is approximately 45 mi to the north of the landing zone.

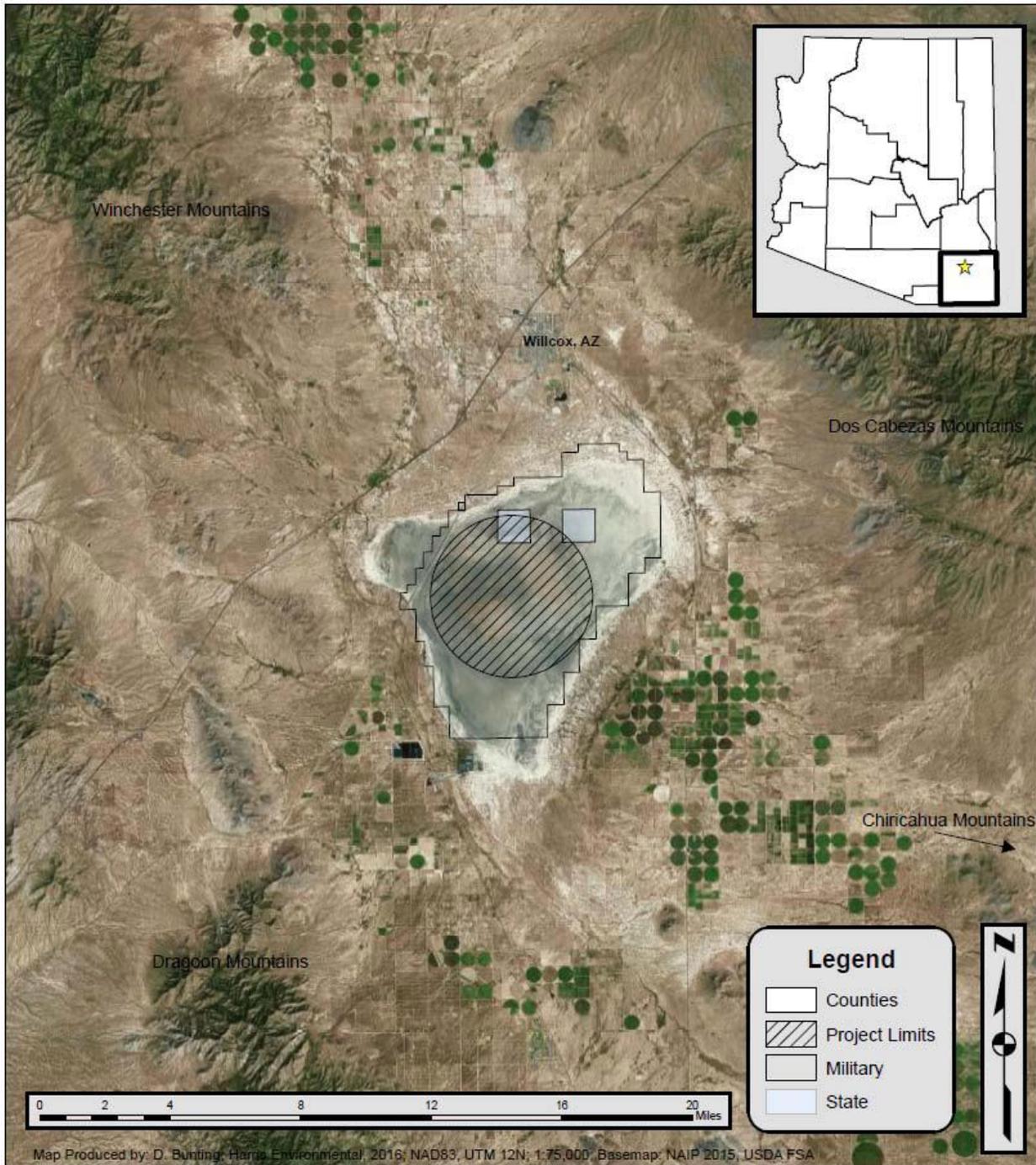


Figure 5-1: Willcox Landing Zone and Vicinity

(Source: Biological and Physical Resources Report/Appendix E)

As part of the development of this EA, Harris Environmental qualified biologists queried the United States Fish and Wildlife Service (USFWS) Information, Planning, and Conservation (IPaC) system to obtain a list of threatened, endangered, proposed, and candidate flora and fauna species, and designated and proposed critical habitat that are within one, 7.5-minute quadrangle of the landing zone. In addition, the Arizona Game and Fish Department’s (AGFD) Heritage Data Management System was queried to determine: 1) whether any special status species have been documented within close proximity (i.e., 3-5

miles) to the landing zone; or 2) whether any species of greatest conservation need (based on predicted range models) are within the project vicinity. Soil and water resources were also researched and included in the final report, which is included as Appendix E of this EA. A summary is included below (for biological resources) and in section 3.6 (for physical resources).

The IPaC system was also queried to obtain a list of fauna and critical habitat that is within the footprint of the sonic boom (shown in Appendix D).

5.2.1.1 Flora

The project area is located within the Arizona Upland Subdivision of the Sonoran Desert scrub Biotic Community (Brown 1982), and is characterized by a diversity of low shrub land of legume trees and many succulents. The Willcox Playa, however, is an endorheic dry lake with high alkalinity. The largely barren playa spans approximately eight by ten miles with an elevation documented between 4,135 and 4,136 ft. (1,260 m) above mean sea level (Schreiber 1978).

The only significant shrub that grows within the playa is Mohave seablite (*Suaeda moquinii*), a highly drought- and salt-tolerant species which is not protected. A biological survey of the project area revealed species commonly observed around the perimeter of the playa (Appendix E). Shrubs included Mohave seablite (see photos Appendix H), fourwing saltbush (*Atriplex canescens*), and Griffith's saltbush (*A. griffithsii*). Common grasses included sacaton (*Sporobolus airoides* and *S. wrightii*), saltgrass (*Distichlis spicata*), and cane bluestem (*Bothriochloa barbinodis*) (see photos in Appendix E). Plant diversity was dramatically reduced moving closer toward the playa until only saltgrass and Mohave seablite were present. Perimeter vegetation also included invasive saltcedar (*Tamarix ramosissima*), Russian thistle (*Salsola tragus*), and various grasses (e.g.; Bermuda grass [*Cynodon dactylon*], stinkgrass [*Chlorus virgata*], and soft-feather pappusgrass [*Enneapogon cenchroides*]).

5.2.1.2 Fauna

The Chiricahua leopard frog (*Lithobates chiricahuensis*) is the only federal status species documented within five miles of the landing zone. There are no proposed or critical habitat designations within the landing zone. Table 5-1 shows the federally listed species and whether or not there is critical habitat within the footprint of the sonic boom as shown in the USFWS IPaC system. Fish and plants were not included, as they will not be affected by the boom.

Table 5-1: Federally Listed Species within Sonic Boom Footprint

(Source: USFWS IPaC)

Species	Status	Critical Habitat within Sonic Boom Footprint
Mammals		
Jaguar (<i>Panthera onca</i>)	Endangered	Yes
Lesser Long-nosed Bat (<i>Leptonycteris curasoae</i> <i>yerbabuenae</i>)	Endangered	No
Ocelot (<i>Leopardus pardalis</i>)	Endangered	No
Mount Graham Red Squirrel (<i>Tamiasciurus hudsonicus</i> <i>grahamensis</i>)	Endangered	No

Species	Status	Critical Habitat within Sonic Boom Footprint
Gray Wolf (<i>Canis lupus</i>)	Proposed Experimental Population	No
Mexican Wolf (<i>Canis lupus baileyi</i>)	Endangered	Yes
Sonoran Pronghorn (<i>Antilocapra americana sonoriensis</i>)	Experimental Population	No
Birds		
Mexican Spotted Owl (<i>Strix occidentalis lucida</i>)	Threatened	Yes
Northern Aplomado Falcon (<i>Falco femoralis septentrionalis</i>)	Experimental Population	No
Southwestern Willow Flycatcher (<i>Empidonax traillii extimus</i>)	Endangered	Yes
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	Threatened	Yes
California Least Tern (<i>Sterna antillarum browni</i>)	Endangered	No
Yuma Clapper Rail (<i>Rallus longirostris yumanensis</i>)	Endangered	No
Reptiles		
Northern Mexican Gartersnake (<i>Thamnophis eques megalops</i>)	Threatened	Yes
Sonoyta Mud Turtle (<i>Kinosternon sonoriense longifemorale</i>)	Proposed Endangered	No
Amphibians		
Chiricahua Leopard Frog (<i>Rana chiricahuensis</i>)	Threatened	Yes
Sonora Tiger Salamander (<i>Ambystoma tigrinum stebbinsi</i>)	Endangered	No

With the exception of domestic pigeons (*Columba livia*), house sparrows (*Passer domesticus*), and European starlings (*Sturnus vulgaris*), all birds in the project area are protected under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712). The Migratory Bird Treaty Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. The Bald and Golden Eagle Protection Act also protects these two birds of prey species.

As defined by BirdLife International and administered by the National Audubon Society, the Willcox Playa itself is considered an Important Bird Area. The Audubon Society states that the Willcox Playa and Crane Lake (within the AGFD Wildlife Viewing Area), within the northern portion of the Sulphur Springs Valley of Southeast Arizona, supports the second largest over-wintering concentration of Sandhill Cranes (*Grus canadensis*) in Arizona, typically 4,000 to 9,000 birds. Hundreds to thousands of ducks and grebes also over-winter at these sites and also may pass through during spring and fall. Hundreds of shorebirds may be present during spring migration, using the water sources as stopover habitat.

5.2.2 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 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.

5.2.2.1 Flora

The construction crew and LRT convoy drivers would be instructed to drive through the sandy borders of the playa in single file to minimize disturbances of vegetation present in that area, then fan out to minimize disturbance to the soil of the plaza. Some vegetation, if present, would be disturbed during the removal of the RGFF infrastructure, at the Starliner landing site and during the recovery of jettisoned pieces; but only a small area would be affected due to the lack of vegetation on the playa. Overall, there would be no long-term significant impacts to site vegetation. The only debris generated is from the concrete pillar removal, pieces of the spacecraft that are jettisoned during landing and any trash generated as part of the landing and recovery operations. All debris, jettisoned pieces and trash located on the playa would be collected as efficiently as possible to minimize the impact to surrounding vegetation and wildlife. Any small jettisoned part that lands outside the playa would be left in place to prevent the disturbance of vegetation that would be caused by driving around a large area looking for these parts. Their size and composition would not have any adverse impacts to the environment.

5.2.2.2 Fauna

The Willcox Playa itself does not appear to have attributes suitable for Chiricahua leopard frog habitat. Inundation after heavy rains could create temporary puddles, but ponding would not be deep and vegetative resources are lacking. Furthermore, the high alkaline content of the soils may not promote the presence of prey species that this frog would rely on to survive at all life stages. Known Chiricahua leopard frog populations and designated critical habitat are located in the surrounding mountain ranges and drainages extending from these mountains toward the Willcox Playa lack connectivity due to agricultural operations along the perimeter of the playa. Cumulatively, these factors exclude the landing zone as suitable habitat for the Chiricahua leopard frog. Therefore, the project will have no effect on the Chiricahua leopard frog or its federally designated critical habitat.

While it is possible that protected birds may inhabit or travel through the landing area, it is not anticipated any protected birds to be injured during the Starliner mission. The Starliner requires a dry playa to support

landing operations. The majority of the bird population is present on the playa only during times of standing water.

The proposed action could affect fauna, if present. There would be increased traffic on the playa for access, demolition, and removal of the EFG infrastructure and during recovery of the Starliner spacecraft, but both would be for short durations. During Starliner landing, the probability that fauna would be directly hit by the spacecraft or jettisoned pieces is inherently low. A larger area, and therefore more species, would be affected by the sonic boom. The footprints for the sonic boom are shown in Appendix D. 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.

Small mammals, reptiles, and amphibians could be injured or killed by vehicles during the demolition and landing and recovery operations. To minimize project-related mortality of wildlife, vehicles would keep to existing roadways to access the playa. Personnel would be instructed not to collect, harm or harass any wildlife species.

Noise from the sonic boom, vehicles and general human activities could cause some disruption to wildlife found in the landing area. 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 to non-protected species, regional populations of species would not be affected. Also landing activities would affect only a limited portion of the total available habitat within and around Willcox Playa.

5.2.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in biological resource impacts at the Willcox landing site or the surrounding area.

5.2.4 Mitigation Measures

Ground vehicles would use existing roads to access the playa. Demolition activities would be scheduled to avoid the migratory bird nesting season (typically May-Sept). Should any protected species be found following the completion of this EA, the Ft. Huachuca Environmental Office would be consulted to determine if additional mitigation is necessary to prevent impact to the listed species' populations.

5.3 Climate

5.3.1 Affected Environment

Both elevation and the physical characteristics for the surrounding topography moderate the climate of Cochise County near Willcox Playa. The average maximum summer temperature (June-September) is 92 degrees F. Although temperatures in excess of 100 degrees F occur, they do not normally persist for a substantial length of time. The average minimum winter temperature (November-February) is 31 degrees F. The average daily temperature difference is 33 degrees F.

The Willcox area receives slightly more than 12 inches of precipitation annually. The surrounding mountains can receive more than 26 inches per year. The precipitation is bi-seasonal and distributed unevenly over the area. The summer rainy period occurs principally during June through September. These summer storms are often intense, localized thunderstorms that may include intense rainfall and strong winds. These storms provide 50 to 70 percent of the annual rainfall. Winter storms typically occur from November to February producing about 30 percent of the annual precipitation as light rain or snow.

5.3.2 Environmental Consequences

In August 2016, the White House CEQ released final guidance regarding the consideration of greenhouse gases (GHGs) in NEPA documents for federal actions (CEQ 2016). The 2016 guidance encourages agencies to draw from their experience and expertise to determine the appropriate level and type of analysis required to comply with NEPA; discusses methods to appropriately analyze reasonably foreseeable direct, indirect, and cumulative GHG emissions and climate effects; and recommends that agencies quantify a proposed action's projected direct and indirect GHG emissions, taking into account available data and GHG quantification tools.

The Starliner spacecraft lands under parachutes. Reentry does not generate greenhouse gas emissions. No propulsion jet firings take place below approximately 30000 feet altitude so the spacecraft itself will not affect the climate around Willcox Playa. There would be exhaust from support vehicles and portable generators, as well as some dust caused by the movement of the demolition vehicles during removal of the RGFF infrastructure and from recovery vehicles during the landing recovery operations. Project emissions would not alter the global climate or climate at Willcox. The contribution of GHG emissions from the proposed action to global climate change would be negligible. 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 climate impacts.

5.3.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in climate impacts at the Willcox landing site or the surrounding area.

5.3.4 Mitigation Measures

No mitigation is necessary as the proposed action is not expected to result in climate impacts.

5.4 Department of Transportation Act, Section 4(f)

5.4.1 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.

There are two parcels of state land within the 4 km landing zone but neither is open to the public. There are state and BLM public spaces located within the landing zone extension to the southeast of the playa.

Arizona State Route 191 runs along the west side of the playa and provides access to the Apache Station Wildlife Area, which is on the southwest corner of the Playa. Arizona State Route 186 and S. Kansas Settlement Road run along the northeast and east sides of the playa and provide access to the wildlife viewing area at Crane Lake. Both wildlife areas are outside the landing zone of the Starliner spacecraft so will not be affected by landing and recovery operations.

The sonic boom footprint, depending on re-entry trajectory, could be heard in parts of Yavapai, Gila, Maricopa, Pinal, Graham, Pima, and Cochise Counties. Potential Section 4(f) properties within the two footprints include public facilities in the Tonto and the Coronado National Forests, the San Pedro Riparian and the Las Cienegas National Conservation Areas, several wilderness areas and state parks, several historic districts, and many properties listed on the NRHP. The NRHP properties closest to the

landing site, and therefore more likely to hear the sonic boom, are the Railroad Avenue Historic District and other properties in Willcox, the Schilling Ranch Historic District in Corral, the Benson Historic Barrio, the Apache Powder Historic Residential District, the Benson Railroad Historic District, and other properties in Benson, the Tombstone Historic District and other properties in Tombstone, and individual properties in Cochise, Dragoon, and Pearce. (See Appendix D)

5.4.2 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 physical use of any potential Section 4(f) property. Boeing plans to coordinate with the Arizona DOT to close highways leading to the landing zone extension to the SE of the playa during landing activities. This would shut down access to state and BLM public spaces located in the landing zone. This potential closure would last a few hours during a landing event and would occur at most two times per year. NASA has coordinated with the state and BLM regarding the potential closures. The sonic boom generated during reentry would last less than a second and would not cause any impacts or damage. Therefore, the FAA has determined the Proposed Action would not result in a constructive use of any potential Section 4(f) property. In summary, the proposed action would not result in significant impacts on Section 4(f) properties.

5.4.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in DoT Section 4 (f) impacts at the Willcox landing site or the surrounding area.

5.4.4 Mitigation Measures

No mitigation measures are needed as the proposed action has no impact on Section 4(f) properties.

5.5 Land Use and Airspace, Including Farm Land

5.5.1 Affected Environment

The United States government owns a 27,387-acre parcel within the playa, a 50 square mile dry lakebed. The parcel of land was withdrawn from the public domain in 1934. The entire dry lakebed was designated as a bombing range by Executive Order 9337 on 24 April 1943 and Public Land Order 127 dated 22 May 1943. After World War II, the Willcox Playa continued to be used as a bombing range until its transfer to the US Army Garrison, Ft. Huachuca, AZ by Public Land Order 1747 on 14 October 1958. At that time, two one-square mile sections of state land were excluded from the federal land withdrawal. Although the Bureau of Land Management retains ownership of the land, the US Army has exclusive use and control over the parcels.

Public access to the playa is technically restricted due to the presence of unexploded ordnance from prior use as a bombing range. However, due to the lack of fencing at the entrance roads, the public has access

to the playa. The rest of the playa is enclosed with fencing posted with “No Trespassing” and “Danger” signs. The fencing is maintained by the US Army and adjacent state, federal, and private landowners. The Willcox Playa is currently utilized by the U.S. Army EPG for occasional classified military electronics and communications testing.

The landing zone extension to the SE of the playa contains public land controlled by the state of Arizona, BLM, and privately owned land, some of which is farmland.

The term airspace is described as the aboveground region used for transit of aerial vehicles. At Willcox Playa, Albuquerque Center is in charge of management and control (e.g. air traffic control and scheduling) of the airspace in the area described for the proposed action.

5.5.2 Environmental Consequences

There would be an increase in vehicular traffic on Willcox Playa during the demolition of the RGFF infrastructure and for a 3-4 day period around the Starliner landings. The demolition activities are short term in nature and would result in the playa being returned to its natural state once the RGFF infrastructure is removed. This has a positive impact on the land. The landings are infrequent and most parts of the Starliner spacecraft and any waste generated during its recovery are collected and removed, returning the playa to its original state. Several mortar lids and mortar sabots jettisoned during the landing approach are the only items that could be left on the playa post-landing. An attempt would be made to locate them however, due to their small size, they may not all be found. Their size and material are similar to other debris located on the playa. Equipment used for landing and recovery activities would be inspected in accordance with established site procedures for petroleum, oil, and lubricant (POL) leaks and 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. Waste disposal is addressed in section 3.13 of this EA. There would be no long term affect or change to the land from the proposed action.

The landing zone extension SE of the playa, including farm land, would be impacted by the landing of up to six small jettisoned parts that would be left in place and by roadblocks established for a few hours before the landing to prevent a large increase in the population of this area due to public interest in watching the landing. The size of these parts would not cause any damage to the land at impact. Their material would not have any long-term environmental impacts nor affect the use of the land.

The State of Arizona would require Boeing to obtain a land use permit for this action in order to use the Arizona state land both on the playa and in the landing zone extension. Boeing is in the process of obtaining this permit.

BLM determined no Right-of-Way/Permit would be required for the use of their land in the landing zone extension. (See Appendix F)

Impacts on airspace from the proposed action would include re-routing of commercial aircraft over southern Arizona during a maximum 2-hour period preceding the landing. The proposed action would involve over flight from the west to the Willcox landing site. All airspace re-entry operations would comply with the necessary notification requirements, including issuance of Notices to Airmen (NOTAM) and Local Notices to Mariners (LNM), as defined in the launch license issued by the FAA Office of Commercial Space Transportation. As part of the licensing process, Boeing will have to negotiate and enter into a Letter of Agreement (LOA) with relevant Air Traffic Control facilities to accommodate the flight parameters of the Starliner. The LOA will call for and define procedures for Air Traffic Control to issue a NOTAM defining the affected airspace prior to re-entry. A NOTAM provides notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (FAA Order JO 7930.2M, Air Traffic Policy). 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. Advance notice via NOTAMs and

LNMs 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 (1-2 per year), of short duration, and scheduled in advance to minimize interruption to airspace.

For the above reasons, environmental impacts of the temporary closures of airspace and the issuance of NOTAMS under the Proposed Action are not anticipated and thus are not addressed further in the EA. Moreover, in accordance with FAA Order 1050.1F, Section 5-6.1 (Categorical Exclusions for Administrative/General Actions), issuance of NOTAMS is categorically excluded from NEPA review absent extraordinary circumstances.

Demolition and landing and recovery activities under the proposed action would not result in a significant impact to land use and airspace resources.

5.5.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in land use or airspace impacts at the Willcox landing site or the surrounding area.

5.5.4 Mitigation Measures

Equipment used for landing and recovery activities would be inspected in accordance with established site procedures for POL leaks and 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.

Road closures would be coordinated with the Arizona DOT and local authorities to prevent a large population increase in the landing zone extension SE of the playa where the small jettisoned parts could land.

Close scheduling and coordination from Albuquerque Center would minimize any airspace or scheduling conflicts at the Willcox landing site.

5.6 Physical Resources

5.6.1 Affected Environment

The landing zone is located within the Basin and Range physiographic province, characterized by mountain ranges on a northwest-southeast axis separated by broad alluvial valleys. The Willcox Playa is roughly 8-mi by 10-mi and is surrounded by multiple mountain ranges. These include the Dragoon Mountains approximately 10 miles to the southwest, the Winchester Mountains approximately 15 miles to the northwest, the Dos Cabezas Mountains approximately 7 miles to the east, and the Chiricahua Mountain range approximately 25 miles to the southeast. The Willcox Playa is the drainage terminus for many of the surrounding mountain ranges and has accumulated sediments over thousands of years. A report from Harris Environmental that includes both physical and biological resources for the landing area and vicinity is included as Appendix E of this EA.

5.6.1.1 Soils

In the 1960s, the Willcox Playa was studied by Texas Tech University professor Dr. Schreiber and his students. Sediments from a 43-m auger hole and from other auger holes located in the west-central playa consisted exclusively of clay and some mud (Schreiber 1978). Sand was more common in sediments deposited near the historic shorelines, and sand, gravelly sand, and sandy gravel are more abundant at the north and south ends of the playa where the main streams contributed fluvial sediment loads. It is no surprise that fine silt and clay, easily transferred as suspended solids during runoff events, is the most common surface soil on the playa.

The project limits for the Starliner mission are centered near the middle of the playa, thus soils within the project footprint are surface clay deposits. The characteristic cracked soil surface results from clay particles undergoing shrink-swell cycles between wet and dry periods (Figure 5-2). The exposed interior portion of the playa is not stabilized by vegetation. These areas are, however, stabilized in part by clay-crusted soils. Varying levels of salt, calcium carbonate, organic content, etc., as well as crust thickness and affinity to rupturing all impact susceptibility of soil crust to wind erosion (Gillette et al. 1982). Solar heating can produce dust devils and thunderstorms can produce dust storms, both strong enough to displace and carry away surface soils. Both of these phenomena are common within the Willcox Playa region; however, the largest dust storms, or “haboobs,” have been caused by fallow, denuded, or retired agricultural lands near the towns of San Simon and Willcox, AZ.

Soil and wind erosion within the playa can be exacerbated by ground disturbance such as off-roading, which may break up clay fragments, increasing the volatility of dust particles. However, studies also have shown that thick, hardened clay-crusted soils are resistant to wind erosion even after disturbances (e.g., passes with a one-quarter ton pickup truck; Gillette et al. 1982). While detailed soil analyses were not conducted within the project limits, it was noted that the surface soils were composed mostly of clay-crusted soils of variable thickness.



Figure 5-2: Soil at Willcox Playa

(Source: Biological and Physical Resources Report/Appendix E)

The Willcox Playa, when dry, can be driven upon with little risk of getting stuck. The sandier buffer regions extending from the main roads to the shoreline, however, can present hazards due to the presence of thick sand. Generally, a vehicle with four-wheel-drive capability should not have a problem entering and exiting the playa. It should be noted, however, that clay soils can be very hazardous after precipitation events. Clay accumulating on vehicle tires often reduces traction increasing the risk of vehicles getting stuck. It is not recommended to enter the playa after significant rainfall. The Willcox Playa region receives over half of its precipitation from convective thunderstorms produced during the Monsoon season (July-September), with the remainder coming from frontal winter storms extending from the Pacific Ocean.

In addition to literature and technical report reviews, the Natural Resources Conservation Service (NRCS), United States Department of Agriculture Web Soil Survey was used to analyze soil types characterized within the Willcox Playa. The Area of Interest selected was an arbitrary ~11-mi x 11-mi square polygon (~80,000 ac) that encompassed the entire Willcox Playa and surrounding landscape (Figure 5-3). The majority of the Willcox Playa is considered by the USDA to be “Water.” However, the playa only inundates to a shallow depth during seasonal precipitation events.

Soils immediately surrounding the playa include Torriorthents, hummocky (TrC) and Crot sandy loam (Ct) (NRCS 2016). The soil across the dry lakebed likely is TrC and for the most part is not habitable by

vegetation other than extremely drought and salt-tolerant species such as Mohave seablite and saltgrass. The minimal vegetation growing closer to the shorelines tends to be Mohave seablite, often growing on hummocks commonly formed in wind-swept landscapes with fine textured soils. The buffered region surrounding the barren playa labeled as Ct supports saltgrass and sacaton grasses as well as drought and salt-tolerant shrubs (e.g., saltbushes and saltcedar). These areas are more stabilized by vegetation and have higher sand and gravel content.

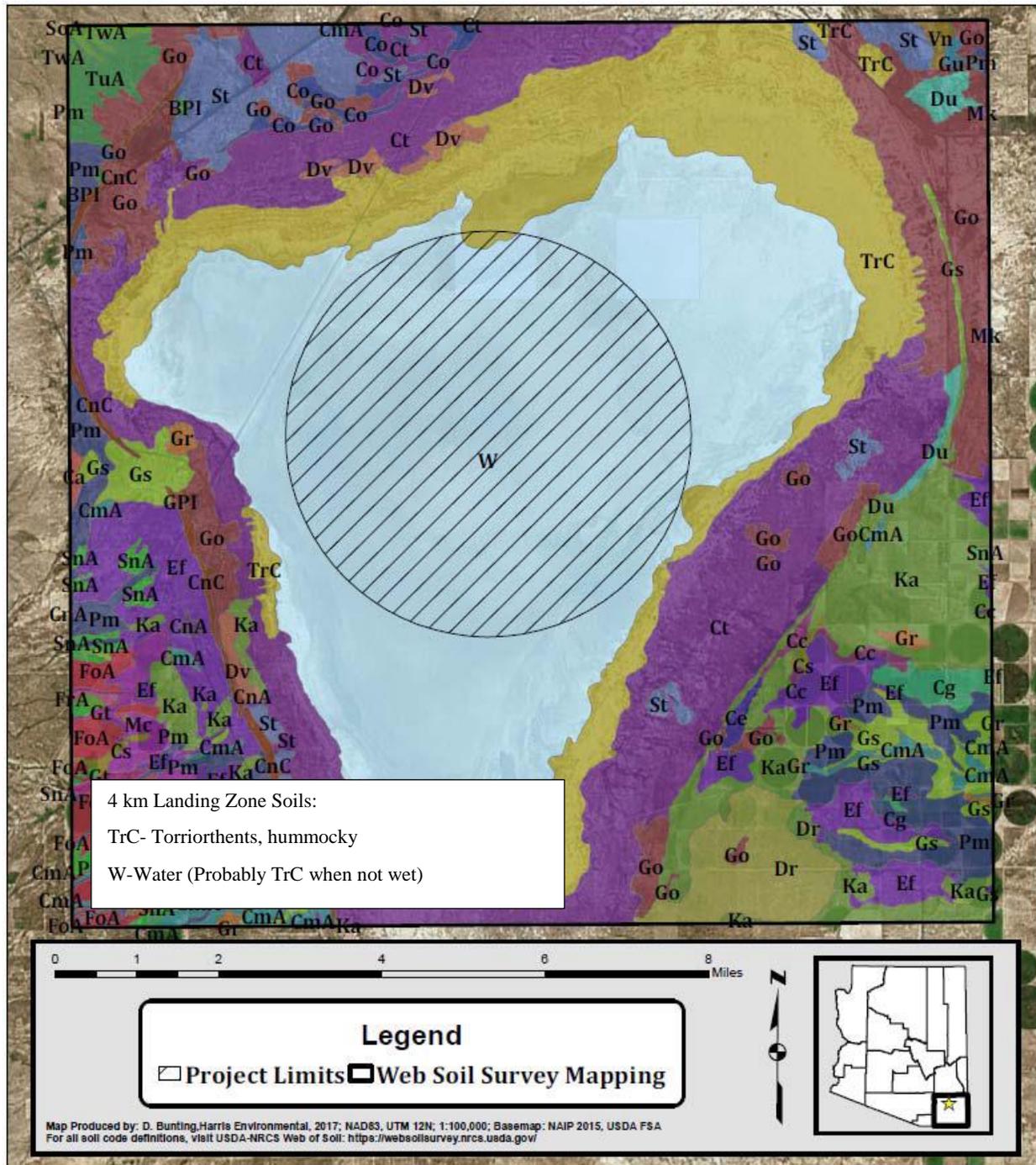


Figure 5-3: Soil Types Around Willcox Playa

(Source: Biological and Physical Resources Report/Appendix E)

5.6.1.2 Water Resources

Fifteen thousand years ago, maintained by the relatively cool, moist Pleistocene climate, the Willcox Playa reached a maximum depth of 46 feet covering 140 square miles (Stevens and Ledbetter 2011). In modern day, the playa is an endorheic dry lake, or sink, with multiple inflows and no natural outflows, although some have been manually constructed to drain portions of the playa. Although many streams flow from the surrounding mountains toward the playa today, only a few deliver water to the playa surface because water is lost to infiltration of streambeds and porous slope alluvium, retention in tanks and behind dams, or evaporation (Schreiber 1978). In addition, agricultural lands bordering the playa now disconnect many of the historical drainages from entering the playa.

The Willcox Playa is dry the majority of the year and lacks perennial water resources. With a mean annual rainfall of 12-14 inches per year and average high temperatures reaching high 90s F in the summer, the playa only supports shallow, ephemeral ponds that form after heavy rains or snows. In more extreme scenarios (e.g. large, low frequency, intense thunderstorms), the playa has the potential to be inundated for longer periods of time. According to the Federal Emergency Management Agency (FEMA), the entire playa is within the 100-yr floodplain (i.e., 1% Annual Chance Flood Hazard, Figure 5-4).

A search of the USFWS National Wetlands Inventory website shows the entire playa listed as a wetland. The USFWS wetlands mapper describes this wetland as lacustrine (relating to or associated with lakes), due to seasonal flooding.

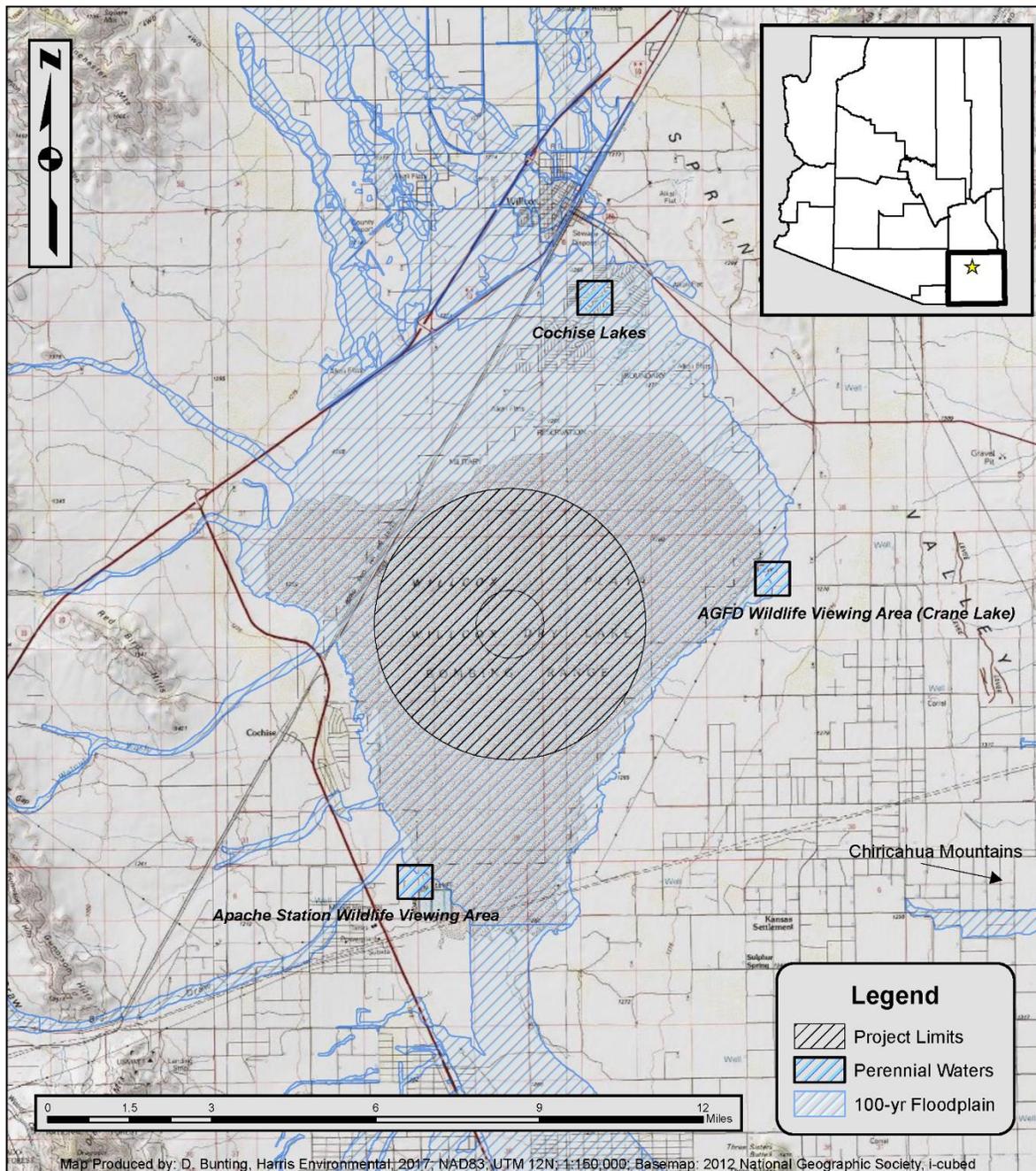


Figure 5-4: Willcox Playa Floodplain Boundary and Perennial Water Locations

(Source: Biological and Physical Resources Report/Appendix E)

Perennial water resources that surround the Willcox Playa include: 1) Cochise Lakes and surrounding ponds; 2) Crane Lake and surrounding ponds; and 3) the Apache Station Wildlife Viewing Area (Figure 3-4). Cochise Lakes is located just over 3.5 miles to the north of the 4-km project limits and is adjacent to Twin Lakes Golf Course in Willcox, AZ. Cochise Lake is a large treated effluent pond for the town of Willcox, Arizona. The lake and surrounding smaller ponds adjacent to and within the golf course are used seasonally by shorebirds. Crane Lake is a 30-ac constructed pond within the AGFD Wildlife Viewing

Area located just over two miles from the 4-km project limits. This site is primarily managed for optimizing waterfowl habitat and providing for hunting opportunities. Additionally, there are ten pot-hole ponds within the wildlife viewing area. The Apache Station Wildlife Viewing Area is located just over 2.5 miles to the south of the 4-km project limits and is adjacent to the Apache Generating Station. Arizona Electric Power Company established the wildlife area in 1997 operating under a stewardship agreement with the AGFD. The site is a primary wintering roost location for sandhill cranes.

5.6.2 Environmental Consequences

A copy of the biological and physical resources report generated in support of the development of this EA can be found in Appendix E.

5.6.2.1 Soils

The variability of clay thickness and desiccation patterns across the playa would likely result in variable degrees of disturbance from the vehicle convoy required to enter and exit the playa during Starliner recovery operations. As evident during a recent survey, single passes with quarter-ton pickup trucks imprinted surface soils, but did not appear to heavily damage soil crusts (See Figure 3-2). A convoy of heavy vehicles and machinery, however, would have potential to cause significantly more disturbance. Therefore, fugitive dust is likely to be generated, but also would be dependent on wind conditions. Ground disturbance would be limited by instructing the landing convoy to spread out once they reach the playa when traveling to and from the landing site. Disturbance would be temporary, and a water truck would be used if needed to reduce fugitive dust and mitigate potential air pollution.

Equipment used for landing and recovery activities would be inspected in accordance with established site procedures for POL leaks and 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. Likewise, should an unlikely failure occur in the Starliner or GCUs, any contaminants would be cleaned up utilizing applicable regulations. Groundwater would not be contaminated such that water quality standards would be exceeded, and no aquifers used for water supply would be affected.

5.6.2.2 Water Resources

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.

Executive Order 11990, Protection of Wetlands, requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Impacts to floodplains would be significant if the proposed action causes notable adverse impacts on natural and beneficial floodplain values as defined in Paragraph 4.k of DOT Order 5650.2, *Floodplain Management and Protection*. Impacts to wetlands would be significant if the proposed action would (1) Adversely affect a wetland's function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers; (2) Substantially alter the hydrology needed to sustain the affected wetland system's values and functions or those of a wetland to which it is connected; (3) Substantially reduce the affected wetland's ability to retain floodwaters or storm runoff, thereby threatening public health, safety or welfare (the term welfare includes cultural, recreational, and scientific resources or property important to the public); (4) Adversely affect the maintenance of natural systems supporting wildlife and fish habitat or economically important timber, food, or fiber resources of the affected or surrounding wetlands; (5) Promote development of secondary activities or services that

would cause the circumstances listed above to occur; or (6) Be inconsistent with applicable state wetland strategies. 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, five landing sites are required for the Starliner landing and Willcox Playa is one of five sites that adequately met the landing criteria. Therefore, there is no practical alternative to using Willcox as one of the five landing sites, even though the entire playa is within a floodplain and considered a wetland. Should standing water be expected for the planned Starliner landing, an alternate landing site would be selected. Any damage to the playa caused by landings during the non-flooded months would be repaired, if needed, to put the playa back to its original state. The removal of the RGFF infrastructure will take place when the playa is dry so will not impact the floodplain or wetland. This will also put the playa back to its original state, which would have a positive impact on the floodplain and wetland by removing obstacles that can currently impede the flow of water. As a result, the proposed activities would have a beneficial impact on the floodplain and wetland.

All of the aforementioned perennial water resources are outside of the 4-km landing zone and the Starliner mission will have no impacts to these resources. No permanent water bodies (e.g. stream, creeks) occur within the landing area. Standing water can temporarily accumulate during the summer rainy season; however, RGFF infrastructure removal and Starliner landings would be scheduled when the playa is dry. Therefore, water resources would not be affected by any of the proposed action.

All water needed for the recovery activities would be transported to the landing site by the landing recovery convoy. All wastewater generated by the recovery operations would be removed by the LRT and disposed of in accordance with local regulations.

Overall, the proposed would not significantly affect the water resources or soils on the playa.

5.6.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in water resource or soil impacts at the Willcox landing site or the surrounding area.

5.6.4 Mitigation Measures

Equipment used for landing and recovery activities 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 recovery operations would be repaired, if needed, so as not to affect the floodplain.

5.7 Cultural Resources (Architectural, Archaeological, and Tribal Areas of Interest)

5.7.1 Affected Environment

Willcox Playa is situated in the northern end of the Sulphur Springs Valley in Cochise County in southeastern Arizona. This region was culturally diverse, and no single cultural-historical framework is widely applicable. The earliest occupation of southeastern Arizona can be dated between 9500 and 9000 B.C. Table 5-2 shows the cultural periods for the Willcox Playa vicinity. In modern time, Arizona history can be divided into three periods, corresponding to the three successive political entities that have prevailed in the region: the Spanish Colonial period (A.D. 1692–1821), the Mexican period (A.D. 1821–

1854), and the U.S. period (A.D. 1854–present). Transportation, ranching and farming, mining, and military activities have all been major economic activates during the U.S. period.

Table 5-2: Cultural Periods Defined for the Willcox Playa Vicinity

(Source: Cultural Resources Report)

Cultural Period	Time
Paleoindian Period	9500–8000 B.C.
Archaic Period	8000 B.C.–A.D. 1
Formative Period	A.D. 1–1450
<i>Early Formative Period</i>	<i>A.D. 1–650</i>
<i>Middle Formative Period</i>	<i>A.D. 650–1150</i>
<i>Late Formative Period</i>	<i>A.D. 1150–1450</i>
Protohistoric Period	A.D. 1450–1540
The Historic Period	A.D. 1540–Present
<i>Spanish Colonial Period</i>	<i>A.D. 1692–1821</i>
<i>Mexican Period</i>	<i>A.D. 1821–1854</i>
<i>U.S. Period</i>	<i>A.D. 1854–Present</i>

Land within Willcox Playa was withdrawn by the Bureau of Land Management (BLM) from public domain by Executive Order 6910 on November 26, 1934. On April 1, 1943, Executive Order 9337 withdrew approximately 30,100 acres, which were reserved for the War Department as a bombing range. The Willcox Dry Lake Bombing Range was used by the Air Force for strafing and bombing during World War II (Tagg 2012). On October 14, 1958, Public Land Order 1747 transferred the Willcox Playa bombing range from the Department of the Air Force to the Department of the Army, Fort Huachuca, for use of the U.S. Army EPG. The EPG operated a Radar Geometric Fidelity Facility (constructed in 1962) and a Radar Geology Test Area (constructed in 1965) within Willcox Playa. In addition, there is a World War II era bombing target and an old fence line in the landing zone extension.

The RGFF is an EPG Technical Target Facility that covered 20 square miles and was designed to measure spatial fidelity, range accuracy, and range and azimuth resolution of airborne surveillance and mapping radars. The facility was organized in a grid. Tetrahedron-shaped radar reflectors were placed on 65 concrete pillars, spaced approximately one mile apart. None of the reflectors are currently present. (Tagg 2012)

The RGTA occupied one square mile, set between four previously installed radar reflectors, and contained patches of various minerals and materials with various levels of backfill cover. The features are located in the northern half of the square formed by four pillars in the northern portion of the landing zone. Six of the units are on Arizona State Trust Land (two corrugated steel units, two quartzite units, and two basalt units). The rest of the units are on land managed by Fort Huachuca. The RGTA features include 19 units measuring 100 by 100 ft. and five units measuring 40 by 40 ft., all with sides oriented at cardinal directions. The facility was designed for NASA in support of the lunar landing program (USFWS 2002:44).

Figure 5-5 shows the locations of the pillars and the remains of the RGTA found during the recent survey. Figure 5-6 shows a pillar in its original state with the reflector attached. Figure 5-7 shows a map and

materials used for the RGTA. Figure 5-8 shows the location of the WWII bombing target, which consists of slightly raised, concentric sandy berms.

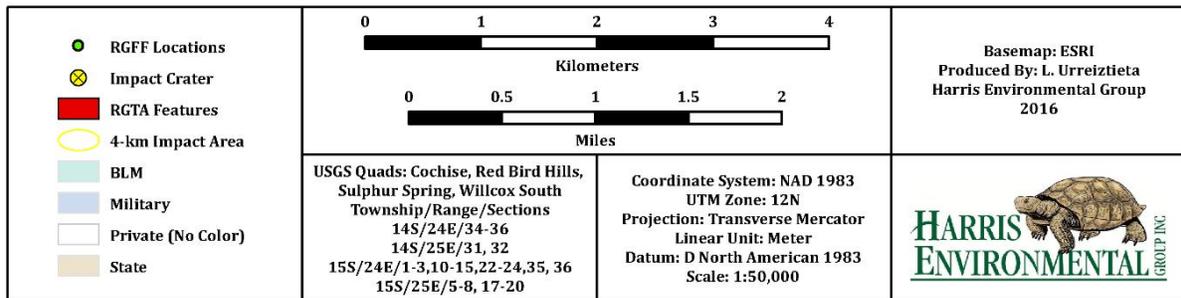
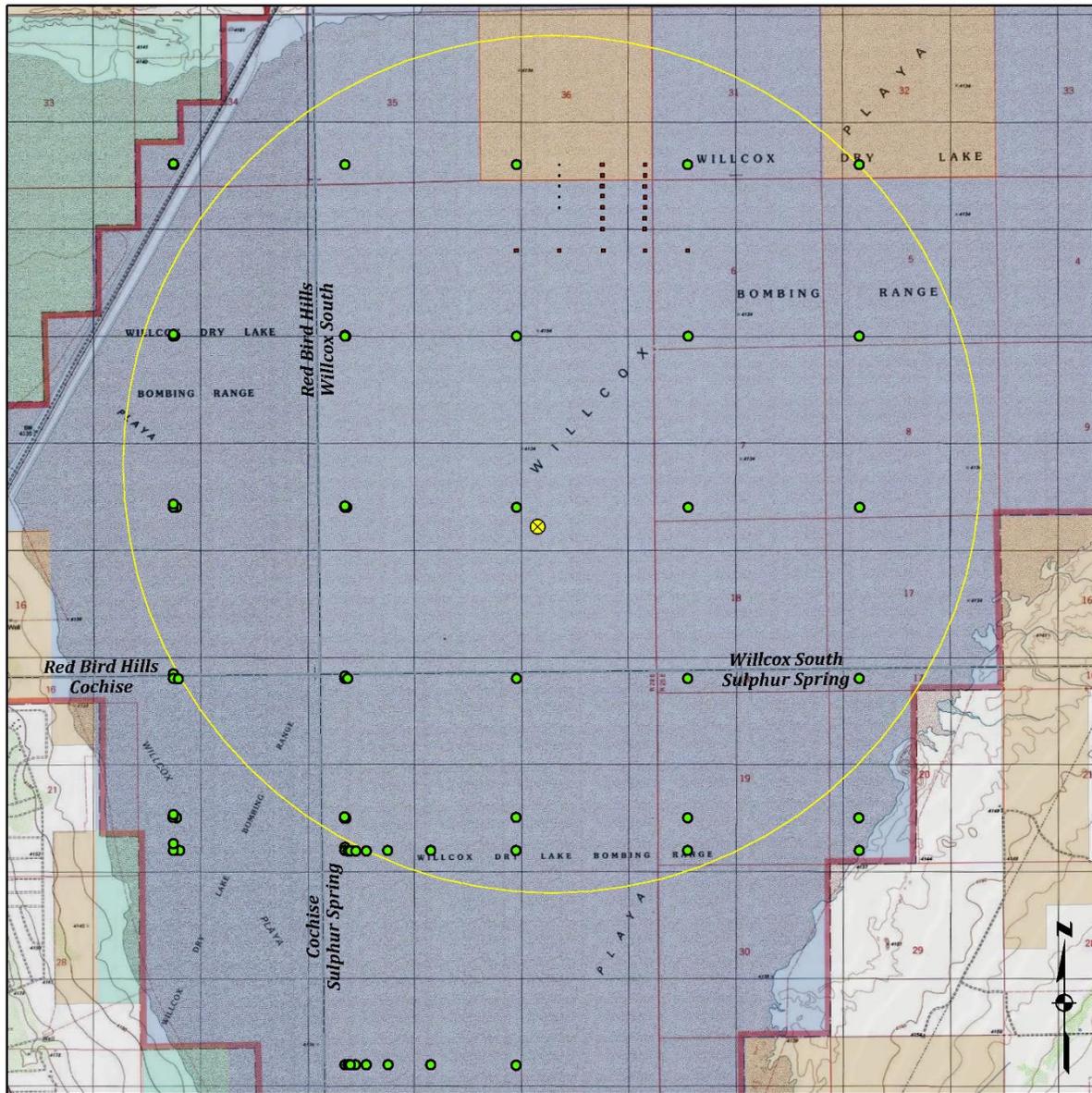


Figure 5-5: EPG Locations on Willcox Playa

(Source: Cultural Resources Report)

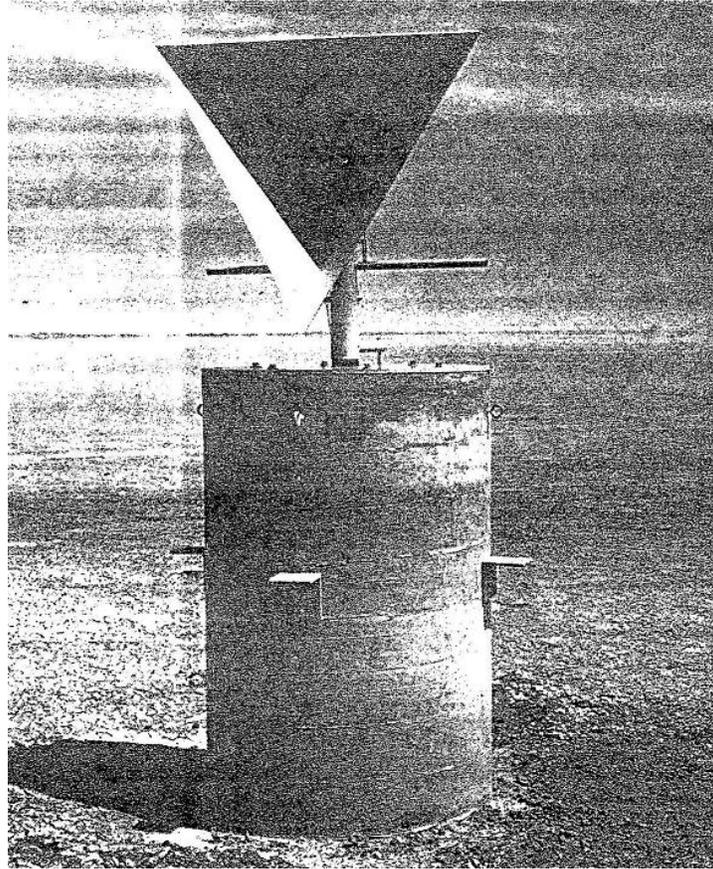
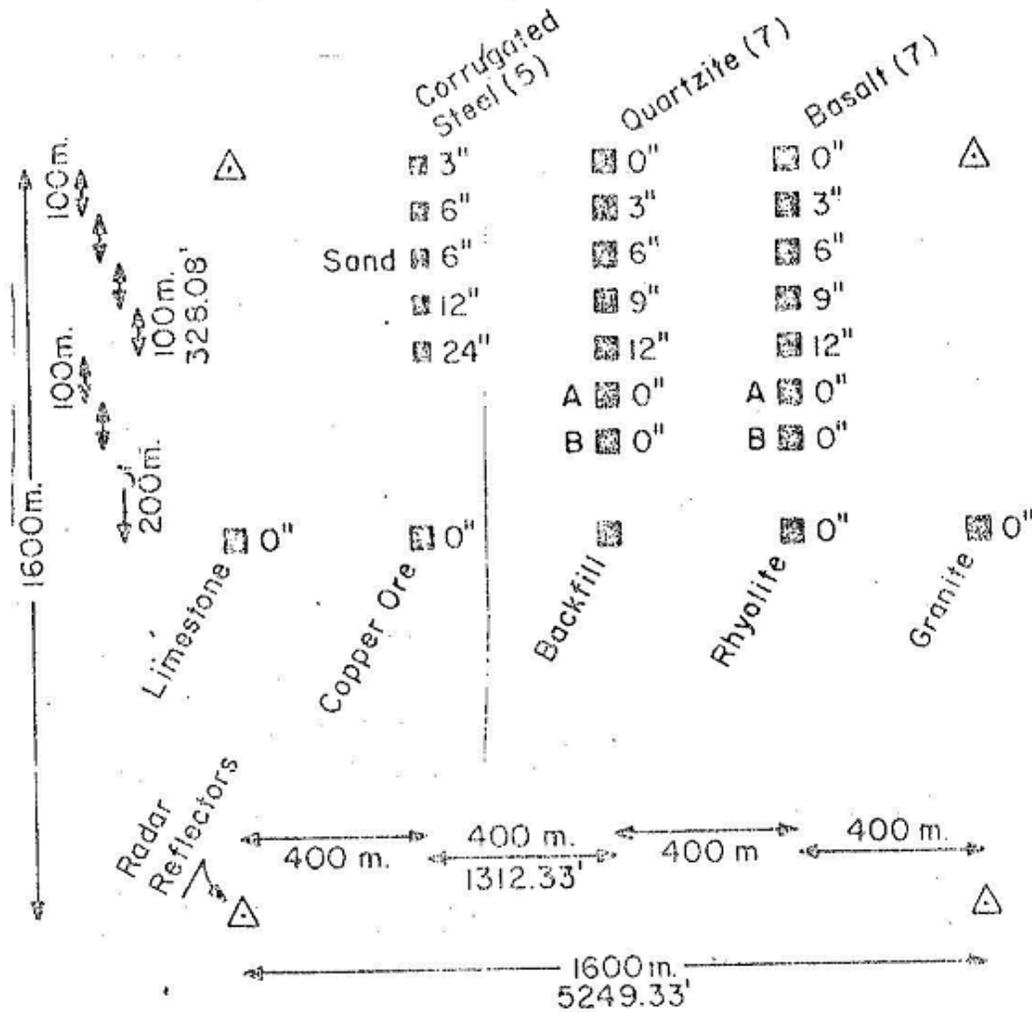


Figure 5-6: Original RGFF Pillar Configuration

(Source: Cultural Resources Report)

RADAR GEOLOGY TEST AREA WILCOX PLAYA, ARIZONA



Rock Patches--100' X 100' X 9"; rock size 3" to 8", except A: 1-3" and B: less than 1/2".
 Corrugated Steel--40' X 40' sheets, oriented E-W.
 Figures by the squares show the depth of backfill cover. Lakebed soil used for all backfill, except sand as noted. One patch was only excavated, backfilled, and recompactd to determine effects of reworking the soil.
 These patches are located in a square formed by four of the previously installed reflectors.
 Distances are shown in meters and feet.

Figure 5-7: Radar Geology Test Area Map and Materials

(Source: Cultural Resources Report)



Figure 5-8: WWII Era Bombing Target on Willcox Playa

(Source: Google Earth)

As part of the development of this EA, the Harris Environmental Group reviewed all previous cultural surveys for the landing area and area immediately surrounding Willcox Playa. They also performed a review and documentation of the remaining RGFF and RGTA infrastructure to determine eligibility in the National Register of Historic Places. Previous cultural resources studies and previously recorded sites within the 4 km radius landing zone plus a 1-mile buffer were identified using AZSITE, the online cultural resources database operated by the Arizona State Museum (ASM).

Results indicate that the landing zone has not been previously surveyed for cultural resources. Five previous cultural resources studies have been carried out within a mile of the landing zone. These consisted of a total survey area of approximately 35,360 acres and identified 395 sites. None of these was within the landing zone, with the closest being just inside the 1-mile buffer.

Figure 5-9 and Table 5-3 show the previous surveys around the landing zone.

According to records available from AZSITE, no archaeological sites have been documented within the landing zone. While the landing zone has not been previously surveyed for archaeological resources, the geology of Willcox Playa makes it highly unlikely that any prehistoric archaeological remains exist on the playa surface.

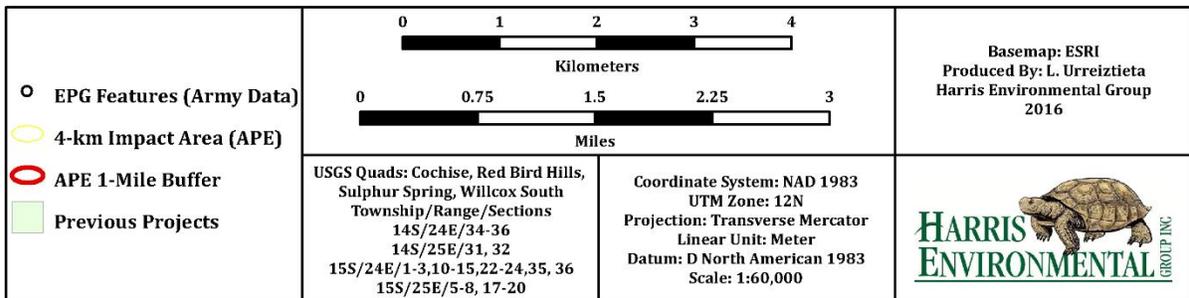
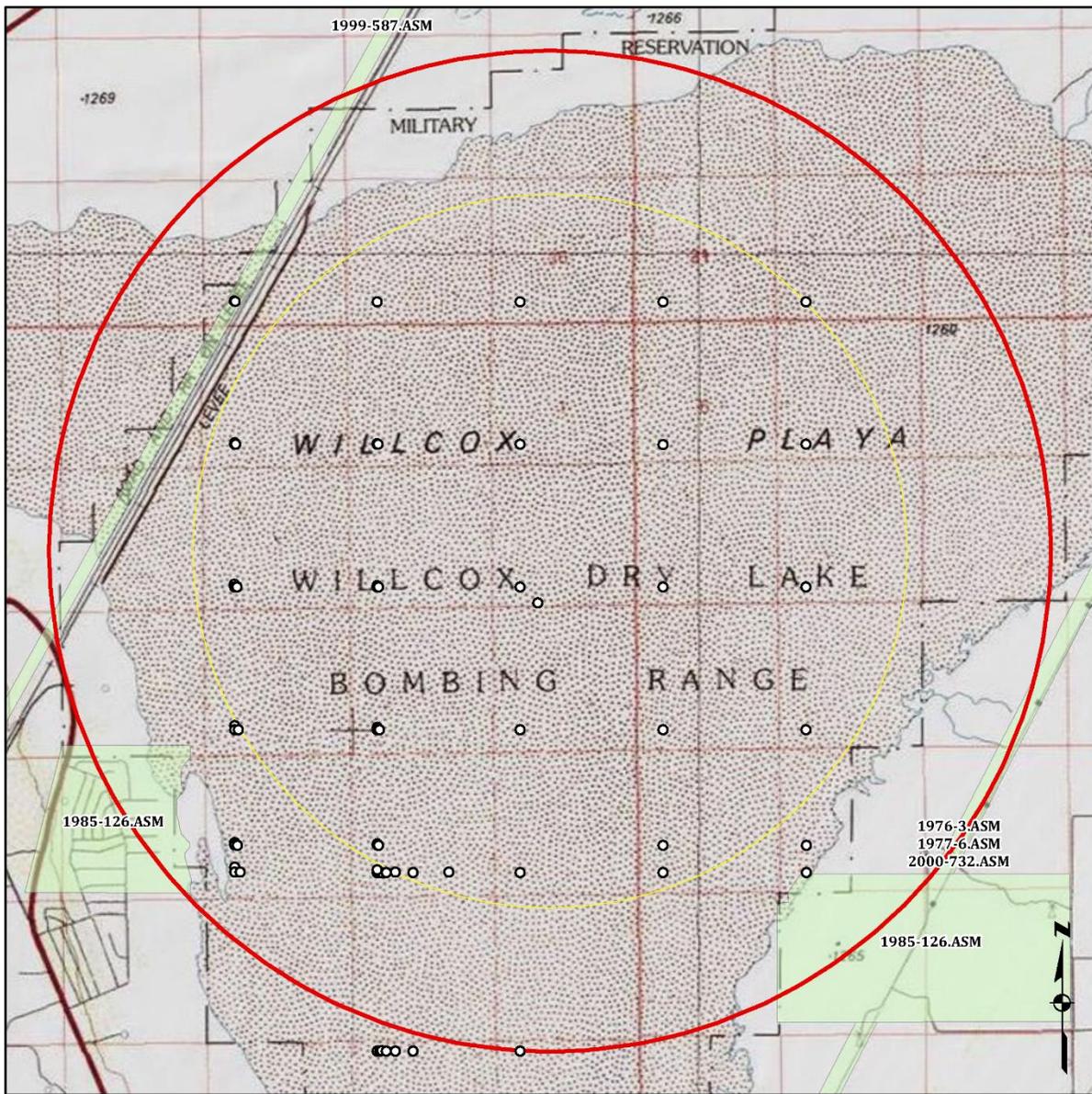


Figure 5-9: Location of Previous Surveys in the Vicinity of Willcox Playa

(Source: Cultural Resources Report)

Table 5-3: Previous Cultural Surveys around Willcox Playa

(Source: Cultural Resources Report)

Project Number	Project Name	Reference
1976-3.ASM	Arizona Electric Power Coops (AEPCO) I, Greenlee to Apache	Simpson et al. (1978)
1977-6.ASM	Arizona Electric Power Coops (AEPCO) II, Dos Condados to Apache	Westfall (1979)
1985-126.ASM	Archaeology of the Willcox Playa	Woosley et al. (1985)
1999-587.ASM	PBNS Level 3 Fiber Optic Line	Doak (1999)
2000-732.ASM	Arizona Electric Power Coops (AEPCO) Apache to Dos Condados	Becker et al. (2001)

The only known historical resources within the landing zone are the RGFF pillars, the RGTA, and the WWII bombing target. Prior to the Harris Environmental study, the condition of the RGFF and RGTA was not known. The U.S. Army, in consultation with the Arizona State Historic Preservation Office (SHPO), determined that a pedestrian cultural resources survey was not required for this project, due to a low probability of cultural materials within the playa. As a result, Harris fieldwork was restricted to documentation and evaluation of the 89 remnant features of the decommissioned RGFF (65) and RGTA (24). The landing zone extension was added after completion of the Harris fieldwork. Ft. Huachuca documented the WWII bombing target and the old fence line.

The legislative mandate to protect historical properties is found in Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. Regulations governing the Section 106 review process are found in 36 CFR Part 800, *Protection of Historic Properties*. As implied in 36 CFR Part 800, the federal agency's authority to protect an historical property is based on the determination that the property or site is included in or eligible for the NRHP. Procedures for determining eligibility are described in the National Register Bulletins. Three key requirements for eligibility include: 1) that a site possess historical significance; 2) that a site retains integrity; and 3) that it be more than 50 years old (National Park Service 1982, 1986). As defined in 36 CFR 60.4, *National Register of Historic Places, Definitions*, an historic property will possess significance if it satisfies one of four criteria, as follows:

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and

- (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
- (b) that are associated with the lives of persons significant in our past; or
- (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- (d) that have yielded, or may be likely to yield, information important in prehistory or history.

In addition to historical significance, a property must also possess sufficient integrity to convey its significance, in order to be eligible to the NRHP. The NRHP criteria recognize seven aspects or qualities of integrity. The importance of each of these aspects is dependent upon the nature of the property and the criteria under which it is considered significant. Historic properties are considered to retain their integrity if they possess a majority of the following seven aspects of integrity:

1. *Location*. Location is the place where the historic property was constructed or the place where the historic event occurred.

2. *Design*. Design is the composition of elements that constitute the form, plan, space, structure, and style of a property. Design includes such elements as organization of space, proportion, scale, technology, ornamentation, and materials.
3. *Setting*. Setting is the physical environment of a historic property. Setting refers to the character of the place in which the property played its historical role. It involves how, not just where, the property is situated and its relationship to surrounding features and open space.
4. *Materials*. Materials are the physical elements combined in a particular period of time and in a particular pattern or configuration to form an historic property.
5. *Workmanship*. Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory.
6. *Feeling*. Feeling is a property's expression of the aesthetic or historic sense of a past period of time.
7. *Association*. Association is the direct link between a significant historic event or person and an historic property.

The U.S. Army's EPG RGFF and RGTA are considered significant under Criterion A for its contribution to the development of radar technology and the role this played at the national level in the development of electronic warfighting capability during the early Cold War from 1954 to 1967. However, the RGFF does not possess sufficient integrity to convey this significance. The radar reflectors have been removed from the RGFF pillar features, compromising the facility's integrity of design and materials. Use of the pillars as shooting targets has resulted in significant damage to many of the pillars, further compromising integrity of design and materials. Figure 5-10 shows the range of pillar integrity, with the left pillar being relatively pristine (minus the radar reflector on top) and the right pillar having major damage. All 24 features of the RGTA were visible using aerial imagery, but three were not identifiable on the surface (the backfill unit and two deeply buried corrugated steel units). The majority of the units were in excellent or good condition. Some had evidence of disturbance through vehicle tracks crossing the units. Others had some scattering of the rocks outside of the designated square; however, none showed evidence of materials having been removed. The units with corrugated steel at shallow depths showed deterioration of the steel with rusted steel fragments scattered on the surface and just outside the units. Figure 5-11 shows four of the squares.

Both facilities have experienced changes in association and change in feeling as a result of the decommissioning of the facility and current use of the playa for recreation. In addition, limited information from the district has been retained through field recordation, and further investigations are unlikely to yield information significant for advancing our understanding of the historic use of this area as an Electronic Proving Ground during the late twentieth century. Thus, the EPG RGFF and RGTA are recommended not eligible for listing on the NRHP.

Ft. Huachuca is recommending the WWII bombing target as eligible for the NRHP. The fence line is recommended as not eligible.

The U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory is currently preparing an historic context and survey document for the U.S. Army EPG facilities (Smith et al. 2017 [draft]). This document is currently a draft and has not been finalized. The document describes the results of a survey of 144 buildings and structures constructed by the U.S. Army EPG that are located at Fort Huachuca. Facilities located outside the boundaries of Fort Huachuca were not surveyed nor evaluated for NRHP eligibility. The draft report recommends that a selection of EPG facilities are considered eligible for the NRHP as a discontinuous historic district under Criterion A for their role in the development of electronic warfighting capability during the Cold War era. The RGFF at Willcox Playa is mentioned in this report; however, neither facility has been evaluated for inclusion in this proposed historic district.

Due to its size (several thousand sq. mi. for both 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 D. The impact to NRHP properties is included in section 3.4 Department of Transportation Act, Section 4(f) of this EA.



Figure 5-10: Example RGFF Pillars, Least and Most Damage
(Source: Cultural Resources Report)



Figure 5-11: Radar Geology Test Area
(Limestone UL, Basalt UR, Corrugated Steel LL, Quartzite LR)
(Source: Cultural Resources Report)

5.7.2 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 NRHP.
2. Damage or impact previously unknown and recorded cultural resources eligible for inclusion into the NRHP.
3. Cause substantial unauthorized artifact collection by personnel.
4. Adversely affect known Traditional Cultural Properties on Willcox Playa. 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.

As discussed in the previous section, the RGFF infrastructure does not possess sufficient integrity to convey its significance in the development of radar technology and electronic warfighting capability during the early Cold War and neither it nor the Radar Geology Test Area are eligible for the NRHP. While there is the possibility of a small jettisoned item impacting on the WWII bombing target, the chances are inherently low due to the overall size of the landing zone and the parts small enough that any damage would be negligible. The LRT will use caution and only traverse this area on foot if needed to retrieve a part. These are the only known cultural resources on the playa.

The geology of Willcox Playa makes it highly unlikely that any prehistoric archaeological remains exist on the playa surface. The convoy will access the playa only via existing roads and access points.

Should a previously unknown site be uncovered at the CM landing site, it will be marked for avoidance and the minimum activities necessary to recover the crew and critical cargo would be performed. All work would then stop until direction on how to proceed is received from the Ft. Huachuca cultural resources manager. Every effort would be made to minimize disturbance at the site during the performance of these two activities. Should a previously unknown site be uncovered during RGFF demolition or during any other activity related to the Starliner landing and recovery, it would be marked for avoidance and all work would stop immediately until direction on how to proceed is received from the Ft. Huachuca cultural resources manager.

The Ft. Huachuca cultural resource manager performed the Native American and Arizona SHPO consultations for the proposed action for the 4km radius landing zone according to Section 106 of the NHPA following accepted practices and procedures as outlined in the Integrated Cultural Resource Management Plan (ICRMP). Only one affected tribe responded and the only comment was a concern with how the proposed action could affect the bird population on the playa. As Starliner landings cannot take place when the playa is wet, which is the time of year birds are present, the action would not affect the bird population. The SHPO consultation resulted in a determination that no historical properties would be affected by the action (See Appendix F). The Ft. Huachuca cultural resource manager is in the process of performing follow-on consultations with the tribes and SHPO due to the landing zone expansion to include the wedge out to 8 km. The results of these consultations will be included in the final EA.

In summary, the proposed action would have no impacts to any significant cultural resources.

5.7.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in cultural resource impacts at the Willcox landing site or the surrounding area.

5.7.4 Mitigation Measures

Should a previously unknown site be uncovered during any activities of the proposed action, the Ft. Huachuca cultural resources manager would be notified for guidance on how to proceed. Should the LRT

need to retrieve a jettisoned part that lands in the WWII bombing target they will use caution and only traverse this area on foot.

5.8 Noise and Noise-Compatible Land Use

5.8.1 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 5-12 compares the relative noise of common sounds.

Willcox Playa is in a relatively remote location and devoid of any permanent noise sources. The primary sources of noise near the playa are attributable to surface and air vehicular travel, especially those associated with Interstate 10 northwest of the playa and the active train tracks that traverses the northwest side of the playa, and wind.

Several towns are within the sonic boom footprint and close enough to the landing zone for the boom to be noticeable. The towns of Willcox and Cochise are within the footprint of the sonic boom generated as the spacecraft slows during entry and landing for both ascending and descending node landing trajectories. Sierra Vista and Tombstone are also within the footprint for descending node trajectories.

Common Outdoor Sound Levels

Common Indoor Sound Levels

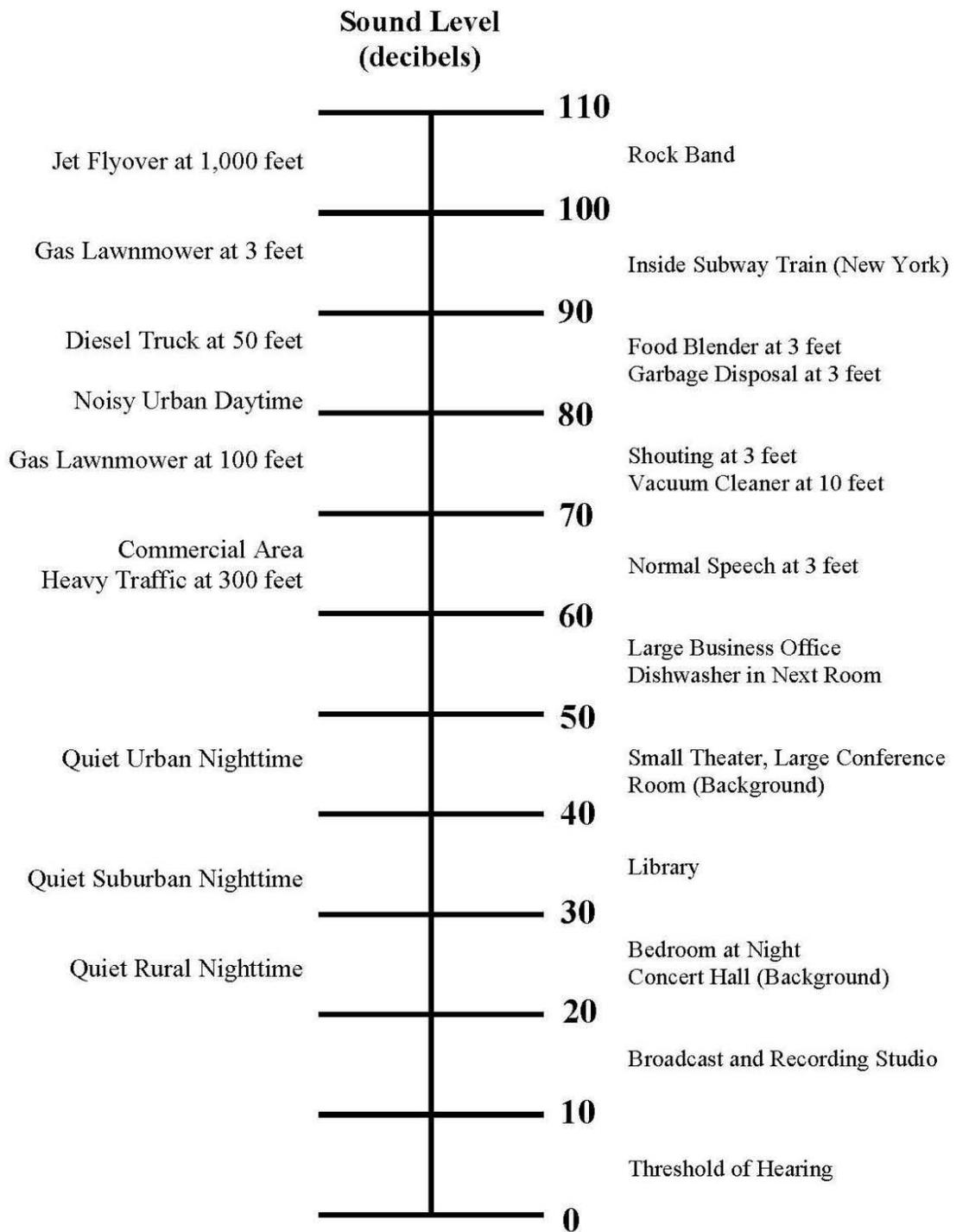


Figure 5-12: Relative Noise Comparisons
 (Source: California Department of Transportation)

5.8.2 Environmental Consequences

A significant impact would occur if the proposed action would increase noise by day-night average sound level (DNL)² 1.5 decibels (dB) or more for a noise sensitive area³ that is exposed to noise at or above the DNL 65 dB noise exposure level, or that would 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).

Demolition vehicle traffic would generate noise and vibrations for the short period required to remove the RGFF infrastructure. Landing recovery vehicle traffic, portable generators, and recovery operations would also generate noise and vibrations. Per figure 3-11, this noise could be as high as 90db in the areas of the demolition work but would probably not be noticeable outside the playa with the possible exception of during the time needed to demolish the small number of pillars closest to the boundary. The vehicle traffic for both the demolition activities and the landing and recovery operations will be short term in nature and are not expected to affect the DNL of the area.

The Starliner spacecraft would generate a sonic boom during atmospheric reentry to the Willcox 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 that surrounds us (2,116 psf/14.7 psi). At one pound overpressure, no damage to structures would be expected. Overpressures of 1 to 2 pounds 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. Some residents may be concerned about property damage. The most common sonic boom property damage is to fragile items like glass. The probability of a 1.0 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 (NASA Armstrong).

Details of the dispersion model showing the footprint of the sonic boom are in Appendix D. As shown, the maximum overpressure for any trajectory is 0.5 psf, which is not high enough to cause damage. This equates to a C-weighted DNL of 24 dB, below the FAA threshold of 65 dB. Sonic booms do not create any long-term high levels of noise. Any loud noise or vibration generated during these operations would be one time and very short in duration, and are not expected to impact the local people or wildlife. The sonic boom could occur up to two times annually.

As shown in Appendix D, some reentry trajectories could result in a sonic boom impacting the ground in Mexico. The estimated maximum overpressure occurring in Mexico would be 0.3 psf. At this level, the boom could be heard by someone that is listening for it, but it would not result in any structural damage. The Mexican government would be notified of Boeing's operations prior to Starliner reentry. The

² 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.

³ 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, recreational areas, areas with wilderness characteristics, wildlife and waterfowl refuges, and cultural and historical sites.

proposed action would be below the significance threshold listed above and therefore would not result in significant noise impacts.

5.8.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in noise impacts at the Willcox landing site or the surrounding area.

5.8.4 Mitigation Measures

For the safety of workers, proper protective equipment including hearing protection would be required (Reference: 29 CFR 1910.95, Occupational Safety and Health Administration (OSHA) standard for Noise Exposure) for those working close to noise sources. The public would be notified when Willcox Playa is utilized as a planned or backup landing site for any particular landing.

5.9 Socioeconomics

5.9.1 Affected Environment

Socioeconomics consists of the basic attributes and resources associated with the human environment especially concerning population and economic activity. The towns of Cochise (approximately 6.5 km (4 mi) away) and Willcox (approximately 11 km (7 mi) away) are the nearest in proximity to the landing site. Sierra Vista, the location of Ft. Huachuca that controls Willcox Playa, is approximately 120 km (75 miles) from the landing site.

5.9.2 Environmental Consequences

Impacts resulting from the proposed action would be considered significant if they were to cause a major increase or decrease in populations and/or employment levels in the region, substantially change the quality of life for persons living in the region or generate an unfairly high and disproportionate burden on persons living in the region.

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. Proposed RGFF removal activities would provide a very small economic benefit for the contractor selected for the work. Towns close to Willcox Playa such as Willcox and Cochise would also see a small economic benefit from the landing and recovery activities. This is due to the approximately 24 members of the LRT who would travel to and spend a week in the area for the landing and the approximately 30 NASA officials who would spend two days in the area around the landing date. An additional net positive impact could take place as it is anticipated people would travel from the surrounding area to witness the Starliner landings. Personnel working in support of the proposed activities would include military, civil servants, and contractors. The additional influx of people would occur up to two times per year.

The proposed action would not result in an increase in population in the area.

5.9.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in socioeconomic impacts at the Willcox landing site or the surrounding area.

5.9.4 Mitigation Measures

Under the proposed action, direct and indirect impacts on the local economy would have an insignificant and short term positive impact therefore no mitigation measures are needed.

5.10 Environmental Justice and Children’s Environmental Health and Safety Risks

5.10.1 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 2013).

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 proposed action’s region of influence. Statistics for minority populations in the region of influence indicate an average of 32.4 percent Hispanic of any race with a combined average of 17.5 percent minority population for “other” minority groups. The population in poverty within the region of influence averages 17.5 percent. The general population of minority and low-income population in the state of Arizona average 17.4 percent Hispanic of any race, 20.5 percent population of “other” minority groups, and 14.8 percent in poverty (USCB 2014). The proposed landing site is remote and not near towns or schools. The closest towns are Cochise (approximately 6.5 km (4 mi) away) and Willcox (approximately 11 km (7 mi) away).

5.10.2 Environmental Consequences

The proposed action would have direct insignificant impact on Willcox air quality, noise, soils and other environments as identified above. Direct impacts are not anticipated to extend outside the boundaries of the Willcox Playa to the surrounding communities, with the exception of the sonic boom which is very short term in nature, low in magnitude, and occurs up to two times per year, and the potential for up to six small jettisoned parts to land in the landing zone extension SE of the playa. The sonic boom also could be heard across the border in Mexico, requiring notification prior to landings. Additionally impacts related to additional personnel temporarily located in the surrounding communities while supporting RGFF demolition and the landing recovery would not pose adverse effects and would be insignificant. Therefore, there would be no impact on, nor a potential for, disproportionately high and adverse effects on minority or low-income populations or children.

Only the employees of the RGFF demolition contractor would be allowed within the Willcox playa during demolition activities. Only members of the LRT would be allowed within the Willcox playa following landing. A discussion the overall public risk to personnel in the landing zone extension is included in Section 5.14 below. No children would be allowed around or within the playa during landing and recovery operations. As such, there would be no additional risk to children’s environmental health and safety.

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

5.10.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in environmental justice or children's environmental health and safety impacts at the Willcox landing site or the surrounding area.

5.10.4 Mitigation Measures

Under the proposed action, there would be no impact and therefore no mitigation measures would be necessary.

5.11 Visual Effects

5.11.1 Affected Environment

The Willcox Playa is characterized by mountain ranges on a northwest-southeast axis separated by broad alluvial valleys. The playa is roughly 8-mi by 10-mi and is surrounded by multiple mountain ranges and is the drainage terminus for many of the surrounding mountain ranges and has accumulated sediments over thousands of years. It is a desert environment for most of the year but prone to seasonal flooding. Currently the remnants of the RGFF impact on the visual environment of the playa.

There are no Federal statutory or regulatory requirements for classifying and assessing light emissions and visual impacts. For the majority of the year, light emissions at the Willcox landing site are minimal, primarily because this area is devoid of any permanent buildings and people except during testing activities. There is no permanent lighting or other high-powered light sources used on a daily basis.

5.11.2 Environmental Consequences

The proposed action would only require portable lighting for those times when the Starliner spacecraft lands after sunset or late enough in the day that the recovery operations would extend past sunset. The LRT would remove all the parts of the Starliner spacecraft post-landing, with the exception of the mortar lids and mortar sabots. If found, these would also be removed. All RGFF infrastructure demolition activities would take place during daylight hours.

The pillar removal would have a short-term, slight impact on visual effects due to additional traffic to and from the work sites and the potential for dust generation. It is not anticipated that any construction work would take place after dark, so no temporary lighting would be involved. However, the long-term affect would be positive as the pillars would no longer be present and the land would be visually back to its original state.

The proposed action would have a slight impact on light emissions at the Willcox landing site for those instances where the Starliner spacecraft lands after sunset or late enough in the day that the recovery operations would extend past sunset. For these instances, portable lighting would be required around the landing site until recovery operations are complete. The planned action would have no long-term impacts on the visual environment as the LRT removes all parts of the spacecraft the landing site with the possible exception of any mortar lids and mortar sabots not found and those parts left in the field should they land in the landing zone extension SE of the playa. 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.

5.11.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in visual impacts at the Willcox landing site or the surrounding area.

5.11.4 Mitigation Measures

The lighting needs would be assessed to ensure the level of lighting is commensurate with safely performing the proposed action.

5.12 Infrastructure and Utilities

5.12.1 Affected Environment

The infrastructure that could potentially be affected from the proposed action includes physical structures (e.g. buildings), site use, electricity, utilities, waste disposal and treatment, transportation and roads, and communications. The capacity and current demands of the following infrastructure elements around Willcox Playa were examined to determine infrastructure constraints.

5.12.1.1 Structures and Utilities

The Willcox playa landing site is situated in an undeveloped area. The only infrastructure within the playa landing zone are concrete pillars and other remnants remaining from the RGFF and several areas of various surface materials remaining from the RGTA built in the 1960's. The RGFF infrastructure would be removed as part of this proposed action. Existing electrical power and communication lines are the only utilities located nearby on the outskirts of the playa. The playa is also surrounded by fencing, some maintained by the state and federal government and some by neighboring landowners. There is also fencing along the railroad tracks that traverse the northwest side of the playa.

No permanent buildings exist on the playa. There are several farmsteads and other structures in the landing zone extension SE of the playa. These make up only approximately 2 acres total of the approximately 14,700 acres contained within the extension.

5.12.1.2 Transportation and Roads

Access to Willcox Playa is via Interstate 10 and U. S. Route 191. There are no existing roads within the playa. Access is gained via gravel roads at two access points, one from the northwest and one from the south. Vehicles would fan out when traveling across the playa to minimize soil disturbance. Vehicular traffic and parking in the surrounding areas are expected to increase during the week before a Starliner landing, after the convoy arrives at Willcox, through the completion of landing and recovery operations. However, the only traffic within the playa itself would be during the recovery simulation scheduled two days before the landing and during the actual recovery operations. Ft. Huachuca, state, and local guidelines would dictate the transportation and handling of waste and hazardous materials to and from the landing site.

Access to the landing zone extension SE of the playa is via State Route 186 and South Kansas Settlement Road, which also connects to U. S. Route 191 south of the playa.

5.12.2 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 RGFF demolition contractor would utilize existing infrastructure during the demolition phase. The landing and recovery convoy would utilize existing hotels, roads, and parking lots during the one-week staging at Willcox prior to landing and would travel to the Playa via existing roads. The proposed action would not significantly impact public infrastructure or increase the burden on infrastructure. Generators would be inspected to ensure proper working order and compliance with applicable permitting requirements, safety, air quality, and spill containment.

Temporary tents would be erected at the landing site to support landing recovery operations. All power and water, as well as sanitation capability in the form of portable toilets, would be brought to the site by the EFG demolition contractor and by the landing recovery convoy. The landing recovery convoy would

park in Willcox, Arizona for approximately a week before the landing. The demolition contractor would coordinate needed public services, including police, fire protection, and emergency medical treatment services during RGFF demolition. Those functions supporting landing recovery would be a combination of those operated and /or supervised by the U.S. Army at Ft. Huachuca or contracted by Boeing. The landing and recovery convoy would park in the town of Willcox for approximately a week before the landing but would not require any services from Ft. Huachuca except during the recovery simulation scheduled two days before the landing.

Water and septic system use in the surrounding areas would increase under the proposed action. 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 communication and electrical sources. Cellular phones or radios, required for personnel traveling to the playa, would see increased use during demolition and landing and recovery operations, but the increased use of this communication would not significantly impact communication resources.

Increased vehicle traffic to the demolition sites and the landing site would result from the proposed action but would not be significant. The existing roads would be used and are considered adequate to handle the demands under the proposed action. The contract for transportation of waste or hazardous materials would include a requirement to comply with local and state procedures and applicable regulations. Only approved or existing routes would be used.

The chances of a jettisoned part hitting a structure in the landing zone extension is inherently low given structures only account for a small percentage of the overall area and jettisoned parts would only travel into that area for wind conditions of enough strength and in the right direction. Based on historical wind data, these would account for less than half the potential landings at the playa.

To prevent an increase in the population of the landing zone extension, roadblocks will be established on State Route 186 and South Kansas Settlement Road. Road closures would be coordinated with the Arizona DOT and local authorities and would be short term in nature. These would be cancelled if wind forecasts for landing day indicate all jettisoned parts will remain within the playa.

5.12.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in infrastructure or utility impacts at the Willcox landing site or the surrounding area.

5.12.4 Mitigation Measures

There is currently no plan to close the train tracks during the landing activities. Road closures for the landing zone extension would be coordinated with the Arizona DOT and local authorities and would be short term in nature.

5.13 Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention

5.13.1 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) as are any waste or combination of wastes that either exhibit one or more hazardous characteristics including ignitibility, corrosivity, toxicity, or reactivity or are listed as a hazardous waste

under 40 CFR 261, *Identification and Listing of Hazardous Waste*. 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.

5.13.2 Environmental Consequences

The removal of the RGFF infrastructure would generate solid waste in the form of concrete, wood, and metals. The demolition contractor would be responsible for the removal and disposal of all waste, hardware, and debris generated during the removal of the RGFF infrastructure in accordance with applicable federal, state, and Ft. Huachuca regulations.

The Starliner landing and recovery would require the use of H4N2 hydrazine, ordnance, Galden (a perfluoropolyether heat transfer fluid), ethylene glycol, hydrofluorocarbons (HFC) 134a refrigerant, halocarbon Rf-404A, and ammonia. Solid waste and potential biohazard material would also be generated.

For the Starliner landing and recovery, removal of all waste, hardware, debris, and other hazardous or potentially hazardous material would be the responsibility of the Boeing CCTS program. Boeing would contract with a local company for removal and disposal of solid waste. Boeing would also contract with a local company to provide emergency hazardous waste cleanup and removal. Both would take place per state and local guidelines.

Following the Starliner landing, hazardous materials or waste in the spacecraft would be in the form of the unused hydrazine in the Starliner liquid propellant tanks, Galden heat transfer fluid and ammonia in the thermal system, batteries, and unexploded ordnance.

Following a nominal landing, the only unexpended ordnance devices would be for the NDS Emergency Undock System and the Airbag Vent Cord Cable Cutters (AVCCC) in the landing airbag water drains and center airbag. These are in a safe configuration for landing and would require multiple failures to inadvertently fire post landing. In a failure case that required an emergency undock from the ISS, the docking system ordnance devices would be fired at undock so would already be expended during recovery operations. For an emergency water landing, the AVCCCs for the landing airbag water drains and center airbag fire at splashdown so would already be expended during the recovery operations. The majority of Starliner ordnance is Class 1 Division 1.4 per the Department of Transportation CFR 49, Vol. 2, Part 173 section 50. 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 AVCCs, 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 of the Starliner. All ordnance is developed per MIL-HDBK-83578, Criteria for Explosive Systems and Devices used on Space Vehicles.

“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.”

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.

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. For a nominal flight, the spacecraft would contain unburned propellant at landing. Entry to the landing site would be restricted to approved hazardous materials response personnel until the area is determined to be safe. Unless a failure occurs that would allow a release, all hazardous material would remain in the spacecraft and be transported back to the Boeing facility at the Kennedy Space Center in Florida. Any hazardous material that escapes from the spacecraft would be cleaned up by the emergency response contractor and disposed of in accordance with applicable federal, state, and Ft. Huachuca regulations.

The GCUs (two total) used by the LRT contain ethylene glycol (28 gallons each), hydrofluorocarbons (HFC) 134a refrigerant (4.5 gallons each), and halocarbon Rf-404A (2.3 gallons each). Unless a failure occurs that would allow release, all hazardous material would remain in the GCUs and be transported back to the Boeing facility at WSMR after recovery operation are complete. Any hazardous material that escapes would be collected and disposed of by the emergency response team in accordance with the above regulations.

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 a heat pipe. The maximum amount of ammonia in any heat pipe is just under 12 grams.

Nonhazardous waste would be handled as solid waste or non-regulated waste. All solid waste generated would be disposed of by the contracted solid waste company. The only petroleum, oil, and lubricants used during the landing and recovery operations would be contained in support equipment, generators, cranes, and vehicles. In the unlikely event of accidental POL spills, the established local regulations would be followed by the emergency response contractor.

Biomedical hazardous waste could be generated during the post-landing crew medical evaluation and would be removed and disposed of by the NASA medical team. Sanitary waste would be removed and processed by the provider of the portable toilets.

Appendix B contains typical material safety data sheets for the hazardous material used in the Starliner and GCUs.

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

5.13.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in waste or pollution impacts at the Willcox landing site or the surrounding area.

5.13.4 **Mitigation Measures**

All demolished RGFF infrastructure, the Starliner spacecraft, and all jettisoned hardware would be collected and removed from the landing site. Hazardous materials and hazardous wastes would be recovered immediately, transported, stored, and disposed of in accordance with federal, state, and local regulations. Nonhazardous waste would be handled as solid waste or non-regulated waste and disposed of accordingly. Vehicles and the GCUs would be routinely inspected to ensure proper operation and no leaking of POLs or hazardous material.

5.14 Human Health and Safety

5.14.1 Affected Environment

Human health and safety is defined as the protection of workers and the public from hazards. 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 defines the region of influence. General health and safety protocols for personnel are addressed in various Federal, State, and Ft. Huachuca guidelines, rules, and regulations.

The proposed action will involve locally contracted construction personnel for the RGFF demolition and Boeing personnel, Boeing locally contracted service personnel, and personnel from Ft. Huachuca for the Starliner landing recovery team. All activities for the proposed action will take place outdoors on the Willcox Playa.

5.14.2 Environmental Consequences

The contractor performing the RGFF demolition would be required to meet all applicable safety regulations for its personnel involved in those activities.

The Starliner landing would require the use of fuel (H4N2 hydrazine, gas, and diesel), ordnance, perfluoropolyether heat transfer fluid and other hazardous materials. Other safety issues include radiation from the Starliner S-band antennas, encounters with unexploded ordnance (UXO), injury due to jettisoned parts landing off-range onto private land, biological hazards such as venomous snakes and spiders, and biomedical hazards related to the astronaut post-landing medical evaluations.

As a safety precaution, personnel would remain outside the 4km radius-landing zone until after the landing of the spacecraft. Upon landing, the convoy would reposition to a location approximately 500 feet upwind of the Starliner. After confirmation from the astronauts that the Starliner systems have been safed, including powering down of the Starliner S-band antennas, a two-person safety assessment team (donned in Totally Encapsulated Suits), 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 emergency response team would be called in to assist in mitigating the hazard and to perform toxic spill or contamination cleanup. Once the area around the CM is deemed safe, the convoy 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 Ft. Huachuca, state, and OSHA safety procedures would be followed.

Personnel would be required to receive UXO training before being allowed entry onto Willcox Playa, including instruction not to disturb potential UXO items. All potential UXO and unfamiliar objects would be reported to Ft. Huachuca personnel.

There is some risk to personnel from venomous snakebites, but these typically occur only when the species is harassed or provoked. Recovery personnel would be instructed not to harass venomous spiders and snakes. Personnel training would take place prior to arrival at the Willcox.

Public safety is also an issue with the proposed landing and recovery operations. Up to six small jettisoned parts could land on public or private land in the landing zone extension SE of the playa. These parts consist of up to two FHS composite doors that are 10 in. by 12 in. and weigh 1 lb. each, up to two round aluminum mortar lids 7.4 in. in diameter and weighing 0.25 lb. each, and up to two round aluminum mortar lids 16 in. in diameter and weighing 0.75 lb. each. Boeing performed a public risk assessment for a landing at Willcox Playa that included public risk calculations for both nominal and off-nominal landings. Per applicable FAA regulations in Title 14 CFR, part 431.35, Launch and Reentry of a Reusable Launch Vehicle, Boeing must show that the risk to any individual member of the public (defined as E_c) does not exceed a casualty expectation of 1×10^{-6} for each hazard for the launch and reentry of the Starliner. The calculated hazard to people living in the landing zone extension SE of the

playa is on the order of 10^{-8} . These were calculated as part of the public risk assessment Boeing must perform to obtain a launch and landing license.

As an added precaution to ensure the risk to the public is minimized in the landing zone extension Boeing plans to take the following additional actions:

- Approximately 10 days before any planned landing at Willcox, Boeing will send certified letters to the owners of record for all private land and anyone holding a lease agreement for the state of Arizona or BLM land in the extension explaining the slight risk for the small jettisoned items that could land on their property and recommending that all personnel vacate the property for a period approximately one hour before the landing until one hour after.
- Boeing will work with the Arizona DOT and local authorities to establish roadblocks to prevent an influx of people to the area who might be interested in watching the landing. These would be cancelled if the wind data for the day of landing indicate all jettisoned parts will remain on the playa.

Since the CCTS initiative is developing the next generation of U.S. space exploration vehicles, the potential for news media and public interest in the landing exists. The areas along Interstate 10 and U.S. Route 191 could provide viewing space for interested parties. The public viewers are restricted to areas outside of the 4 km landing zone and the landing zone extension. NASA and Ft. Huachuca Public Affairs would provide the necessary guidance and assistance in providing landing information to the public.

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

5.14.3 **No Action Alternative**

Under the No Action Alternative, no Starliner reentry activities would occur at Willcox, nor would the RGFF infrastructure be removed. Therefore, the No Action Alternative would not result in human health or safety impacts at the Willcox landing site or the surrounding area.

5.14.4 **Mitigation Measures**

All personnel working on the 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.

Boeing will send certified letters to the owners of record for all private land and anyone holding a lease agreement for the state of Arizona or BLM land in the extension explaining the slight risk for the small jettisoned items that could land on their property and recommending that all personnel vacate the property for a period approximately one hour before the landing until one hour after. Boeing will also work with the Arizona DOT and local authorities to establish roadblocks to prevent an influx of people to the extension area who might be interested in watching the landing.

Safe viewing sites would be provided during the landing. At a minimum, viewers would be placed outside the landing zone. NASA and Ft. Huachuca Public Affairs would also provide ways to inform the public of the landing and related activity.

6.0 Irretrievable and Irreversible Commitment of Resources and Cumulative Impacts

6.1 Irretrievable and Irreversible Commitment of Resources

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

6.2 Cumulative Impacts

Cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

The launch of the Starliner on the expendable launch vehicle will not increase the launch rate at CCAFS above existing or previously approved and documented levels; therefore, there would be no cumulative impacts to the Cape Canaveral area.

The Willcox Playa is utilized by Ft. Huachuca for ground testing of electronic and communications equipment. On average, the Army utilizes the playa 2-3 times per year. None of this testing results in any long term impacts to the playa. The demolition activities needed to remove the RGFF pillars is a one-time event and are relatively short in duration. Removal of the pillars will have the long-term positive impact of returning the playa close to its natural state. The landing recovery operations are infrequent (1-2 times per year, spread out over the five landing sites). Standard operating procedures would be developed to ensure adherence to all Army, state, and federal regulations. Established Ft. Huachuca coordinating and scheduling procedures would be utilized.

The small number of jettisoned parts that could land outside the playa and be left in place will not cause any environmental concerns.

When taken in conjunction with other current, planned, and reasonably foreseeable activities at Willcox Playa, the impacts from the proposed action would not result in any cumulative impacts to the existing environment on the playa and the surrounding area.

The Starliner will only launch and land twice per year. Therefore, the cumulative impacts for the entire program, regardless of which landing site is used for any particular landing, would be insignificant.

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Appendix A - Abbreviations and Acronyms

ADWR	Arizona Department of Water Resources
AEGL	Acute Exposure Guideline Level
AEPCO	Arizona Electric Power Cooperative
ASM	Arizona State Museum
AVCCC	Airbag Vent Cord Cable
BLM	Bureau of Land Management
BHS	Base Heat Shield
BLS	Backup Landing Site
C3PF	Commercial Crew and Cargo Processing Facility
CATEX	Categorical Exclusion
CCAFS	Cape Canaveral Air Force Station
CCDev	Commercial Crew Development
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
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
EPG	Electronic Proving Ground
ERPG	Emergency Response Planning Guideline
FAA	Federal Aviation Administration
FHS	Forward Heat Shield
FONPA	Finding of No Possible Alternatives
FONSI	Finding Of No Significant Impact
GHG	Greenhouse Gases
HFC	Hydro-fluorocarbon
in	Inch
ISS	International Space Station
km	kilometers
KSC	Kennedy Space Center

LAS	Launch Abort System
lb.	pound
LC	Launch Complex
LOC	Level of Concern
LRT	Landing/Recovery Team
mi	miles
MRoD	Modified Record of Decision
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCPC	National Capital Poison Center
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOI	Notification of Intent
NPR	NASA Procedural Requirement
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSI	NASA Standard Initiator
ODS	Ozone Depleting Substance
OFT	Orbital Flight Test
OSHA	Occupational Safety and Health Administration
PLS	Primary Landing Site
PM	Particulate Matter
POL	Petroleum, Oil and Lubricant
RCRA	Resource Conservation and Recovery Act
RGFF	Radar Geometric Fidelity Facility
RGTA	Radar Geology Test Area
RoD	Record of Decision
SLS	Space Launch System
SM	Service Module
SOP	Standard Operating Procedure
TES	Threatened, Endangered, or Sensitive
ULA	United Space Alliance
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

Appendix B Typical Material Safety Data Sheets

Below are the safety data sheets for the following hazardous materials:

In the Starliner Spacecraft:

- Perfluoropolyether Heat Transfer Fluid
- Propellant
- Lithium Ion Battery
- Pyro material
- DuPont Hydro-fluorocarbon (HFC) 134a (also in the Ground Cooling Units)
- Ammonia

In the Ground Cooling Units:

- Ethylene Glycol
- Airgas Halocarbon R404a

SECTION 1: Identification of the substance/mixture and of the company/undertaking**1.1 Product identifier**

- Trade name GALDEN® HT170

1.2 Relevant identified uses of the substance or mixture and uses advised against**Uses of the Substance / Mixture**

- Heat transfer medium
- For industrial use only.

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

SOLVAY SPECIALTY POLYMERS USA, LLC
4500 McGINNIS FERRY ROAD
30005-3914, ALPHARETTA
USA
Tel: +1-770-7728200
Fax: +1-770-7728213
Product Information:
+1-800-2210553

1.4 Emergency telephone

FOR EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT CONTACT: CHEMTREC 800-424-9300 within the United States and Canada, or 703-527-3887 for international collect calls.

SECTION 2: Hazards identification

Although OSHA has not adopted the environmental portion of the GHS regulations, this document may include information on environmental effects.

2.1 Classification of the substance or mixture**HCS 2012 (29 CFR 1910.1200)**

- Not a hazardous product according to the OSHA Globally Harmonized System (GHS).

2.2 Label elements**HCS 2012 (29 CFR 1910.1200)**

- Not a hazardous product according to the OSHA Globally Harmonized System (GHS).

2.3 Other hazards which do not result in classification

None identified

SECTION 3: Composition/information on ingredients**3.1 Substance**

- Chemical nature Perfluorinated polyethers

Hazardous Ingredients and Impurities

- No ingredients are hazardous.

Non Hazardous Ingredients and Impurities

Chemical name	Identification number CAS-No.	Concentration [%]
1-Propene, 1,1,2,3,3,3-hexafluoro-, oxidized, polymd.	69991-67-9	> 99.9

3.2 Mixture

Not applicable, this product is a substance.

SECTION 4: First aid measures**4.1 Description of first-aid measures****In case of inhalation**

- Move to fresh air in case of accidental inhalation of fumes from overheating or combustion.
- Oxygen or artificial respiration if needed.

In case of skin contact

- Wash off with soap and water.

In case of eye contact

- Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
- If eye irritation persists, consult a specialist.

In case of ingestion

- Drink 1 or 2 glasses of water.
- Do NOT induce vomiting.
- If symptoms persist, call a physician.

4.2 Most important symptoms and effects, both acute and delayed**In case of inhalation****Effects**

- No known effect.

In case of skin contact**Effects**

- Effects of skin contacts may include:
- Redness

In case of eye contact**Effects**

- Contact with eyes may cause irritation.
- Redness

In case of ingestion**Symptoms**

- Ingestion may provoke the following symptoms:
- Nausea
- Vomiting
- Diarrhea

4.3 Indication of any immediate medical attention and special treatment needed

- no data available

SECTION 5: Firefighting measures

Flash point The product is not flammable.

Autoignition temperature no data available

Flammability / Explosive limit no data available

5.1 Extinguishing media**Suitable extinguishing media**

- Water
- powder
- Foam
- Dry chemical
- Carbon dioxide (CO2)

Unsuitable extinguishing media

- None.

5.2 Special hazards arising from the substance or mixture**Specific hazards during fire fighting**

- The product is not flammable.
- Not explosive
- In case of fire hazardous decomposition products may be produced such as: Gaseous hydrogen fluoride (HF), Fluorophosgene

Hazardous combustion products:

- Gaseous hydrogen fluoride (HF).
- Fluorophosgene
- The release of other hazardous decomposition products is possible.

5.3 Advice for firefighters**Special protective equipment for fire-fighters**

- Wear self-contained breathing apparatus and protective suit.
- When intervention in close proximity wear acid resistant over suit.

Further information

- Evacuate personnel to safe areas.
- Approach from upwind.
- Protect intervention team with a water spray as they approach the fire.
- Keep containers and surroundings cool with water spray.
- Keep product and empty container away from heat and sources of ignition.

SECTION 6: Accidental release measures**6.1 Personal precautions, protective equipment and emergency procedures****Advice for non-emergency personnel**

- Prevent further leakage or spillage if safe to do so.

Advice for emergency responders

- Ensure adequate ventilation.
- Material can create slippery conditions.
- Sweep up to prevent slipping hazard.
- Keep away from open flames, hot surfaces and sources of ignition.

6.2 Environmental precautions

- Should not be released into the environment.
- Do not flush into surface water or sanitary sewer system.
- The product should not be allowed to enter drains, water courses or the soil.
- In case of accidental release or spill, immediately notify the appropriate authorities if required by Federal, State/Provincial and local laws and regulations.

6.3 Methods and materials for containment and cleaning up

- Soak up with inert absorbent material.
- Suitable material for picking up.
- Dry sand
- Earth
- Shovel into suitable container for disposal.

6.4 Reference to other sections

- Refer to protective measures listed in sections 7 and 8.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

- Ensure adequate ventilation.
- Use personal protective equipment.
- Keep away from heat and sources of ignition.
- To avoid thermal decomposition, do not overheat.
- Take measures to prevent the build up of electrostatic charge.
- Clean and dry piping circuits and equipment before any operations.
- Ensure all equipment is electrically grounded before beginning transfer operations.

Hygiene measures

- Ensure that eyewash stations and safety showers are close to the workstation location.
- When using do not eat, drink or smoke.
- Wash hands before breaks and at the end of workday.
- Handle in accordance with good industrial hygiene and safety practice.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/Storage conditions

- Keep away from heat and sources of ignition.
- Keep in properly labeled containers.
- Keep away from combustible material.
- Keep away from incompatible products
- Provide tight electrical equipment well protected against corrosion.
- Refer to protective measures listed in sections 7 and 8.

Packaging material

Suitable material

- polyethylene containers

7.3 Specific end use(s)

- Contact your supplier for additional information

SECTION 8: Exposure controls/personal protection

Introductory Remarks: These recommendations provide general guidance for handling this product. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Assistance with selection, use and maintenance of worker protection equipment is generally available from equipment manufacturers.

8.1 Control parameters

- Contains no substances with occupational exposure limit values.

Threshold limit values of by-products from thermal decomposition:**Components with workplace occupational exposure limits**

Ingredients	Value type	Value	Basis
Hydrofluoric acid	TWA	3 ppm 2.5 mg/m ³	National Institute for Occupational Safety and Health
Hydrofluoric acid	C	6 ppm 5 mg/m ³ 15 minute ceiling value	National Institute for Occupational Safety and Health
Hydrofluoric acid	TWA	3 ppm Z37.28-1969	Occupational Safety and Health Administration - Table Z-2
Hydrofluoric acid	TWA	0.5 ppm Danger of cutaneous absorption Expressed as :Fluorine	American Conference of Governmental Industrial Hygienists
Hydrofluoric acid	C	2 ppm Danger of cutaneous absorption Expressed as :Fluorine	American Conference of Governmental Industrial Hygienists
Hydrofluoric acid			Occupational Safety and Health Administration - Table Z-1 Limits for Air Contaminants See Table Z-2 Expressed as :Fluorine
Carbonyl difluoride	TWA	2 ppm	American Conference of Governmental Industrial Hygienists
Carbonyl difluoride	STEL	5 ppm	American Conference of Governmental Industrial Hygienists
Carbonyl difluoride	TWA	2 ppm 5 mg/m ³	National Institute for Occupational Safety and Health

Carbonyl difluoride	ST	5 ppm 15 mg/m3	National Institute for Occupational Safety and Health
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Biological Exposure Indices

Ingredients	Value type	Value	Basis
Hydrofluoric acid	BEI	2 mg/l Fluoride Urine Prior to shift (16 hours after exposure ceases)	American Conference of Governmental Industrial Hygienists
Hydrofluoric acid	BEI	3 mg/l Fluoride Urine End of shift (As soon as possible after exposure ceases)	American Conference of Governmental Industrial Hygienists

8.2 Exposure controls**Control measures****Engineering measures**

- Provide local ventilation appropriate to the product decomposition risk (see section 10).
- Refer to protective measures listed in sections 7 and 8.
- Apply technical measures to comply with the occupational exposure limits.
- For additional information, consult the current edition of The Guide to the Safe Handling of Fluoropolymers published by the Society of Plastics Industry, Inc. (SPI) Fluoropolymer Division.

Individual protection measures**Respiratory protection**

- Use respirator when performing operations involving potential exposure to vapor of the product.
- In case of decomposition (see section 10), use an air breathing apparatus with face mask.
- Use only respiratory protection that conforms to international/ national standards.
- When respirators are required, select NIOSH/MSHA approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or industrial recommendations.
- Comply with OSHA respiratory protection requirements.

Hand protection

- Wear protective gloves.
- Protective gloves - impervious chemical resistant:

Suitable material

- Nitrile rubber
- PVC
- Neoprene gloves
- butyl-rubber

- Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).

Eye protection

- Safety glasses with side-shields
- If splashes are likely to occur, wear:

- Tightly fitting safety goggles

Skin and body protection

- Wear work overall and safety shoes.
- If splashes are likely to occur, wear:
- Chemical resistant apron

Hygiene measures

- Ensure that eyewash stations and safety showers are close to the workstation location.
- When using do not eat, drink or smoke.
- Wash hands before breaks and at the end of workday.
- Handle in accordance with good industrial hygiene and safety practice.

SECTION 9: Physical and chemical properties

Physical and Chemical properties here represent typical properties of this product. Contact the business area using the Product information phone number in Section 1 for its exact specifications.

9.1 Information on basic physical and chemical properties

<u>Appearance</u>	<u>Physical state:</u> liquid <u>Color:</u> colorless
<u>Odor</u>	odorless
<u>Odor Threshold</u>	no data available
<u>Molecular weight</u>	760 Da Polymer Molar Mass
<u>pH</u>	no data available
<u>Melting point/freezing point</u>	<u>Melting point/range:</u> () Not applicable
<u>Initial boiling point and boiling range</u>	<u>Boiling point/boiling range:</u> 338 °F (170 °C)
<u>Flash point</u>	The product is not flammable.
<u>Evaporation rate (Butylacetate = 1)</u>	no data available
<u>Flammability (liquids)</u>	The product is not flammable.
<u>Flammability / Explosive limit</u>	no data available
<u>Autoignition temperature</u>	no data available
<u>Vapor pressure</u>	ca. 0.83 mmHg (1.1 hPa) (77 °F (25 °C))
<u>Vapor density</u>	no data available
<u>Density</u>	1.77 g/cm3
<u>Relative density</u>	no data available

<u>Solubility</u>	<u>Water solubility:</u> insoluble
<u>Partition coefficient: n-octanol/water</u>	<u>Solubility in other solvents:</u> Fluorinated solvents : soluble no data available
<u>Decomposition temperature</u>	> 554 °F (> 290 °C)
<u>Viscosity</u>	<u>Viscosity, dynamic :</u> 3 mPa.s
<u>Explosive properties</u>	Not explosive
<u>Oxidizing properties</u>	Not considered as oxidizing.

9.2 Other information

no data available

SECTION 10: Stability and reactivity

10.1 Reactivity

- No dangerous reaction known under conditions of normal use.

10.2 Chemical stability

- Stable under recommended storage conditions.
- Metals promote and lower decomposition temperature

10.3 Possibility of hazardous reactions

- No dangerous reaction known under conditions of normal use.

10.4 Conditions to avoid

- Avoid to use in presence of high voltage electric arc and in absence of oxygen.
- Keep away from flames.
- To avoid thermal decomposition, do not overheat.

10.5 Incompatible materials

- Alkali metals
- Lewis acids (Friedel-Crafts) above 100°C
- Aluminum and magnesium in powder form above 200°C

10.6 Hazardous decomposition products

- Gaseous hydrogen fluoride (HF).
- Fluorophosgene

SECTION 11: Toxicological information**11.1 Information on toxicological effects****Acute toxicity****Acute oral toxicity** no data available**Acute inhalation toxicity** no data available**Acute dermal toxicity** no data available**Acute toxicity (other routes of administration)** no data available**Skin corrosion/irritation** no data available**Serious eye damage/eye irritation** no data available**Respiratory or skin sensitization** no data available**Mutagenicity****Genotoxicity in vitro** no data available**Genotoxicity in vivo** no data available**Carcinogenicity** no data available

This product does not contain any ingredient designated as probable or suspected human carcinogens by:

NTP
IARC
OSHA
ACGIH

Toxicity for reproduction and development**Toxicity to reproduction / fertility** no data available**Developmental Toxicity/Teratogenicity** no data available**STOT****STOT-single exposure** no data available**STOT-repeated exposure** no data available

<u>Aspiration toxicity</u>	no data available
<u>Further information</u>	<p>Description of possible hazardous to health effects is based on experience and/or toxicological characteristics of several ingredients.</p> <p>Thermal decomposition can lead to release of toxic and corrosive gases. The exposure to decomposition products causes severe irritation of eyes, skin and mucous membranes.</p>

SECTION 12: Ecological information

12.1 Toxicity

Aquatic Compartment

Acute toxicity to fish	no data available
Acute toxicity to daphnia and other aquatic invertebrates.	no data available
Toxicity to aquatic plants	no data available
Toxicity to microorganisms	no data available
Chronic toxicity to fish	no data available
Chronic toxicity to daphnia and other aquatic invertebrates.	no data available
Chronic Toxicity to aquatic plants	no data available

12.2 Persistence and degradability

<u>Abiotic degradation</u>	no data available
<u>Physical- and photo-chemical elimination</u>	no data available
<u>Biodegradation</u>	no data available

12.3 Bioaccumulative potential

Partition coefficient: n-octanol/water	no data available
Bioconcentration factor (BCF)	no data available

12.4 Mobility in soil

Adsorption potential (Koc) no data available

Known distribution to environmental compartments no data available

12.5 Results of PBT and vPvB assessment no data available

12.6 Other adverse effects no data available

Remarks Ecological injuries are not known or expected under normal use.

SECTION 13: Disposal considerations**13.1 Waste treatment methods****Product Disposal**

- Do not dump into any sewers, on the ground, or into any body of water. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations.
- Waste characterizations and compliance with applicable laws and regulations are the responsibility of the waste generator.
- Can be incinerated, when in compliance with local regulations.
- The incinerator must be equipped with a system for the neutralization or recovery of HF.

Advice on cleaning and disposal of packaging

- Empty containers can be landfilled, when in accordance with the local regulations.

SECTION 14: Transport information**DOT**

not regulated

TDG

not regulated

IMDG

not regulated

IATA

not regulated

Note: The above regulatory prescriptions are those valid on the date of publication of this sheet. Given the possible evolution of transportation regulations for hazardous materials, it would be advisable to check their validity with your sales office.

SECTION 15: Regulatory information**15.1 Notification status**

Inventory Information	Status
United States TSCA Inventory	- Listed on Inventory
Canadian Domestic Substances List (DSL)	- Listed on Inventory
Australia Inventory of Chemical Substances (AICS)	- Listed on Inventory
Korea. Korean Existing Chemicals Inventory (KECI)	- Listed on Inventory
China. Inventory of Existing Chemical Substances in China (IECSC)	- Listed on Inventory
Japan. ISHL - Inventory of Chemical Substances	- Listed on Inventory
Japan. CSCL - Inventory of Existing and New Chemical Substances	- Listed on Inventory
Philippines Inventory of Chemicals and Chemical Substances (PICCS)	- Listed on Inventory
New Zealand. Inventory of Chemical Substances	- Listed on Inventory
Taiwan. Chemical Substance Inventory (TCSI)	- Listed on Inventory
EU. European Registration, Evaluation, Authorisation and Restriction of Chemical (REACH)	- If product is purchased from Solvay in Europe it is in compliance with REACH, if not please contact the supplier.

15.2 Federal Regulations**US. EPA EPCRA SARA Title III****Section 313 Toxic Chemicals (40 CFR 372.65)**

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.

Section 302 Emergency Planning Extremely Hazardous Substance Threshold Planning Quantity (40 CFR 355)

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

Section 302 Emergency Planning Extremely Hazardous Substance Reportable Quantity (40 CFR 355)

This material does not contain any components with a SARA 302 RQ.

Section 304 Emergency Release Notification Reportable Quantity (40 CFR 355)

This material does not contain any components with a section 304 EHS RQ.

US. EPA CERCLA Hazardous Substances and Reportable Quantities (40 CFR 302.4)

This material does not contain any components with a CERCLA RQ.

15.3 State Regulations**US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)**

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

SECTION 16: Other information

Further information

- Product evaluated under the US GHS format.

Date Prepared: 10/17/2016

Key or legend to abbreviations and acronyms used in the safety data sheet

- C Ceiling limit
- ST STEL - 15-minute TWA exposure that should not be exceeded at any time during a workday
- STEL Short-term exposure limit
- TWA 8-hour, time-weighted average
- ACGIH American Conference of Governmental Industrial Hygienists
- OSHA Occupational Safety and Health Administration
- NTP National Toxicology Program
- IARC International Agency for Research on Cancer
- NIOSH National Institute for Occupational Safety and Health

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. Such information is only given as a guidance to help the user handle, use, process, store, transport, dispose, and release the product in satisfactory safety conditions and is not to be considered as a warranty or quality specification. It should be used in conjunction with technical sheets but do not replace them. Thus, the information only relates to the designated specific product and may not be applicable if such product is used in combination with other materials or in any other manufacturing process, unless otherwise specifically indicated. It does not release the user from ensuring he is in conformity with all regulations linked to its activity.

SIGMA-ALDRICH

sigma-aldrich.com

SAFETY DATA SHEETVersion 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 sheetCompany : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USATelephone : +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 ₄ N 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
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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 Confirmed animal carcinogen with unknown relevance to humans Danger of cutaneous absorption		
		TWA	0.01 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Upper Respiratory Tract cancer Confirmed animal carcinogen with unknown relevance to humans Danger of cutaneous absorption		
		TWA	1.000000 ppm 1.300000 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		Skin designation The value in mg/m3 is approximate.		
		C	0.030000 ppm 0.040000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential Occupational Carcinogen See Appendix A 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 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) 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 carcinogen The 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
(Directive 67/548/EEC, Annex V, C.3.)

Toxicity to bacteria Respiration inhibition EC50 - Sludge Treatment - 5.5 mg/l - 3 h
(OECD Test Guideline 209)

12.2 Persistence and degradability

Biodegradability Biotic/Aerobic - Exposure time 20 d
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

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

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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



FOR ANY EMERGENCY, 24 HOURS / 7 DAYS, CALL:	1-800-654-6911 (OUTSIDE USA: 1-423-780-2970)
FOR ALL TRANSPORTATION ACCIDENTS, CALL CHEMTREC®:	1-800-424-9300 (OUTSIDE USA: 1-703-527-3887)
FOR ALL SDS QUESTIONS & REQUESTS, CALL:	1-800-511-MSDS (OUTSIDE USA: 1-423-780-2347)

PRODUCT NAME: **MONOMETHYLHYDRAZINE**

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Arch Chemicals, Inc. 1200 Bluegrass Lakes Parkway Alpharetta, GA 30004 United States of America	REVISION DATE:	06/02/2015
	SUPERCEDES:	
	MSDS Number:	000000017053
	SYNONYMS:	
	CHEMICAL FAMILY:	None
	DESCRIPTION / USE	None established
	FORMULA:	None established

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids	:	Category 2
Acute toxicity (Oral)	:	Category 2
Acute toxicity (Inhalation)	:	Category 1
Acute toxicity (Dermal)	:	Category 2
Skin corrosion	:	Category 1B
Carcinogenicity	:	Category 1B

GHS Label element

Hazard pictograms	:	
Signal word	:	Danger
Hazard statements	:	H225 Highly flammable liquid and vapour. H300 + H310 + H330 Fatal if swallowed, in contact with skin or if



**Arch
Chemicals,
Inc.**

SAFETY DATA SHEET

inhaled
H314 Causes severe skin burns and eye damage.
H350 May cause cancer.

Precautionary statements : **Prevention:**
 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.
 P262 Do not get in eyes, on skin, or on clothing.
 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.
 P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
 P284 Wear respiratory protection.
Response:
 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): Take off immediately all contaminated clothing. Rinse skin with water/shower.
 P304 + P340 + P310 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or doctor/ physician.
 P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
 P308 + P313 IF exposed or concerned: Get medical advice/ attention.
 P362 Take off contaminated clothing and wash before reuse.
 P370 + P378 In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
Storage:
 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.
Disposal:
 P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards



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None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

<u>CAS OR CHEMICAL NAME</u>	<u>CAS #</u>	<u>% RANGE</u>
Hydrazine, methyl-	60-34-4	>= 90 - <= 100

SECTION 4. FIRST AID MEASURES

Inhalation:	Move to fresh air. Call a physician immediately. If breathing is irregular or stopped, administer artificial respiration.
Skin Contact:	After contact with skin, wash immediately with plenty of soap and water. Take off all contaminated clothing immediately. If skin irritation persists, call a physician.
Eye Contact:	Immediately flush eye(s) with plenty of water. Call a physician immediately.
Ingestion:	Immediately give plenty of water (if possible charcoal slurry). Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Take victim immediately to hospital.

SECTION 5. FIREFIGHTING MEASURES

Flammability Summary (OSHA): This material is not regulated as a hazardous material

Flammable Properties

Flash Point:	21 °C open cup
Fire / Explosion Hazards:	Heating or fire can release toxic gas.
Extinguishing Media:	Dry powder Water spray Foam
Fire Fighting Instructions:	Use water spray to cool unopened containers.
Upper Flammable / Explosive Limit, % in air:	98 %(V)
Lower Flammable / Explosive Limit, % in air:	2.5 %(V)

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal Protection for Emergency Situations: Use respirator when performing operations involving potential exposure to vapour of the product.

Spill Mitigation Procedures

None established



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SECTION 7. HANDLING AND STORAGE

Handling: Provide sufficient air exchange and/or exhaust in work rooms. In case of insufficient ventilation, wear suitable respiratory equipment. Avoid contact with skin and eyes.

Empty Container Warning: Dispose of as unused product.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective Equipment for Routine Use of Product

Respiratory Protection : In the case of vapour formation use a respirator with an approved filter.

Eye Protection: Tightly fitting safety goggles

Protective Clothing Type: Choose body protection according to the amount and concentration of the dangerous substance at the work place., No special protective equipment required.

Components with workplace control parameters

Components (CAS-No.)	Value	Control parameters	Basis (Update)
Hydrazine, methyl- (60-34-4)	TWA	0.01 ppm	ACGIH (02 2014)
		Dermal absorption possible	ACGIH (02 2014)

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State: liquid

Form: No data.

Color: colourless

Odor: Amine

Molecular Weight: None established

pH : 11 - 11.5

Boiling Point: 77 F (25 °C)
189.5 F (87.5 °C)

Freezing point/range: -62.3 F (-52.4 °C)

Vapor Pressure:

Vapor Density:

Viscosity:

Solubility in Water: Completely miscible



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Inc.**

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Partition coefficient n-octanol/water:
Evaporation Rate:
Oxidizing: None established
Volatiles, % by vol.:
VOC Content 97 % This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCM I Intermediate or Final VOC's (40 CFR 60.489). This product does not contain any VOC exemptions listed under the U.S. Clean Air Act Section 450.
HAP Content

SECTION 10. STABILITY AND REACTIVITY

Stability and Reactivity Summary: May become unstable at elevated temperatures and/or pressure. Direct exposure to ultraviolet radiation causes slow decomposition. Not sensitive to mechanical shock.
Conditions to Avoid: Product is sensitive to electrical static discharge., Contact with incompatible materials will result in immediate ignition., Avoid contact with organic materials., Temperatures above the flash point in combination with sparks, open flames, or other sources of ignition.
Decomposition Temperature: No data

SECTION 11. TOXICOLOGICAL INFORMATION

Product Animal Toxicity

Oral LD50 value: LD50 32 mg/kg Rat
Dermal LD50 value: LD50 93 mg/kg Rabbit
Inhalation LC50 value: LC50 4 h 74 ppm Rat

Skin Irritation: This material is expected to be corrosive.
Eye Irritation: This material is expected to cause irreversible effects to the cornea with impairment of vision or corrosion to the eyes.
Skin Sensitization: May cause allergic skin sensitization in some individuals.

Subchronic / Chronic Toxicity:

Reproductive and Developmental Toxicity:

Mutagenicity:

Carcinogenicity:

SECTION 12. ECOLOGICAL INFORMATION

Overview: Moderately toxic to fish and other aquatic organisms.

MONOMETHYLHYDRAZINE

REVISION DATE : 06/02/2015

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SECTION 13. DISPOSAL CONSIDERATIONS

CARE MUST BE TAKEN TO PREVENT ENVIRONMENTAL CONTAMINATION FROM THE USE OF THE MATERIAL. THE USER OF THE MATERIAL HAS THE RESPONSIBILITY TO DISPOSE OF UNUSED MATERIAL, RESIDUES AND CONTAINERS IN COMPLIANCE WITH ALL RELEVANT LOCAL, STATE AND FEDERAL LAWS AND REGULATIONS REGARDING TREATMENT, STORAGE AND DISPOSAL FOR HAZARDOUS AND NONHAZARDOUS WASTES.

Waste Disposal Summary : Spent or discarded material is a hazardous waste.

Disposal Methods : Dispose of by incineration following Federal, State, Local, or Provincial regulations.

Potential US EPA Waste Codes : D001, P068

SECTION 14. TRANSPORT INFORMATION

DOT

UN number : 1244
 Description of the goods : Methylhydrazine
 Class : 6.1
 Packing group : I
 Labels : 6.1 (3, 8)
 Emergency Response : 131
 Guidebook Number

TDG

UN number : 1244
 Description of the goods : METHYLHYDRAZINE
 Class : 6.1
 Packing group : I
 Labels : 6.1 (3, 8)

IATA

UN number : 1244
 Class : 6.1
 Not permitted for transport

IMDG-CODE

UN number : 1244



Description of the goods : METHYLHYDRAZINE
 Class : 6.1
 Packing group : I
 Labels : 6.1 (3, 8)
 EmS Number 1 : F-E
 EmS Number 2 : S-C
 Marine pollutant : yes

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Methylhydrazine	60-34-4	10	10

SARA 304 Extremely Hazardous Substances Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Methylhydrazine	60-34-4	10	10

SARA 302

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

Methylhydrazine 60-34-4 99 %

SARA 313

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

Methylhydrazine 60-34-4 99 %

Clean Air Act

The following chemical(s) are listed as HAP under the U.S. Clean Air Act, Section 12 (40 CFR 61):

Methylhydrazine 60-34-4 99 %

The following chemical(s) are listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F):

Methylhydrazine 60-34-4 99 %



This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCM Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.

This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

US State Regulations

Massachusetts Right To Know

Methylhydrazine	60-34-4	90 - 100 %
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Pennsylvania Right To Know

Methylhydrazine	60-34-4	90 - 100 %
-----------------	---------	------------

New Jersey Right To Know

Methylhydrazine	60-34-4	90 - 100 %
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California Prop 65

WARNING! This product contains a chemical known to the State of California to cause cancer.

Methylhydrazine	60-34-4
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SECTION 16. OTHER INFORMATION

Major References : Available upon request.

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS MSDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. THIS INFORMATION HAS BEEN PREPARED FOR THE GUIDANCE OF PLANT ENGINEERING, OPERATIONS AND MANAGEMENT AND FOR PERSONS WORKING WITH OR HANDLING THIS PRODUCT. ARCH CHEMICALS BELIEVES THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF THE DATE OF PUBLICATION BUT, MAKES NO WARRANTY THAT IT IS. ADDITIONALLY, IF THIS MSDS IS MORE THAN THREE YEARS OLD, YOU SHOULD CONTACT ARCH CHEMICALS MSDS CONTROL AT THE PHONE NUMBER ON THE FRONT PAGE TO MAKE CERTAIN THAT THIS DOCUMENT IS CURRENT. .



Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

Safety Data Sheet

according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

Date of issue: 15 May 2015 Supersedes: 12/12/2012 Version: 1.0

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Substance
 Trade name : Dinitrogen Tetroxide, Mixed Oxides of Nitrogen
 Chemical name : dinitrogen tetroxide
 CAS No : 10544-72-6
 Formula : N₂O₄
 Other means of identification : Nitrogen Oxide, Nitrogen Dioxide, Nitrogen Peroxide, Nitrogen Tetroxide, Dinitrogen Tetroxide, Tetra Oxide, NTO

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

Use of the substance/mixture : Fuel Oxidizer-Propellant
 Sterilizing agent (poison inhalation hazard)-pharmaceutical

1.3. Details of the supplier of the safety data sheet

CF Industries Sales, LLC
 4 Parkway North, Suite 400
 Deerfield, Illinois 60015-2590 - United States
 T 1 (847) 405-2400

1.4. Emergency telephone number

Emergency number : CHEMTREC (U.S.): 1-800-424-9300

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

GHS-US classification

Ox. Gas 1
 Liquefied gas
 Acute Tox. 1 (Inhalation:gas)
 Skin Corr. 1B
 Eye Dam. 1
 Muta. 2
 STOT SE 3 (respiratory tract irritation)
 STOT RE 1

2.2. Label elements

GHS-US labelling

Hazard pictograms (GHS-US) :



Signal word (GHS-US) :

Danger

Hazard statements (GHS-US) :

May cause or intensify fire; oxidizer
 Contains gas under pressure; may explode if heated
 Causes severe skin burns and eye damage
 Fatal if inhaled
 May cause respiratory irritation
 Suspected of causing genetic defects
 Causes damage to organs through prolonged or repeated exposure

Precautionary statements (GHS-US) :

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Keep/Store away from clothing, combustible materials
 Keep reduction valves/valves and fittings free from oil and grease
 Do not breathe gas, mist, vapors
 Wash hands thoroughly after handling
 Do not eat, drink or smoke when using this product
 Use only outdoors or in a well-ventilated area

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

Safety Data Sheet

according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

Wear eye protection, face protection, protective clothing, protective gloves
 [In case of inadequate ventilation] wear respiratory protection
 If swallowed: rinse mouth. Do NOT induce vomiting
 If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
 If inhaled: Remove person to fresh air and keep comfortable for breathing
 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
 If exposed or concerned: Get medical advice/attention
 Immediately call a POISON CENTER
 Get medical advice/attention if you feel unwell
 Wash contaminated clothing before reuse
 In case of fire: stop leak if safe to do so
 Store in a well-ventilated place. Keep container tightly closed
 Store locked up
 Store in a well-ventilated place
 Dispose of contents/container to comply with applicable local, national and international regulation.

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS-US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substance

Name : Dinitrogen Tetroxide, Mixed Oxides of Nitrogen
 Synonyms : N₂O₄; NO₂; Nitrogen peroxide; Nitrogen tetroxide
 CAS No : 10544-72-6

Name	Product identifier	%	GHS-US classification
dinitrogen tetroxide	(CAS No) 10544-72-6	>= 99.5	Ox. Gas 1 Liquefied gas Acute Tox. 1 (Inhalation) Skin Corr. 1B Eye Dam. 1 STOT SE 3 (respiratory tract irritation) STOT RE 1
nitrogen dioxide	(CAS No) 10102-44-0	< 0.5	Ox. Gas 1 Liquefied gas Acute Tox. 1 (Inhalation:gas) Skin Corr. 1B Eye Dam. 1 Muta. 2 STOT SE 3 (respiratory tract irritation)

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).

First-aid measures after inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/physician. If exposure symptoms persist, seek medical attention. If not breathing, give artificial respiration by trained personnel.

First-aid measures after skin contact : Remove/Take off immediately all contaminated clothing. Immediately flush skin with plenty of water for at least 15 minutes. Wash skin thoroughly with mild soap and water. Immediately call a POISON CENTER or doctor/physician. If skin irritation persists, seek medical attention.

First-aid measures after eye contact : Rinse immediately with plenty of water for 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/physician. Seek medical attention if excessive tearing, redness, or pain persists.

First-aid measures after ingestion : Rinse mouth. Do NOT induce vomiting. Immediately call a POISON CENTER or doctor/physician.

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

Safety Data Sheet

according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries	: Causes severe skin burns and eye damage. Suspected of causing genetic defects. Causes damage to organs through prolonged or repeated exposure. A single acute exposure may cause death. The vapor is highly irritating to the upper respiratory tract and lungs. Medical conditions aggravated by exposure: Chronic respiratory or skin disease.
Symptoms/injuries after inhalation	: Fatal if inhaled. May cause respiratory irritation. Symptoms may be delayed. Repeated inhalation may result in bronchitis or emphysema.
Symptoms/injuries after skin contact	: The liquid is highly corrosive to the skin and may cause chemical burns.
Symptoms/injuries after eye contact	: The vapor is extremely irritating to the eyes and is capable of causing pain and severe conjunctivitis.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically. Pneumonitis should be anticipated after inhalation or ingestion. If severe exposure is suspected, observe for 48-72 hours for delayed pulmonary edema. Nitrogen dioxide may exert an allergic response on the bronchial epithelium and may predispose the respiratory tract to viral infections (Pathmanathan et al. 2003; Frampton et al. 2002). NO₂ exposure may reduce bronchociliar activity (Helleday et al. 1995). Even at low exposures, NO₂ may increase asthmatic exacerbations following respiratory infections (Linaker et al. 2000).

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media	: Use extinguishing media appropriate for surrounding fire. Water fog. Water spray. Runoff of less volatile nitrogen oxides may contain highly corrosive nitric acid.
Unsuitable extinguishing media	: Do not use a heavy water stream. Water contact with liquid will create large amounts of toxic vapors. Do not add water to an enclosed vessel. Water addition in a contained vessel may rapidly increase pressure due to vapor generation.

5.2. Special hazards arising from the substance or mixture

Fire hazard	: Not flammable. May intensify fire; strong oxidizer. Contact with readily oxidizable organic material may cause ignition/fire. Hygroscopic with hydrazine.
Explosion hazard	: Heating may cause expansion or decomposition leading to violent rupture of containers.
Reactivity	: On burning: release of toxic and corrosive gases/vapors (nitrous vapors, nitric acid). In presence of moisture, the material is corrosive to aluminum, zinc and tin producing highly flammable hydrogen gas. Reacts vigorously with alkali metals and incompatible materials.

5.3. Advice for firefighters

Firefighting instructions	: Stop leak if safe to do so. Do not get water inside containers. Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire. Prevent fire-fighting water from entering environment.
Protective equipment for firefighters	: Do not enter fire area without proper protective equipment, including respiratory protection. Use self-contained breathing apparatus and chemically protective clothing suitable for nitric acid during a fire.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment	: Use personal protective equipment as required.
Emergency procedures	: Keep upwind. Evacuate unnecessary personnel.

6.1.2. For emergency responders

Protective equipment	: Equip cleanup crew with proper protection. Wear approved self-contained breathing apparatus (set on positive pressure mode).
Emergency procedures	: Consider evacuation as the first appropriate action. Ventilate area. Stop leak if safe to do so. Remove all sources of ignition. Use ventilation/water spray/fog to disperse vapors.

6.2. Environmental precautions

Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters.

6.3. Methods and material for containment and cleaning up

For containment	: Contain and/or absorb spill with inert material (sand, vermiculite or other appropriate material), then place in suitable container. Carefully, contain and neutralize with slaked lime.
Methods for cleaning up	: Collect all waste in suitable and labelled containers and dispose according to local legislation. Store away from other materials. After clean up operations, decontaminate protective gear and equipment by soaking in 5% soda ash solution for at least 24 hours. Rinse and dry.

6.4. Reference to other sections

See Heading 8. Exposure controls and personal protection.

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

Safety Data Sheet

according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

SECTION 7: Handling and storage

7.1. Precautions for safe handling

- Precautions for safe handling : Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapor. Keep reduction valves free from grease and oil. Do not breathe mist, spray, vapors. Avoid contact with eyes, skin, and clothing. Use only outdoors or in a well-ventilated area. Obtain special instructions before use. Use personal protective equipment as required. Do not handle until all safety precautions have been read and understood.
- Hygiene measures : Wash hands thoroughly after handling. Wash contaminated clothing before reuse. Do not eat, drink or smoke when using this product.

7.2. Conditions for safe storage, including any incompatibilities

- Technical measures : Comply with applicable regulations.
- Storage conditions : Store in a dry, cool and well-ventilated place. Keep container tightly closed.
- Incompatible products : Strong bases. Water. Explosions may occur on contact with ammonia, boron trichloride, carbon disulfide, cyclohexane, fluorine, formaldehyde, hydrazine, nitrobenzene, toluene, incompletely halogenated hydrocarbons, propylene, alcohols, and ozone.
- Incompatible materials : Sources of ignition. Easily oxidizable materials. Combustible materials. Aluminum and copper.
- Storage area : Store in a well-ventilated place.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

nitrogen dioxide (10102-44-0)		
USA ACGIH	ACGIH TWA (ppm)	0.2 ppm
USA IDLH	NIOSH IDLH (ppm)	20 ppm
USA NIOSH	NIOSH REL STEL (mg/m ³)	1.8 mg/m ³
USA NIOSH	NIOSH REL STEL (ppm)	1 ppm

nitrogen monoxide (10102-43-9)		
USA ACGIH	ACGIH TWA (ppm)	25 ppm
USA IDLH	NIOSH IDLH (ppm)	100 ppm
USA NIOSH	NIOSH REL TWA (mg/m ³)	30 mg/m ³
USA NIOSH	NIOSH REL TWA (ppm)	25 ppm

8.2. Exposure controls

- Appropriate engineering controls : Ensure adequate ventilation. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.
- Personal protective equipment : Avoid all unnecessary exposure. Protective goggles. Gloves. Protective clothing. Face shield. Insufficient ventilation: wear respiratory protection.



- Materials for protective clothing : Wear acid-resistant protective clothing.
- Hand protection : Wear protective gloves. Chemical resistant gloves (nitrile-rubber, PVC, neoprene).
- Eye protection : Chemical goggles or face shield.
- Skin and body protection : Wear suitable protective clothing.
- Respiratory protection : If the occupational exposure limit is exceeded: Wear respiratory protection.
- Other information : Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

- Physical state : Gas (Liquefied gas)
- Appearance : Yellowish to reddish-brown gas. Reddish-brown to green liquid. Forms colorless solid.
- Molecular mass : 92.01 g/mol

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

Safety Data Sheet

according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

Color	: Reddish-brown, yellowish, green, colorless (See table below)
Odor	: Pungent;acidic
Odor threshold	: 1 - 3 ppm
pH	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Melting point	: See table
Freezing point	: See table
Boiling point	: See table
Flash point	: Not applicable
Auto-ignition temperature	: Not applicable
Decomposition temperature	: > 320°F (160°C)
Flammability (solid, gas)	: Not flammable
Vapor pressure	: See table
Relative vapor density at 20 °C	: 1.58
Relative density	: No data available
Density	: 1.38 - 1.43 g/ml
Solubility	: No data available
Log Pow	: No data available
Log Kow	: No data available
Viscosity, kinematic	: No data available
Viscosity, dynamic	: No data available
Explosive properties	: Reacts explosively between -32°C and -90°C with propene, 1-butene, isobutene, 1,3-butadiene, cyclopentadiene and 1-hexene, but 6 other unsaturated failed to react. Liquid ammonia reacts explosively with the solid at -80°C.
Oxidizing properties	: May intensify fire; oxidizer
Explosive limits	: No data available
% Volatile by Volume	: 100
Critical pressure	: 10.1 MPa

Grade	NTO	MON-1	MON-3	MON-10	MON-15	MON-25
Molecular Weight (N ₂ O ₄)	92.01	92.01	92.01	92.01	92.01	92.01
Relative Vapor Density	1.58	1.58	1.58	1.58	1.58	1.58
Color	Brown	Green	Green	Green	Green	Green
NO, %	0	1	3	10	15	25
N ₂ O ₄ + NO, %	99.5	99.5	99.5	99.5	99.5	99.5
Boiling (°F)	70	68	65	49	39	16
Freezing (°F)	12	9	5	-10	-24	-69
Vapor @77°F (psia)	17.5	18.5	20.5	30.0	40.5	76
Specific Gravity @77°F	1.431	1.429	1.423	1.407	1.397	1.380

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

On burning: release of toxic and corrosive gases/vapors (nitrous vapors, nitric acid). In presence of moisture, the material is corrosive to aluminum, zinc and tin producing highly flammable hydrogen gas. Alkali metals. Incompatible materials.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

Not established.

10.4. Conditions to avoid

Direct sunlight. Extremely high or low temperatures.

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

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10.5. Incompatible materials

Strong bases. Water. Aluminum and copper. Easily oxidizable materials. Combustible materials. Explosions may occur on contact with ammonia, boron trichloride, carbon disulfide, cyclohexane, fluorine, formaldehyde, hydrazine, nitrobenzene, toluene, incompletely halogenated hydrocarbons, propylene, alcohols, and ozone.

10.6. Hazardous decomposition products

Thermal decomposition generates : Corrosive vapors. Nitrogen oxides (NOx). Nitric acid.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Fatal if inhaled.

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)	
LC50 inhalation rat (ppm)	138 ppm (0.5 hr)

Skin corrosion/irritation : Causes severe skin burns and eye damage.

Serious eye damage/irritation : Causes serious eye damage.

Respiratory or skin sensitisation : Not classified
(Based on available data, the classification criteria are not met)

Germ cell mutagenicity : Suspected of causing genetic defects.

Carcinogenicity : Not classified
(Based on available data, the classification criteria are not met)
ACGIH: A4 Not classified as a human carcinogen

Reproductive toxicity : Not classified
(Based on available data, the classification criteria are not met)
Pig: Temporarily depressed mean daily gain (MDG) at 35 mg/kg in gilts (One generation study)

Specific target organ toxicity (single exposure) : May cause respiratory irritation.

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)	
Additional information	Exposure to 150 ppm or more (no time period given) has been reported to cause death from pulmonary edema [NRC 1979]. It has been predicted that 50% lethality would occur following exposure to 174 ppm for 1 hour.

Specific target organ toxicity (repeated exposure) : Causes damage to organs through prolonged or repeated exposure.

Aspiration hazard : Not classified
(Based on available data, the classification criteria are not met)

Potential Adverse human health effects and symptoms : Fatal if inhaled.

Symptoms/injuries after inhalation : Fatal if inhaled. May cause respiratory irritation. Symptoms may be delayed. Repeated inhalation may result in bronchitis or emphysema.

Symptoms/injuries after skin contact : The liquid is highly corrosive to the skin and may cause chemical burns.

Symptoms/injuries after eye contact : The vapor is extremely irritating to the eyes and is capable of causing pain and severe conjunctivitis.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - water : Note: Dinitrogen Tetroxide will significantly lower the pH of any water source it comes in contact with (form nitric acid)
a. Nitric acid is harmful to aquatic life in very low concentrations
b. May be dangerous if it enters water intakes. Notify operator of nearby water intakes.
c. Notify local health and wildlife officials

LCL Goldfish:.....750 ppm 5 hours*

LCL Fathead Minnow:.....1000 ppm for 7 hours*

*Information derived from Nitric Acid ecotoxicity data

12.2. Persistence and degradability

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)	
Persistence and degradability	Not established.

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

Safety Data Sheet

according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

12.3. Bioaccumulative potential

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)

Bioaccumulative potential	Not established.
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12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

Effect on ozone layer : No additional information available

Effect on the global warming : No known ecological damage caused by this product.

Other information : Avoid release to the environment.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Dispose of neutralized waste solutions and any residues in compliance with local, state, and Federal laws. EPA RQ is 10 pounds.

Ecology - waste materials : Hazardous waste due to toxicity. Avoid release to the environment.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1067 Dinitrogen tetroxide, 2.3

UN-No.(DOT) : 1067

DOT NA no. : UN1067

Proper Shipping Name (DOT) : Dinitrogen tetroxide

Department of Transportation (DOT) Hazard Classes : 2.3 - Class 2.3 - Poisonous gas 49 CFR 173.115

Hazard labels (DOT) : 2.3 - Poison gas
5.1 - Oxidizer
8 - Corrosive



Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

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DOT Special Provisions (49 CFR 172.102)	: 1 - This material is poisonous by inhalation (see 171.8 of this subchapter) in Hazard Zone A (see 173.116(a) or 173.133(a) of this subchapter), and must be described as an inhalation hazard under the provisions of this subchapter. B7 - Safety relief devices are not authorized on multi-unit tank car tanks. Openings for safety relief devices on multi-unit tank car tanks shall be plugged or blank flanged. B14 - Each bulk packaging, except a tank car or a multi-unit-tank car tank, must be insulated with an insulating material so that the overall thermal conductance at 15.5 C (60 F) is no more than 1.5333 kilojoules per hour per square meter per degree Celsius (0.075 Btu per hour per square foot per degree Fahrenheit) temperature differential. Insulating materials must not promote corrosion to steel when wet. B45 - Each tank must have a reclosing combination pressure relief device equipped with stainless steel or platinum rupture discs approved by the AAR Tank Car Committee. B46 - The detachable protective housing for the loading and unloading valves of multi-unit tank car tanks must withstand tank test pressure and must be approved by the Associate Administrator. B61 - Written procedures covering details of tank car appurtenances, dome fittings, safety devices, and marking, loading, handling, inspection, and testing practices must be approved by the Associate Administrator before any single unit tank car tank is offered for transportation. B66 - Each tank must be equipped with gas tight valve protection caps. Outage must be sufficient to prevent tanks from becoming liquid full at 55 C (130 F). Specification 110A500W tanks must be stainless steel. B67 - All valves and fittings must be protected by a securely attached cover made of metal not subject to deterioration by the lading, and all valve openings, except safety valve, must be fitted with screw plugs or caps to prevent leakage in the event of valve failure. B77 - Other packaging are authorized when approved by the Associate Administrator. T50 - When portable tank instruction T50 is referenced in Column (7) of the 172.101 Table, the applicable liquefied compressed gases are authorized to be transported in portable tanks in accordance with the requirements of 173.313 of this subchapter. TP21 - The wall thickness must not be less than 8 mm. Portable tanks must be hydraulically tested and internally inspected at intervals not exceeding 5 years.
DOT Packaging Exceptions (49 CFR 173.xxx)	: DOT SP 14333, DOT SP11580
DOT Packaging Non Bulk (49 CFR 173.xxx)	: 336
DOT Packaging Bulk (49 CFR 173.xxx)	: 314
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	: Forbidden
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	: Forbidden
DOT Vessel Stowage Location	: D - The material must be stowed "on deck only" on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers or one passenger per each 3 m of overall vessel length, but the material is prohibited on passenger vessels in which the limiting number of passengers is exceeded.
DOT Vessel Stowage Other	: 40 - Stow "clear of living quarters", 89 - Segregation same as for oxidizers, 90 - Stow "separated from" radioactive materials

Additional information

Other information : No supplementary information available.

ADR

Transport document description :

Transport by sea

UN-No. (IMDG) : 1067
 Proper Shipping Name (IMDG) : DINITROGEN TETROXIDE (NITROGEN DIOXIDE)
 Class (IMDG) : 2 - Gases

Air transport

UN-No.(IATA) : 1067
 Proper Shipping Name (IATA) : DINITROGEN TETROXIDE
 Class (IATA) : 2

SECTION 15: Regulatory information

15.1. US Federal regulations

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen

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according to the federal final rule of hazard communication revised on 2012 (HazCom 2012)

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)	
EPA TSCA Regulatory Flag	EHS (Extremely Hazardous Substances) List: Listed (EPA, 1992a)
RQ (Reportable quantity, section 304 of EPA's List of Lists)	10 lb
SARA Section 302 Threshold Planning Quantity (TPQ)	100 lb
SARA Section 313 - Emission Reporting	Dinitrogen Tetroxide does not require reporting under Section 313

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)	
Chemical Facility Anti-Terrorism Standard (CFATS)/ 6 CFR Part 27:	Dinitrogen Tetroxide is listed in Appendix A as a Chemical of Interest (COI) due to threat of theft for use as a component in a WME. Screening Threshold Quantity (STQ): 15 pounds

15.2. International regulations

No supplementary information available

15.2.2. National regulations

Dinitrogen Tetroxide, Mixed Oxides of Nitrogen (10544-72-6)
This material is considered hazardous according to the criteria of the US OSHA Hazard Communication Standard (29 CFR 1910.1200).

15.3. US State regulations

No supplementary information available

SECTION 16: Other information

Abbreviations and acronyms : ACGIH (American Conference of Government Industrial Hygienists). ATE - acute toxicity estimate. CAS - Chemical Abstracts Service. GHS - Globally Harmonised System. HCS - Hazard Communication Standard. OSHA - Occupational Safety and Health Administration. PEL- Permissible Exposure Level. STEL- Short-Term Exposure Limit . TWA- Time Weighted Average.

Date of SDS preparation : 15 May 2015 (replaces MSDS dated 12 December 2012)

Other information : None.

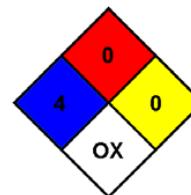
Acute Tox. 1 (Inhalation)	Acute toxicity (inhalation) Category 1
Acute Tox. 1 (Inhalation:gas)	Acute toxicity (inhalation:gas) Category 1
Eye Dam. 1	Serious eye damage/eye irritation, Category 1
Liquefied gas	Gases under pressure : Liquefied gas
Muta. 2	flammable liquids Category 1 flammable liquids Category 4
Ox. Gas 1	Oxidizing Gases, Category 1
Skin Corr. 1B	skin corrosion/irritation Category 1B
STOT RE 1	Specific target organ toxicity (repeated exposure) Category 1
STOT SE 3	Specific target organ toxicity (single exposure) Category 3

NFPA health hazard : 4 - Very short exposure could cause death or serious residual injury even though prompt medical attention was given.

NFPA fire hazard : 0 - Materials that will not burn.

NFPA reactivity : 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.

NFPA specific hazard : OX - This denotes an oxidizer, a chemical which can greatly increase the rate of combustion/fire.



SDS US (GHS HazCom 2012)

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product

CF believes the information contained herein is accurate; however, CF makes no guarantees or warranties with respect to such accuracy and assumes no liability in connection with the use of the information contained herein by any party. The provision of the information contained herein by CF is not intended to be and should not be construed as legal advice or as ensuring compliance by other parties. Judgments as to the suitability of the information contained herein for the party's own use or purposes are solely the responsibility of that party. Any party handling, transferring, transporting, storing, applying or otherwise using this product should review thoroughly all applicable laws, rules, regulations, standards and good engineering practices. Such thorough review should occur before the party handles, transfers, transports, stores, applies or otherwise uses this product.

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 ₃ H ₄ O ₃
	Diethyl Carbonate – Solvent	C ₅ H ₁₀ O ₃
	Lithium Hexafluorophosphate – Salt	LiPF ₆

Cobalt Type

Component	Material	Formula
Positive Electrode	Lithium Cobalt Oxide	LiCoO ₂
Negative Electrode	Graphite	C
Electrolyte	Ethylene Carbonate – Solvent	C ₃ H ₄ O ₃
	Diethyl Carbonate – Solvent	C ₅ H ₁₀ O ₃
	Lithium Hexafluorophosphate – 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 ₃ H ₄ O ₃
	Diethyl Carbonate – Solvent	C ₅ H ₁₀ O ₃
	Lithium Hexafluorophosphate – Salt	LiPF ₆

Notice: The information and recommendations set forth are made in good faith and are believed to be accurate at the date of preparation. Panasonic Industrial Company makes no warranty expressed or implied.



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, 35th 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, 5th 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.

MATERIAL SAFETY DATA SHEET

CR 14849



Date Issued: 02/06/2007

MSDS No: MSDSD10735/1

Date Revised: 08/28/2013

Revision No: 14

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

Product Stewardship: (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; D10724-501; D10724-505; D10735-1; D10735-2; D10735-3; D10759-1; D10783-1; D10783-1-CR10676; D10917-01; D10917-02; D10917-03; D10917-04; D10917-05; D10917-06; D10923-1; 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; D11316-DVL1; D11481-0001; D11481-0501; D11481-0503; D11481-0505; D11481-0509; D11481-0511; D11481-0513; D11481-0515; D11573-1A; D11603-1; D11603-1A

2. HAZARDS IDENTIFICATION

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, 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 entry in the solid state. Prolonged exposure to post-function

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

residues may cause nasal or respiratory irritation.

3. COMPOSITION / INFORMATION ON INGREDIENTS

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

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

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

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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.

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

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

EXPOSURE GUIDELINES

OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200)					
		EXPOSURE LIMITS			
		OSHA PEL		ACGIH TLV	
Chemical Name		ppm	mg/m ³	ppm	mg/m ³
Lead Azide	TWA	[1]	mg/m ³ [1]	[1]	mg/m ³ [1]
Zirconium	TWA		5 mg/m ³	[2]	5 mg/m ³ [2]
	STEL				10
Potassium Perchlorate	TWA	[3]	mg/m ³ [3]	[4]	mg/m ³ [4]
Footnotes: 1. as Pb 2. STEL, 10 mg/m ³ 3. mg/m ³ (total), 5 mg/m ³ (resp) for nuisance dusts 4. mg/m ³ (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.

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

MATERIAL SAFETY DATA SHEET

CR 14849



Date Issued: 02/06/2007

MSDS No: MSDSD10735/1

Date Revised: 08/28/2013

Revision No: 14

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

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

PHYSICAL STATE: Solid Product**ODOR:** No appreciable odor.

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

VAPOR PRESSURE: Not Applicable**10. STABILITY AND REACTIVITY****STABILITY:** Stable under normal conditions, but improper handling can result in accidental detonation.**POLYMERIZATION:** Will not occur.**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 (NO_x); also H₂, Cl, and K₂O. Airborne particulates, including the metals listed in Section II, may also be released.

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

11. TOXICOLOGICAL INFORMATION**CARCINOGENICITY**

MATERIAL SAFETY DATA SHEET

CR 14849



Date Issued: 02/06/2007

MSDS No: MSDSD10735/1

Date Revised: 08/28/2013

Revision No: 14

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

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.

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

MATERIAL SAFETY DATA SHEET

CR 14849



Date Issued: 02/06/2007

MSDS No: MSDSD10735/1

Date Revised: 08/28/2013

Revision No: 14

Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly**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 D11237-601 thru -604

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

PN D10523-2

EX-0103187

Proper Shipping Name: Fuzes, Detonating

Class: 1.4B

UN0257

PN D10724-501

EX2007010039

Proper Shipping Name: Fuzes, Detonating

Class: 1.4B

UN0257

PN D10724-505, D10735-3, D11316-DVL1, D11573-1, D11573-1A, D11603-1, D11603-1A

DOT-SP 8451

Proper Shipping Name: Articles, Explosive, N.O.S. (HNS)

Class: 1.4E

UN0471

Part Numbers**D10735-1, -2, D10759-1, D10783-1-CR0676, D10917-01 thru -06, D10923-1, D11237-501 thru -504, D11237-901 thru -904, D11481-0001, -0501, -0503, -0505, -0509, -0511, -0513, and -0515**

EX2007090094

Proper Shipping Name: Fuzes, Detonating

Class: 1.4B

UN0257

15. REGULATORY INFORMATION**UNITED STATES****SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

MATERIAL SAFETY DATA SHEET

CR 14849



Date Issued: 02/06/2007

MSDS No: MSDSD10735/1

Date Revised: 08/28/2013

Revision No: 14

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

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.

TSCA (TOXIC SUBSTANCE CONTROL ACT)

Chemical Name	CAS
Lead Azide	13424-46-9
Hexanitrostilbene; HNS	20062-22-0
Zirconium	7440-67-7
Potassium Perchlorate	7778-74-7

16. OTHER INFORMATION

APPROVED BY: Ensign-Bickford Aerospace & Defense Company

PREPARED BY: Ensign-Bickford Aerospace & Defense Company

REVISION SUMMARY: Revision #: 14. This MSDS replaces the July 03, 2013 MSDS. Any changes in information are as follows: In Section 1: MSDS Classification..

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.

MSDS for the NASA Explosive Bolt Assembly

Part SEG26152302-XXX

Explosive Classification 1.4D



EURENCO Bofors

SAFETY DATA SHEET

1 (5)

Issued by, department, telephone Birgitta Pettersson, XQ, 83535	Date of revision 2008-02-22	Edition number 6	This edition replace 2004-09-02 ed. 5
Product denomination Hexanitrostilbene, NSE812			

1 PRODUCT IDENTIFICATION AND NAME OF THE COMPANY

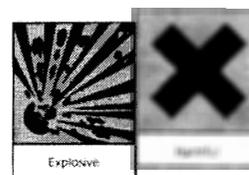
Product name Hexanitrostilbene, NSE812
 Application Explosive
 Manufacturer EURENCO Bofors AB
 SE-691 86 KARLSKOGA
 Tel: 0586-83050 Int. +46-568-83050
 Fax: 0586-83310 Int. +46-586-83310
 Emergency telephone number 0586-832 00, ERC +46-0(8)-33 70 43

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

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.

JSC MSDS # 44678

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 direct contact, such as protective gloves and clothes.

Issued by, department, telephone Birgitta Pettersson, XQ, 83535	Date of revision 2008-02-22	Edition number 6	This edition replace 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 fom	Crystalline powder
Colour	Yellow
Odour	Odourless
Explosion properties	Explosive

Issued by, department, telephone Birgitta Pettersson, XQ, 83535	Date of revision 2008-02-22	Edition number 6	This edition replace 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 rat	>5000 mg/kg Ames test: Positive

Issued by, department, telephone Birgitta Pettersson, XQ, 83535	Date of revision 2008-02-22	Edition number 6	This edition replace 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

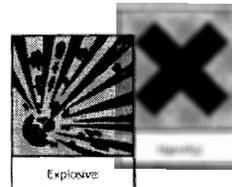
14 TRANSPORT INFORMATION

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: P _v TT 157/06

Issued by, department, telephone Birgitta Pettersson, XQ, 83535	Date of revision 2008-02-22	Edition number 6	This edition replace 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.
R20/21/22, Harmful by inhalation, in contact with skin and if swallowed.

Safety phrases S16, Keep away from sources of ignition – No smoking.
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)
Ordinance about flammable substance and explosive product. (Sweden)
Flammables and Explosives Department instruction about Permit regarding transfer of explosives.

Input product in EINICS Yes except Hexanitrobibenzyl

Other legislation Safety adviser for dangerous goods.
Law about transport of dangerous goods.
Law and ordinance about manufacturing and sell of war material.

16 OTHER INFORMATION

R-pharse from point 2 R2, Risk of explosion by chock, friction, fire or other sources of ignition.
R20/21/22, Harmful by inhalation, in contact with skin and if swallowed.

Training for handling Yes.

References CAMBREX KARLSKOGA AB environment data
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.

SECTION I
Shipping/Delivery Documentation

MATERIAL SAFETY DATA SHEET

CR 12537



**Ensign-Bickford
Aerospace & Defense**

Date Issued: 03/22/2006
MSDS No: MSDSD10448/1
Date Revised: 08/13/2012
Revision No: 11

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)

MANUFACTURER

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

**24 HR. EMERGENCY TELEPHONE
NUMBERS**

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

COMMENTS: This MSDS 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; D11314-DVL1; D11379;
D11501

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

2. HAZARDS IDENTIFICATION

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.

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.

MATERIAL SAFETY DATA SHEET

CR 12537



Date Issued: 03/22/2006
MSDS No: MSDSD10448/1
Date Revised: 08/13/2012
Revision No: 11

Flexible Confined Detonating Cord Assembly (FCDCA)

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	~ 10 - 15	20062-22-0

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: 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

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

MATERIAL SAFETY DATA SHEET

CR 12537



Date Issued: 03/22/2006
 MSDS No: MSDSD10448/1
 Date Revised: 08/13/2012
 Revision No: 11

Flexible Confined Detonating Cord Assembly (FCDCA)

8. EXPOSURE CONTROLS/ PERSONAL PROTECTION

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	Freezing Point (°C)	Solubility in Water	Specific Gravity
Hexanitrostilbene; HNS	318 Under decomposition	Practically insoluble	1.74

PHYSICAL STATE: Solid Product

ODOR: Odorless.

MELTING POINT: to 316°C (601°F) HNS

SOLUBILITY IN WATER: Insoluble

10. STABILITY AND REACTIVITY

STABLE: Yes

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 monoxide and carbon dioxide.

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

11. TOXICOLOGICAL INFORMATION

MATERIAL SAFETY DATA SHEET
CR 12537



Date Issued: 03/22/2006
MSDS No: MSDSD10448/1
Date Revised: 08/13/2012
Revision No: 11

Flexible Confined Detonating Cord Assembly (FCDCA)

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.

COMMENTS: See Section 3.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: No data available.
ECOTOXICOLOGICAL INFORMATION: No data available.

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 MSDS: EPA Hazardous Waste Number D003.

14. TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)
PROPER SHIPPING NAME: FUZES, DETONATING
PRIMARY HAZARD CLASS/DIVISION: 1.4S
SECONDARY HAZARD CLASS/DIVISION: EX2006090083
UN/NA NUMBER: 0367
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

MATERIAL SAFETY DATA SHEET
CR 12537



Date Issued: 03/22/2006
MSDS No: MSDSD10448/1
Date Revised: 08/13/2012
Revision No: 11

Flexible Confined Detonating Cord Assembly (FCDCA)

Part 372.

TSCA (TOXIC SUBSTANCE CONTROL ACT)

Chemical Name	CAS
Hexanitrostilbene; HNS	20062-22-0

16. OTHER INFORMATION

APPROVED BY: Ensign-Bickford Aerospace & Defense Company

PREPARED BY: Ensign Bickford Aerospace & Defense Company

REVISION SUMMARY: Revision #: 11. This MSDS replaces the April 04, 2012 MSDS. Any changes in information are as follows: In Section 1: MSDS Classification. In Section 14: DOT Primary Hazard Class/Division.

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.

SAFETY DATA SHEET

CR 22686



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

CR 22686



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

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 (tih ₂)	< 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

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Revision No : 3

Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly

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

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 MSDS No : MSDSD11260/1
 Date Revised : 07/05/2016
 Revision No : 3

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/m ³	ppm	mg/m ³
Potassium Perchlorate	TWA	[1]	mg/m ³ [1]	[2]	mg/m ³ [2]
Zirconium	TWA		5 mg/m ³	[3]	5 mg/m ³ [3]
	STEL				10
Nitroglycerin	TWA			0.05 [4]	0.46 mg/m ³ [4]
Footnotes:					
1. mg/m ³ (total), 5 mg/m ³ (resp) for nuisance dusts					
2. mg/m ³ (total) for PNOC containing no asbestos and <1% crystalline silica					
3. STEL, 10 mg/m ³					
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

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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**

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Pressure Cartridge Assembly/NASA Standard Initiator (NSI) Assembly

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 absorption 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.

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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 (H2O=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)

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 Toxicology Program 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 Exhaust 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 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.



**Use of this Product
in the United States
is RESTRICTED**

Check all that apply:

Restricted to RESEARCH & DEVELOPMENT only

The TSCA status of this product is unknown. Contact Enterprise EHS TSCA before using in production processes.

Restricted by the vendor of this product. Contact the vendor for further information.

Nanoparticles. This product is or contains components which are engineered in a size range considered to be nanotechnology. The physical and short-term health hazards and the long-term toxicology of exposure to this and other nanomaterials has not been fully characterized. Consult your site EHS office before using this product in production or production simulation tests.

Other. _____

* * * * *

Restricted by a SIGNIFICANT NEW USE RULE (SNUR) The Toxic Substances Control Act (TSCA) requires use restrictions and/or recordkeeping for this product.

SNUR requirements are attached to this MSDS.

Contact Enterprise EHS TSCA for SNUR requirements before any use of this product.

DuPont, Axalta Coating Systems

MSDS 120989

Material Safety Data Sheet

**DuPont™ SUVA® 134a refrigerant**

Version 2.3

Revision Date 07/30/2014

Ref. 13000000349

This SDS adheres to the standards and regulatory requirements of Canada and may not meet the regulatory requirements in other countries.

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	DuPont™ SUVA® 134a refrigerant
Tradename/Synonym	:	HFC-134a SUVA® 134a
MSDS Number	:	13000000349
Product Use	:	Refrigerant
Manufacturer	:	E.I. du Pont Canada Company P.O. Box 2200, Streetsville Mississauga, ON L5M 2H3 Canada
Product Information	:	1-800-387-2122
Medical Emergency	:	1-800-441-3637 (24 hours)
Transport Emergency	:	CHEMTREC: +1-800-424-9300 (outside the U.S. +1-703-527-3887)

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Misuse or intentional inhalation abuse may lead to death without warning. Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing. Rapid evaporation of the liquid may cause frostbite.

Potential Health Effects

Skin

1,1,1,2-Tetrafluoroethane (HFC-134a) : May cause skin irritation. May cause: Discomfort, itching, redness, or swelling..

Eyes

1,1,1,2-Tetrafluoroethane (HFC-134a) : May cause eye irritation. May cause: Tearing, redness, or discomfort..

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Inhalation

1,1,1,2-
Tetrafluoroethane
(HFC-134a)

: Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects. Other symptoms potentially related to misuse or inhalation abuse are: Anaesthetic effects, Light-headedness, dizziness, confusion, incoordination, drowsiness, or unconsciousness, irregular heartbeat with a strange sensation in the chest, heart thumping, apprehension, feeling of fainting, dizziness or weakness, Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing..

Carcinogenicity

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, or OSHA, as a carcinogen.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No.	Concentration
1,1,1,2-Tetrafluoroethane (HFC-134a)	811-97-2	100 %

SECTION 4. FIRST AID MEASURES

- Skin contact : In case of contact, immediately flush skin with plenty of water for at least 15 minutes. Take off all contaminated clothing immediately. Consult a physician. Wash contaminated clothing before re-use. Treat for frostbite if necessary by gently warming affected area.
- Eye contact : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Consult a physician if necessary.
- Inhalation : Remove from exposure, lie down. Move to fresh air. Keep patient warm and at rest. Artificial respiration and/or oxygen may be necessary. Consult a physician.
- Ingestion : Is not considered a potential route of exposure.

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- General advice : Never give anything by mouth to an unconscious person. When symptoms persist or in all cases of doubt seek medical advice.
- Notes to physician : Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, that may be used in situations of emergency life support should be used with special caution.

SECTION 5. FIREFIGHTING MEASURES

Flammable Properties

Flash point : does not flash

Ignition temperature : > 743 °C (> 1,369 °F) at 1,013 hPa

Lower explosion limit/ lower flammability limit : Method : None per ASTM E681

Upper explosion limit/ upper flammability limit : Method : None per ASTM E681

Fire and Explosion Hazard : Cylinders are equipped with pressure and temperature relief devices, but may still rupture under fire conditions. Decomposition may occur. Contact of welding or soldering torch flame with high concentrations of refrigerant can result in visible changes in the size and colour of the torch flame. This flame effect will only occur in concentrations of product well above the recommended exposure limit. Therefore stop all work and ventilate to disperse refrigerant vapors from the work area before using any open flames. This substance is not flammable in air at temperatures up to 100 deg. C (212 deg. F) at atmospheric pressure. However, mixtures of this substance with high concentrations of air at elevated pressure and/or temperature can become combustible in the presence of an ignition source. This substance can also become combustible in an oxygen enriched environment (oxygen concentrations greater than that in air). Whether a mixture containing this substance and air, or this substance in an oxygen enriched atmosphere become combustible depends on the inter-relationship of 1) the temperature 2) the pressure, and 3) the proportion of oxygen in the mixture. In general, this substance should not be allowed to exist with air above atmospheric pressure or at high temperatures; or in an oxygen enriched environment. For example this substance should NOT be mixed with air under pressure for leak testing or other purposes.

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Experimental data have also been reported which indicate combustibility of this substance in the presence of certain concentrations of chlorine.

Suitable extinguishing media : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Firefighting Instructions : In the event of fire, wear self-contained breathing apparatus. Wear neoprene gloves during cleaning up work after a fire. Cool containers/tanks with water spray. Water runoff should be contained and neutralized prior to release.

SECTION 6. ACCIDENTAL RELEASE MEASURES

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Safeguards (Personnel) : Evacuate personnel to safe areas. Ventilate area, especially low or enclosed places where heavy vapours might collect. Refer to protective measures listed in sections 7 and 8.

Spill Cleanup : Evaporates.

Accidental Release Measures : Should not be released into the environment. Self-contained breathing apparatus (SCBA) is required if a large release occurs. Avoid open flames and high temperatures.

SECTION 7. HANDLING AND STORAGE

Handling (Personnel) : Use sufficient ventilation to keep employee exposure below recommended limits. For personal protection see section 8. Handle in accordance with good industrial hygiene and safety practice.

Handling (Physical Aspects) : The product should not be mixed with air for leak testing or used with air for any other purpose above atmospheric pressure. Contact with chlorine or other strong oxidizing agents should also be avoided.

Storage : Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a

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pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems. Never attempt to lift cylinder by its cap. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Cylinders should be stored upright and firmly secured to prevent falling or being knocked over.

Separate full containers from empty containers. Keep at temperature not exceeding 52°C. Do not store near combustible materials. Avoid area where salt or other corrosive materials are present.

Storage temperature : < 52 °C (< 126 °F)

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering controls : Normal ventilation for standard manufacturing procedures is generally adequate. Local exhaust should be used when large amounts are released. Mechanical ventilation should be used in low or enclosed places. Refrigerant Concentration monitors may be necessary to determine vapor concentrations in work areas prior to use of torches or other open flames, or if employees are entering enclosed areas.

Personal protective equipment

Respiratory protection : For rescue and maintenance work in storage tanks use self-contained breathing apparatus. Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

Hand protection : Additional protection: Impervious gloves

Eye protection : Wear safety glasses with side shields. Additionally wear a face shield where the possibility exists for face contact due to splashing, spraying or airborne contact with this material.

Skin and body protection : impervious clothing

Protective measures : Self-contained breathing apparatus (SCBA) is required if a large release occurs.

Exposure Guidelines

Exposure Limit Values

1,1,1,2-Tetrafluoroethane
AEL * (DUPONT) 1,000 ppm 8 & 12 hr. TWA

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* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Form	: Liquefied gas
Color	: colourless
Odor	: slight, ether-like
Boiling point	: -26.1 °C (-15.0 °F) at 1,013 hPa
% Volatile	: 100 %
Oxidising Substance	: The product is not oxidizing.
Vapour Pressure	: 6,661 hPa at 25 °C (77 °F) : 13,190 hPa at 50 °C (122 °F)
Density	: 1.21 g/cm ³ at 25 °C (77 °F) (as liquid)
Specific gravity	: 1.208 at 25 °C (77 °F)
Water solubility	: 1.5 g/l at 25 °C (77 °F) at 1,013 hPa
Vapour density	: 3.6 at 25°C (77°F) and 1013 hPa (Air = 1.0)
Evaporation rate	: > 1 (CCL4=1.0)

SECTION 10. STABILITY AND REACTIVITY

Stability	: Stable under recommended storage conditions.
Conditions to avoid	: The product is not flammable in air under ambient conditions of temperature and pressure. When pressurised with air or oxygen, the mixture may become flammable. Certain mixtures of HCFCs or HFCs with chlorine may become flammable or reactive under certain conditions.
Incompatibility	: Alkali metals Alkaline earth metals, Powdered metals, Powdered metal salts
Hazardous decomposition products	: Decomposition products are hazardous., This material can be decomposed by high temperatures (open flames, glowing metal surfaces, etc.) forming hydrofluoric acid and possibly carbonyl fluoride., These materials are toxic and irritating., Avoid contact with decomposition products
Hazardous reactions	: Polymerization will not occur.

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SECTION 11. TOXICOLOGICAL INFORMATION

1,1,1,2-Tetrafluoroethane (HFC-134a)

- | | | |
|--|---|---|
| Inhalation 4 h LC50 | : | > 567000 ppm , Rat |
| Inhalation No Observed Adverse Effect Concentration | : | 40000 ppm , Dog
Cardiac sensitization |
| Inhalation Low Observed Adverse Effect Concentration (LOAEC) | : | 80000 ppm , Dog
Cardiac sensitization |
| Skin irritation | : | No skin irritation, Rabbit |
| Eye irritation | : | No eye irritation, Rabbit |
| Skin sensitization | : | Does not cause skin sensitisation., Guinea pig
Does not cause respiratory sensitisation., Rat |
| Repeated dose toxicity | : | Inhalation
Rat

No toxicologically significant effects were found. |
| Carcinogenicity | : | Not classifiable as a human carcinogen.
Overall weight of evidence indicates that the substance is not carcinogenic. |
| Mutagenicity | : | Animal testing did not show any mutagenic effects.
Tests on bacterial or mammalian cell cultures did not show mutagenic effects. |
| Reproductive toxicity | : | No toxicity to reproduction
No effects on or via lactation
Animal testing showed no reproductive toxicity. |
| Teratogenicity | : | Animal testing showed no developmental toxicity. |
| Further information | : | Cardiac sensitisation threshold limit : 334000 mg/m3 |

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SECTION 12. ECOLOGICAL INFORMATION

Aquatic Toxicity

1,1,1,2-Tetrafluoroethane (HFC-134a)

96 h LC50 : Oncorhynchus mykiss (rainbow trout) 450 mg/l

96 h ErC50 : Algae 142 mg/l
Information given is based on data obtained from similar substances.72 h NOEC : Pseudokirchneriella subcapitata (green algae) 13.2 mg/l
Information given is based on data obtained from similar substances.

48 h EC50 : Daphnia magna (Water flea) 980 mg/l

SECTION 13. DISPOSAL CONSIDERATIONS

Waste Disposal : Can be used after re-conditioning. Recover by distillation or remove to a permitted waste disposal facility. Comply with applicable Federal, State/Provincial and Local Regulations.

Environmental Hazards : Empty pressure vessels should be returned to the supplier.

SECTION 14. TRANSPORT INFORMATION

TDG_ROAD UN number : 3159

Proper shipping name : 1,1,1,2-TETRAFLUOROETHANE

Class : 2.2

Labelling No. : 2.2

TDG_RAIL UN number : 3159

Proper shipping name : 1,1,1,2-TETRAFLUOROETHANE

Class : 2.2

Labelling No. : 2.2

IATA_C UN number : 3159

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	Proper shipping name	:	1,1,1,2-Tetrafluoroethane
	Class	:	2.2
	Labelling No.	:	2.2
IMDG	UN number	:	3159
	Proper shipping name	:	1,1,1,2-TETRAFLUOROETHANE
	Class	:	2.2
	Labelling No.	:	2.2

SECTION 15. REGULATORY INFORMATION

DSL (CA) Status : On the inventory, or in compliance with the inventory

WHMIS Classification : A - Compressed Gas

Remarks : This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

SECTION 16. OTHER INFORMATION

MSDS preparation date : 07/30/2014

SUVA is a registered trademark of E. I. du Pont de Nemours and Company

® DuPont's registered trademark

Before use read DuPont's safety information.

For further information contact the local DuPont office or DuPont's nominated distributors.

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 given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Significant change from previous version is denoted with a double bar.

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SAFETY DATA SHEET

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 259 North Radnor-Chester Road Suite 100 Radnor, PA 19087-5283 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 GASES UNDER PRESSURE - Liquefied gas ACUTE TOXICITY (inhalation) - Category 4 SKIN CORROSION/IRRITATION - Category 1 SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1 AQUATIC HAZARD (ACUTE) - Category 1

GHS label elements

Hazard pictograms



Signal word

: Danger

Hazard statements

: Flammable gas.
Contains gas under pressure; may explode if heated.
May cause frostbite.
May form explosive mixtures in Air.
Harmful if inhaled.
Causes severe skin burns and eye damage.
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	<p>ACGIH TLV (United States, 3/2015). STEL: 24 mg/m³ 15 minutes. STEL: 35 ppm 15 minutes. TWA: 17 mg/m³ 8 hours. TWA: 25 ppm 8 hours.</p> <p>NIOSH REL (United States, 10/2013). STEL: 27 mg/m³ 15 minutes. STEL: 35 ppm 15 minutes. TWA: 18 mg/m³ 10 hours. TWA: 25 ppm 10 hours.</p> <p>OSHA PEL (United States, 2/2013). TWA: 35 mg/m³ 8 hours. TWA: 50 ppm 8 hours.</p> <p>OSHA PEL 1989 (United States, 3/1989). STEL: 27 mg/m³ 15 minutes. STEL: 35 ppm 15 minutes.</p>

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 (ft³/lb)** : 22.7273
- Gas Density (lb/ft³)** : 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.

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 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. Reportable quantity 100 lbs / 45.4 kg 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). The marine pollutant mark is not required when transported by road or rail. Explosive Limit and Limited Quantity Index 0 ERAP Index 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. Passenger and Cargo Aircraft Quantity limitation: 0 Forbidden Cargo Aircraft Only Quantity limitation: Forbidden

Section 14. Transport information

	to the RQ (reportable quantity) transportation requirements. Limited quantity Yes. Packaging instruction Passenger aircraft Quantity limitation: Forbidden. Cargo aircraft Quantity limitation: Forbidden. Special provisions 13,T50	Passenger Carrying Ship Index Forbidden Passenger Carrying Road or Rail Index Forbidden Special provisions			
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“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		SARA 304 RQ	
			(lbs)	(gallons)	(lbs)	(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
 BCF = Bioconcentration Factor
 GHS = Globally Harmonized System of Classification and Labelling of Chemicals
 IATA = International Air Transport Association
 IBC = Intermediate Bulk Container
 IMDG = International Maritime Dangerous Goods
 LogPow = logarithm of the octanol/water partition coefficient
 MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
 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.



Antifreeze Mix (Ethylene Glycol)

The Boeing Company

Chemwatch Hazard Alert Code: 2

Version No: 1.1

Issue Date: 07/29/2016

Safety Data Sheet according to OSHA HazCom Standard (2012) requirements

Print Date: 07/29/2016

Initial Date: 07/29/2016

S.GHS.USA.EN

SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

Product Identifier

Product name	Antifreeze Mix (Ethylene Glycol)
Synonyms	90197, Ethylene Glycol

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

Relevant identified uses	Antifreeze
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Details of the supplier of the safety data sheet

Registered company name	The Boeing Company
Address	PO Box 3707, Seattle 98124-2207 WA United States
Telephone	(425) 237-1903
Fax	(425) 965-8469
Website	Not Available
Email	msds@boeing.com

Emergency telephone number

Association / Organisation	Chemtrec
Emergency telephone numbers	800-424-9300
Other emergency telephone numbers	Not Available

SECTION 2 HAZARDS IDENTIFICATION

Classification of the substance or mixture



Note: The hazard category numbers found in GHS classification in section 2 of this SDSs are NOT to be used to fill in the NFPA 704 diamond.

Blue = Health

Red = Fire

Yellow = Reactivity

White = Special (Oxidizer or water reactive substances)

GHS Classification	This product does not meet the criteria for GHS classification under OSHA HazCom 2012
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Label elements

GHS label elements	
SIGNAL WORD	NOT APPLICABLE

Antifreeze Mix (Ethylene Glycol)

Hazard statement(s)

Not Applicable

Precautionary statement(s) Prevention**Precautionary statement(s) Response****Precautionary statement(s) Storage****Precautionary statement(s) Disposal****SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS**

CAS No	%[weight]	Name
107-21-1	25-75	<u>ethylene glycol</u>
7732-18-5	25-75	<u>water</u>

SECTION 4 FIRST AID MEASURES**Description of first aid measures**

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> ▶ Wash out immediately with fresh running water. ▶ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. ▶ Seek medical attention without delay; if pain persists or recurs seek medical attention. ▶ Remove contact lenses if easy to do so.
Skin Contact	<p>If skin or hair contact occurs:</p> <ul style="list-style-type: none"> ▶ Flush skin and hair with running water (and soap if available). ▶ Seek medical attention in event of irritation.
Inhalation	<ul style="list-style-type: none"> ▶ If fumes, aerosols or combustion products are inhaled remove from contaminated area. ▶ Other measures are usually unnecessary.
Ingestion	<ul style="list-style-type: none"> ▶ IF SWALLOWED, REFER FOR MEDICAL ATTENTION, WHERE POSSIBLE, WITHOUT DELAY. ▶ For advice, contact a Poisons Information Centre or a doctor. ▶ Urgent hospital treatment is likely to be needed. ▶ In the mean time, qualified first-aid personnel should treat the patient following observation and employing supportive measures as indicated by the patient's condition. ▶ If the services of a medical officer or medical doctor are readily available, the patient should be placed in his/her care and a copy of the SDS should be provided. Further action will be the responsibility of the medical specialist. ▶ If medical attention is not available on the worksite or surroundings send the patient to a hospital together with a copy of the SDS.

SECTION 5 FIREFIGHTING MEASURES**Extinguishing media**

	<p>The product contains a substantial proportion of water, therefore there are no restrictions on the type of extinguishing media which may be used. Choice of extinguishing media should take into account surrounding areas. Though the material is non-combustible, evaporation of water from the mixture, caused by the heat of nearby fire, may produce floating layers of combustible substances.</p> <p>In such an event consider:</p> <ul style="list-style-type: none"> ▶ foam.
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Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.
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Advice for firefighters

Antifreeze Mix (Ethylene Glycol)

Fire Fighting	<ul style="list-style-type: none"> ▶ Alert Fire Brigade and tell them location and nature of hazard. ▶ Wear full body protective clothing with breathing apparatus. ▶ Prevent, by any means available, spillage from entering drains or water course. ▶ Use water delivered as a fine spray to control fire and cool adjacent area.
Fire/Explosion Hazard	<ul style="list-style-type: none"> ▶ Combustible. ▶ Slight fire hazard when exposed to heat or flame. ▶ Heating may cause expansion or decomposition leading to violent rupture of containers. ▶ On combustion, may emit toxic fumes of carbon monoxide (CO).

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Minor Spills	<p>Slippery when spilt.</p> <ul style="list-style-type: none"> ▶ Remove all ignition sources. ▶ Clean up all spills immediately. ▶ Avoid breathing vapours and contact with skin and eyes.
Major Spills	<p>Slippery when spilt. Moderate hazard.</p> <ul style="list-style-type: none"> ▶ Clear area of personnel and move upwind. ▶ Alert Fire Brigade and tell them location and nature of hazard.
Personal Protective Equipment advice is contained in Section 8 of the SDS.	

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	<ul style="list-style-type: none"> ▶ DO NOT allow clothing wet with material to stay in contact with skin ▶ Avoid all personal contact, including inhalation. ▶ Wear protective clothing when risk of exposure occurs. ▶ Use in a well-ventilated area. ▶ Prevent concentration in hollows and sumps.
Other information	<ul style="list-style-type: none"> ▶ Material is hygroscopic, i.e. absorbs moisture from the air. Keep containers well sealed in storage. ▶ Store in original containers. ▶ Keep containers securely sealed.

Conditions for safe storage, including any incompatibilities

Suitable container	<ul style="list-style-type: none"> ▶ DO NOT use aluminium or galvanised containers ▶ Metal can or drum ▶ Packaging as recommended by manufacturer. ▶ Check all containers are clearly labelled and free from leaks.
Storage incompatibility	<ul style="list-style-type: none"> ▶ Glycols and their ethers undergo violent decomposition in contact with 70% perchloric acid. This seems likely to involve formation of the glycol perchlorate esters (after scission of ethers) which are explosive, those of ethylene glycol and 3-chloro-1,2-propanediol being more powerful than glyceryl nitrate, and the former so sensitive that it explodes on addition of water. <p>Alcohols</p> <ul style="list-style-type: none"> ▶ are incompatible with strong acids, acid chlorides, acid anhydrides, oxidising and reducing agents. ▶ reacts, possibly violently, with alkaline metals and alkaline earth metals to produce hydrogen ▶ react with strong acids, strong caustics, aliphatic amines, isocyanates, acetaldehyde, benzoyl peroxide, chromic acid, chromium oxide, dialkylzincs, dichlorine oxide, ethylene oxide, hypochlorous acid, isopropyl chlorocarbonate, lithium tetrahydroaluminate, nitrogen dioxide, pentafluoroguanidine, phosphorus halides, phosphorus pentasulfide, tangerine oil, triethylaluminium, triisobutylaluminium ▶ should not be heated above 49 deg C.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS (OEL)

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
US ACGIH Threshold Limit Values (TLV)	ethylene glycol	‡ Ethylene glycol	Not Available	Not Available	100 mg/m3	TLV® Basis: URT & eye irr
US NIOSH Recommended Exposure Limits (RELs)	ethylene glycol	1,2-Dihydroxyethane; 1,2-Ethanediol; Glycol; Glycol alcohol; Monoethylene glycol	Not Available	Not Available	Not Available	See Appendix D

Antifreeze Mix (Ethylene Glycol)

EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
ethylene glycol	Ethylene glycol	10 ppm	40 ppm	60 ppm

Ingredient	Original IDLH	Revised IDLH
ethylene glycol	Not Available	Not Available
water	Not Available	Not Available

Exposure controls

Appropriate engineering controls	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard 'physically' away from the worker and ventilation that strategically 'adds' and 'removes' air in the work environment.</p>
Personal protection	
Eye and face protection	<ul style="list-style-type: none"> ▶ Safety glasses with side shields ▶ Chemical goggles. ▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience.
Skin protection	See Hand protection below
Hands/feet protection	<ul style="list-style-type: none"> ▶ Wear chemical protective gloves. ▶ Wear safety footwear or safety gumboots. <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p>
Body protection	See Other protection below
Other protection	<ul style="list-style-type: none"> ▶ Overalls. ▶ Apron.
Thermal hazards	Not Available

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Not Available		
Physical state	Liquid	Relative density (Water = 1)	<1.1
Odour	Not Available	Partition coefficient n-octanol / water	Not Available
Odour threshold	Not Available	Auto-ignition temperature (°C)	Not Available
pH (as supplied)	Not Available	Decomposition temperature	Not Available
Melting point / freezing point (°C)	Not Available	Viscosity (cSt)	Not Available
Initial boiling point and boiling range (°C)	Not Available	Molecular weight (g/mol)	Not Available
Flash point (°C)	>110	Taste	Not Available
Evaporation rate	Not Available	Explosive properties	Not Available

Antifreeze Mix (Ethylene Glycol)

Flammability	Not Applicable	Oxidising properties	Not Available
Upper Explosive Limit (%)	Not Available	Surface Tension (dyn/cm or mN/m)	Not Available
Lower Explosive Limit (%)	Not Available	Volatile Component (%vol)	Not Available
Vapour pressure (kPa)	2.27	Gas group	Not Available
Solubility in water (g/L)	Miscible	pH as a solution (1%)	Not Available
Vapour density (Air = 1)	Not Available	VOC g/L	0

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	<ul style="list-style-type: none"> ▶ Unstable in the presence of incompatible materials. ▶ Product is considered stable. ▶ Hazardous polymerisation will not occur.
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	Oxides of carbon.

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	The material is not thought to produce either adverse health effects or irritation of the respiratory tract following inhalation (as classified by EC Directives using animal models). Nevertheless, adverse systemic effects have been produced following exposure of animals by at least one other route and good hygiene practice requires that exposure be kept to a minimum and that suitable control measures be used in an occupational setting.
Ingestion	Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual. If swallowed, the toxic effects of glycols (dihydric alcohols) are similar to those of alcohol, with depression of the central nervous system, nausea, vomiting, and degenerative changes in the liver and kidney. Overexposure to non-ring alcohols causes nervous system symptoms. These include headache, muscle weakness and inco-ordination, giddiness, confusion, delirium and coma.
Skin Contact	Skin contact is not thought to produce harmful health effects (as classified under EC Directives using animal models). Systemic harm, however, has been identified following exposure of animals by at least one other route and the material may still produce health damage following entry through wounds, lesions or abrasions. Most liquid alcohols appear to act as primary skin irritants in humans. Significant percutaneous absorption occurs in rabbits but not apparently in humans.
Eye	Although the liquid is not thought to be an irritant (as classified by EC Directives), direct contact with the eye may produce transient discomfort characterised by tearing or conjunctival redness (as with windburn).
Chronic	Long-term exposure to the product is not thought to produce chronic effects adverse to the health (as classified by EC Directives using animal models); nevertheless exposure by all routes should be minimised as a matter of course. Exposure to ethylene glycol over a period of several weeks may cause throat irritation, mild headache and low backache. These may worsen with increasing concentration of the substance. They may progress to a burning sensation in the throat, a burning cough, and drowsiness.

Antifreeze Mix (Ethylene Glycol)	TOXICITY	IRRITATION
	Not Available	Not Available
ethylene glycol	TOXICITY	IRRITATION
	Dermal (rabbit) LD50: 9530 mg/kgD ^[2]	Eye (rabbit): 100 mg/1h - mild
	Inhalation (rat) LC50: 50.1 mg/L/8 hr ^[2]	Eye (rabbit): 12 mg/m3/3D
	Oral (rat) LD50: 4700 mg/kgd ^[2]	Eye (rabbit): 1440mg/6h-moderate
		Eye (rabbit): 500 mg/24h - mild

Antifreeze Mix (Ethylene Glycol)

	Skin (rabbit): 555 mg(open)-mild	
water	TOXICITY	IRRITATION
	Oral (rat) LD50: >90000 mg/kg ^[2]	Not Available
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

Antifreeze Mix (Ethylene Glycol)	No significant acute toxicological data identified in literature search.
ETHYLENE GLYCOL	Ethylene glycol is quickly and extensively absorbed through the gastrointestinal tract. Limited information suggests that it is also absorbed through the respiratory tract; dermal absorption is apparently slow. Following absorption, ethylene glycol is distributed throughout the body according to total body water. In most mammalian species, including humans, ethylene glycol is initially metabolised by alcohol. [Estimated Lethal Dose (human) 100 ml; RTECS quoted by Orica] Substance is reproductive effector in rats (birth defects). Mutagenic to rat cells.
WATER	No significant acute toxicological data identified in literature search.

Acute Toxicity	<input type="checkbox"/>	Carcinogenicity	<input type="checkbox"/>
Skin Irritation/Corrosion	<input type="checkbox"/>	Reproductivity	<input type="checkbox"/>
Serious Eye Damage/Irritation	<input type="checkbox"/>	STOT - Single Exposure	<input type="checkbox"/>
Respiratory or Skin sensitisation	<input type="checkbox"/>	STOT - Repeated Exposure	<input type="checkbox"/>
Mutagenicity	<input type="checkbox"/>	Aspiration Hazard	<input type="checkbox"/>

Legend: – Data required to make classification available
 – Data available but does not fill the criteria for classification
 – Data Not Available to make classification

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

For Ethylene Glycol: Log Kow: -1.93 to -1.36; Half-life (hr) air: 24 hrs; Henry's Law Constant: 1.41, 10⁻³ or 6.08, 10⁻³ Pa.m³/mol, (depending on method of calculation); Henry's atm m³/mol: 2.3x10 atm-m/mol; Vapor Pressure: 7.9 Pa @ 20 C; BOD 5: 0.15 to 0.81, 12%; COD: 1.21 to 1.29; ThOD: 1.26; BCF: 10 to 190.
 Atmospheric Fate: In the atmosphere, ethylene glycol exists mainly in the vapor phase. It is degraded by reactions with hydroxyl radicals, (estimated half-life 24-50 hours). Direct breakdown of the substance by sunlight is not expected.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
ethylene glycol	LOW (Half-life = 24 days)	LOW (Half-life = 3.46 days)
water	LOW	LOW

Bioaccumulative potential

Ingredient	Bioaccumulation
ethylene glycol	LOW (BCF = 200)
water	LOW (LogKOW = -1.38)

Mobility in soil

Ingredient	Mobility
ethylene glycol	HIGH (KOC = 1)
water	LOW (KOC = 14.3)

SECTION 13 DISPOSAL CONSIDERATIONS

Antifreeze Mix (Ethylene Glycol)

Waste treatment methods

Product / Packaging disposal	<ul style="list-style-type: none"> ▶ Containers may still present a chemical hazard/ danger when empty. ▶ Return to supplier for reuse/ recycling if possible. <p>Otherwise:</p> <ul style="list-style-type: none"> ▶ If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use. ▶ Where possible retain label warnings and SDS and observe all notices pertaining to the product.
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SECTION 14 TRANSPORT INFORMATION

Labels Required

Marine Pollutant	NO
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Land transport (DOT): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Transport in bulk according to Annex II of MARPOL 73 / 78 and the IBC code

Source	Ingredient	Pollution Category
IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk	ethylene glycol	Y

SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

ETHYLENE GLYCOL(107-21-1) IS FOUND ON THE FOLLOWING REGULATORY LISTS

US Clean Air Act - Hazardous Air Pollutants

US EPCRA Section 313 Chemical List

US List of Lists - Consolidated List of Chemicals Subject to EPCRA,

CERCLA and Section 112(r) of the Clean Air Act

US Toxic Substances Control Act (TSCA) - Chemical Substance Inventory

WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

US Toxic Substances Control Act (TSCA) - Chemical Substance Inventory

Federal Regulations

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SECTION 311/312 HAZARD CATEGORIES

Immediate (acute) health hazard	NO
Delayed (chronic) health hazard	NO
Fire hazard	NO
Pressure hazard	NO
Reactivity hazard	NO

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (water; ethylene glycol)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y

Antifreeze Mix (Ethylene Glycol)

Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
Legend:	<i>Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)</i>

SECTION 16 OTHER INFORMATION**Other information**

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review. The information contained herein is based on the data available to Boeing and is believed to be current as of the date of this Safety Data Sheet. Boeing makes no warranty, expressed or implied, regarding the accuracy of the data. The data in this Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material.

SAFETY DATA SHEET

Airgas®

Halocarbon R-404A

Section 1. Identification

GHS product identifier : Halocarbon R-404A
Other means of identification : ASPEN R404A
Product use : Synthetic/Analytical chemistry.
Synonym : ASPEN R404A
SDS # : 007685
Supplier's details : Airgas USA, LLC and its affiliates
 259 North Radnor-Chester Road
 Suite 100
 Radnor, PA 19087-5283
 1-610-687-5253

Emergency telephone number (with hours of operation) : 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 : GASES UNDER PRESSURE - Liquefied gas

GHS label elements**Hazard pictograms****Signal word**

: Warning

Hazard statements

: Contains gas under pressure; may explode if heated.
 May cause frostbite.
 May displace oxygen and cause rapid suffocation.

Precautionary statements**General**

: Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. 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.

Prevention

: Use and store only outdoors or in a well ventilated place.

Response

: Not applicable.

Storage

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

Disposal

: Not applicable.

Hazards not otherwise classified

: In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Date of issue/*Date of revision*

: 4/29/2015.

Date of previous issue

: 11/12/2014.

Version : 0.02

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Section 3. Composition/information on ingredients

Substance/mixture : Mixture
 Other means of identification : ASPEN R404A

CAS number/other identifiers

CAS number : Not applicable.
 Product code : 007685

Ingredient name	%	CAS number
1,1,1 - trifluoroethane	52	420-46-2
Pentafluoroethane	44	354-33-6
1,1,1,2 - tetrafluoroethane	4	811-97-2

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 : 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. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. 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. Get medical attention if adverse health effects persist or are severe. 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 : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

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Section 4. First aid measures

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. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

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. In a fire or if heated, a pressure increase will occur and the container may burst or explode.

- Hazardous thermal decomposition products** : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
halogenated compounds
carbonyl halides

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.

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.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

- For non-emergency personnel** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Avoid breathing 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. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

- Small spill** : Immediately contact emergency personnel. Stop leak if without risk.
- Large spill** : Immediately contact emergency personnel. Stop leak if without risk. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

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Section 7. Handling and storage

Precautions for safe handling

- Protective measures** : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. 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.
- 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). 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

None.

- Appropriate engineering controls** : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.
- 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: safety glasses with side-shields.
- 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. 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.

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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.
- 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** : Clear. Colorless.
- Melting/freezing point** : -103°C (-153.4°F) This is based on data for the following ingredient: pentafluoroethane. Weighted average: -107.52°C (-161.5°F)
- Critical temperature** : Lowest known value: 72.4°C (162.3°F) (pentafluoroethane).
- Odor** : Slight Ethereal.
- Odor threshold** : Not available.
- pH** : Not available.
- Flash point** : Not available.
- Burning time** : Not applicable.
- Burning rate** : Not applicable.
- Evaporation rate** : (CL4 = 1) Greater than 1
- Flammability (solid, gas)** : Not available.
- Lower and upper explosive (flammable) limits** : Not available.
- Vapor pressure** : 182.1 psia at 25 deg C (77 deg F)
- Vapor density** : Highest known value: 4.2 (Air = 1) (pentafluoroethane). Weighted average: 4.14 (Air = 1)
- Gas Density (lb/ft³)** : Weighted average: 0.31
- Relative density** : Not applicable.
- Solubility** : Not available.
- Solubility in water** : Not available.
- Partition coefficient: n-octanol/water** : Not available.
- Auto-ignition temperature** : Not available.
- Decomposition temperature** : Not available.
- SADT** : Not available.
- Viscosity** : Not applicable.

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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** : No specific data.
- Incompatibility with various substances** : Not considered to be reactive according to our database.
- 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

Not available.

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.

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Section 11. Toxicological information

Potential acute health effects

- Eye contact** : No known significant effects or critical hazards.
Inhalation : Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure.
Skin contact : No known significant effects or critical hazards.
Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

- Eye contact** : No specific data.
Inhalation : No specific data.
Skin contact : No specific data.
Ingestion : No specific data.

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.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

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Section 12. Ecological information

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	UN3337	UN3337	UN3337	UN3337	UN3337
UN proper shipping name	Refrigerant gas R 404A (pentafluoroethane, 1,1, 1,2-Tetrafluoroethane)	Refrigerant gas R 404A (pentafluoroethane, 1,1, 1,2-Tetrafluoroethane)	Refrigerant gas R 404A (pentafluoroethane, 1,1, 1,2-Tetrafluoroethane)	Refrigerant gas R 404A (pentafluoroethane, 1,1, 1,2-Tetrafluoroethane)	Refrigerant gas R 404A (pentafluoroethane, 1,1, 1,2-Tetrafluoroethane)
Transport hazard class(es)	2.2 	2.2 	2.2 	2.2 	2.2 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	-	<u>Explosive Limit and Limited Quantity Index</u> 0.125 <u>Passenger Carrying Road or Rail Index</u> 75	-	-	-

“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.

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Section 15. Regulatory information

U.S. Federal regulations : TSCA 8(a) CDR Exempt/Partial exemption: Not determined
United States inventory (TSCA 8b): All components are listed or exempted.

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

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Sudden release of pressure

Composition/information on ingredients

No products were found.

State regulations

Massachusetts : None of the components are listed.

New York : None of the components are listed.

New Jersey : None of the components are listed.

Pennsylvania : None of the components are listed.

Canada inventory : All components are listed or exempted.

International regulations

International lists : **Australia inventory (AICS)**: All components are listed or exempted.
China inventory (IECSC): All components are listed or exempted.
Japan inventory: All components are listed or exempted.
Korea inventory: All components are listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): All components are listed or exempted.
Philippines inventory (PICCS): All components are listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

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Section 15. Regulatory information

Canada

WHMIS (Canada) : Class A: Compressed gas.

CEPA Toxic substances: The following components are listed: Volatile organic compounds; Volatile organic compounds; Volatile organic compounds

Canadian ARET: None of the components are listed.

Canadian NPRI: The following components are listed: Volatile organic compounds; Volatile organic compounds; Volatile organic compounds

Alberta Designated Substances: None of the components are listed.

Ontario Designated Substances: None of the components are listed.

Quebec Designated Substances: None of the components are listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.

Hazardous Material Information System (U.S.A.)

Health	1
Flammability	0
Physical hazards	1

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.

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Section 16. Other information

Key to abbreviations :

- ATE = Acute Toxicity Estimate
- BCF = Bioconcentration Factor
- GHS = Globally Harmonized System of Classification and Labelling of Chemicals
- IATA = International Air Transport Association
- IBC = Intermediate Bulk Container
- IMDG = International Maritime Dangerous Goods
- LogPow = logarithm of the octanol/water partition coefficient
- MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
- UN = United Nations
- ACGIH – American Conference of Governmental Industrial Hygienists
- AIHA – American Industrial Hygiene Association
- CAS – Chemical Abstract Services
- CEPA – Canadian Environmental Protection Act
- CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
- CFR – United States Code of Federal Regulations
- CPR – Controlled Products Regulations
- DSL – Domestic Substances List
- GWP – Global Warming Potential
- IARC – International Agency for Research on Cancer
- ICAO – International Civil Aviation Organisation
- Inh – Inhalation
- LC – Lethal concentration
- LD – Lethal dosage
- NDSL – Non-Domestic Substances List
- NIOSH – National Institute for Occupational Safety and Health
- TDG – Canadian Transportation of Dangerous Goods Act and Regulations
- TLV – Threshold Limit Value
- TSCA – Toxic Substances Control Act
- WEEL – Workplace Environmental Exposure Level
- WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

Indicates information that has changed from previously issued version.

Other special considerations : WARNING: Contains ((Halocarbon 143a) 1,1,1-Trifluoroethane), a substance which harms the public health and environment by destroying ozone in the upper atmosphere.

Notice to reader

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.

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Appendix C: Dispersion Modeling of Hydrazine H4N2 Using 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.

The Areal Locations of Hazardous Atmospheres (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 scenarios were evaluated and modeled based on nominal end of mission hydrazine load with three different weather conditions to establish the range of possible scenarios. 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 Cases

Nominal Propellant: Represents the nominal end of mission based on the propellant loading for the two test missions and a typical mission to the ISS. The Starliner spacecraft will 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 - Nominal Propellant, Daytime Landing, Low Cloud Cover and Wind speed

Note: the majority of Starliner landings will be planned for these conditions.

Test Case 2 - Nominal Propellant, Nighttime Landing, Low Cloud Cover and Wind speed

Test Case 3 - Nominal Propellant, 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 through C-7. By default, the red zone represents the worst hazard. (NOAA 2016)

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)

Toxic Threat Zone

ALOHA® 5.4.6



Time: April 1, 2020 1200 hours MST (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 : 759 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1127 yards --- (13 ppm = AEGL-2 [60 min])
Yellow: 3.5 miles --- (0.1 ppm = AEGL-1 [60 min])

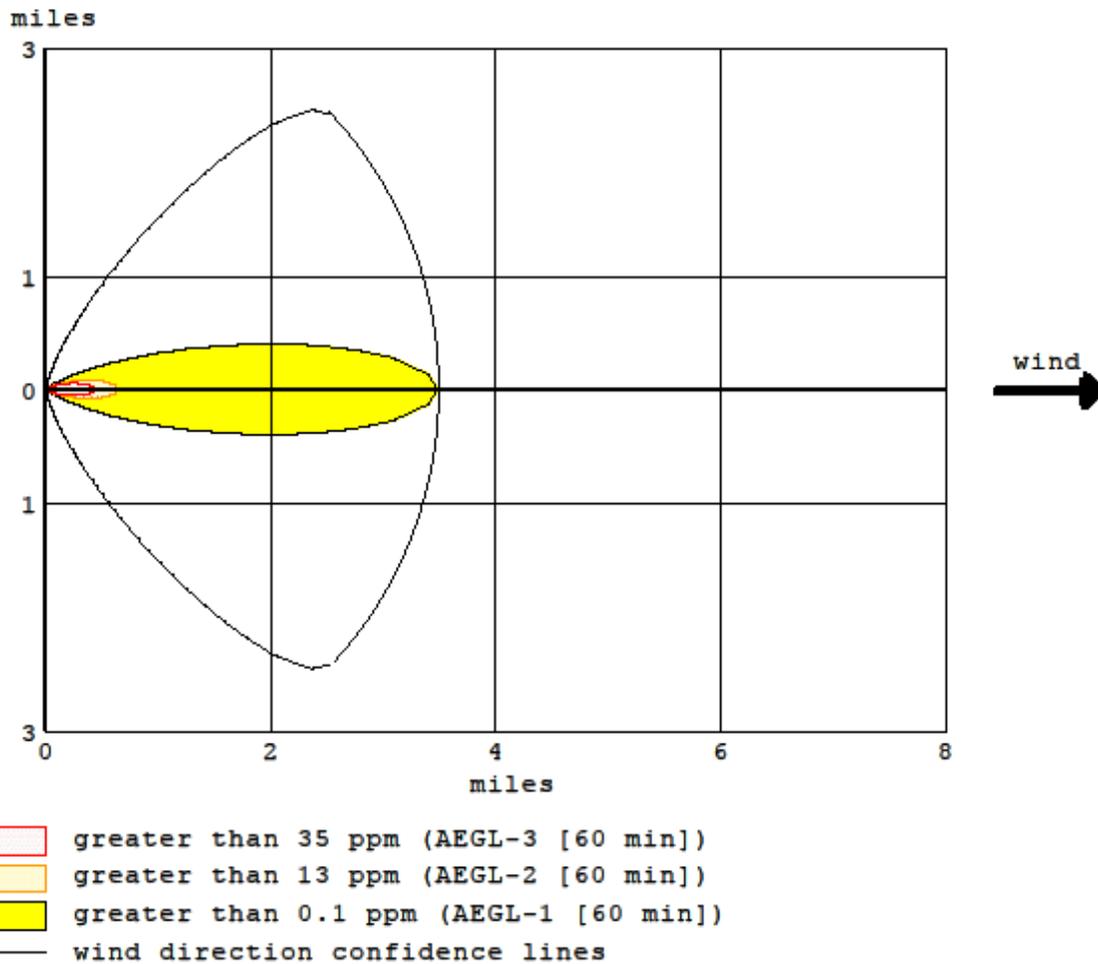


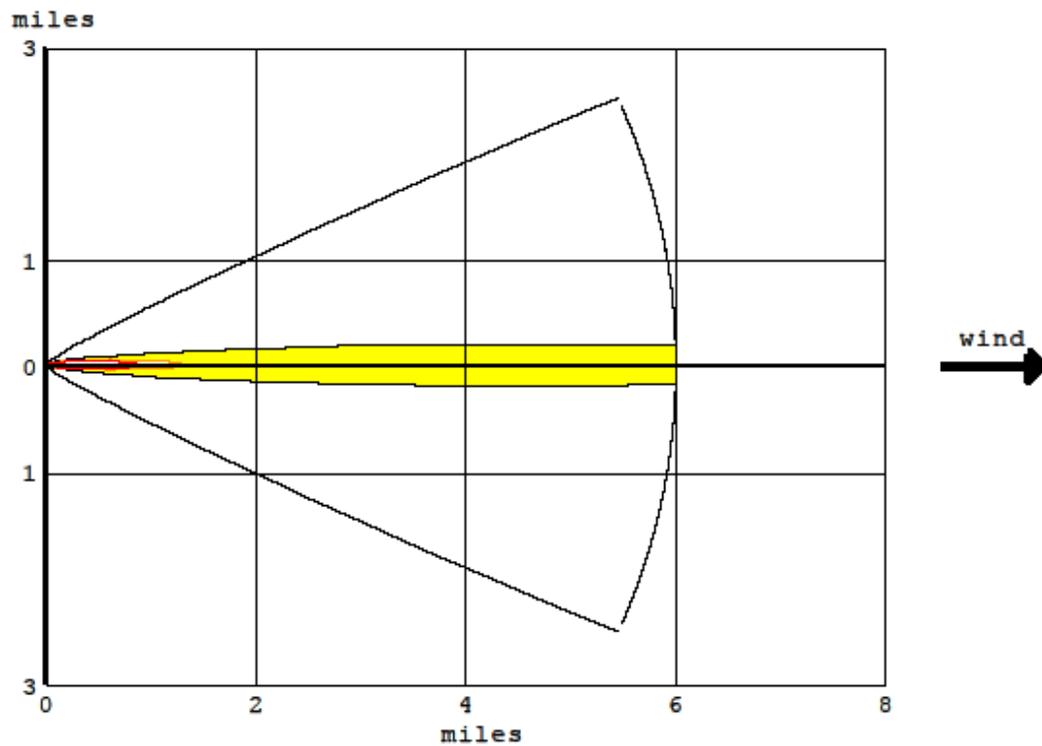
Figure 0-1: Test Case 1 - Nominal Propellant, Daytime Landing, Low Cloud Cover and Wind Speed

Toxic Threat Zone

ALOHA® 5.4.6



Time: April 1, 2020 0000 hours MST (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 : 1580 yards --- (35 ppm = AEGL-3 [60 min])
 Orange: 1.3 miles --- (13 ppm = AEGL-2 [60 min])
 Yellow: greater than 6 miles --- (0.1 ppm = AEGL-1 [60 min])



- greater than 35 ppm (AEGL-3 [60 min])
- greater than 13 ppm (AEGL-2 [60 min])
- greater than 0.1 ppm (AEGL-1 [60 min])
- wind direction confidence lines

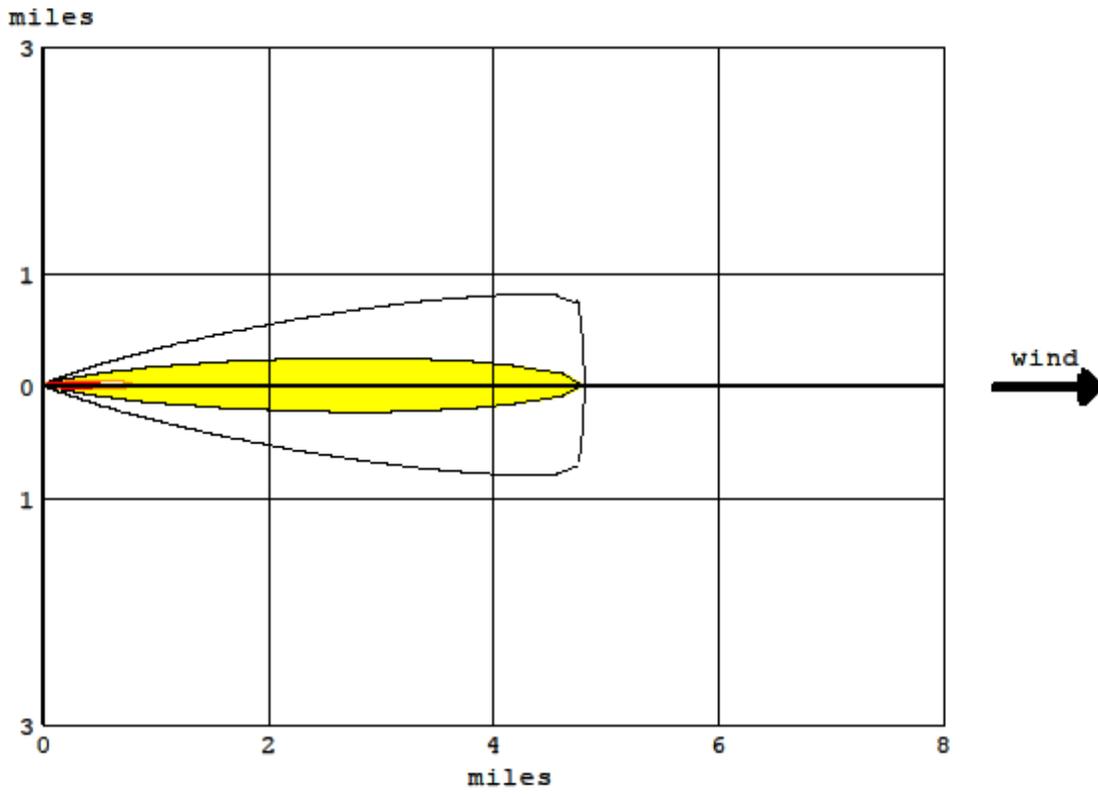
Note: Threat zone picture is truncated at the 6 mile limit.

Figure 0-2: Test Case 2 - Nominal Propellant, Nighttime Landing, Low Cloud Cover and Wind Speed

Toxic Threat Zone



Time: April 1, 2020 1200 hours MST (user specified)
Chemical Name: HYDRAZINE
Carcinogenic risk - see CAMEO Chemicals
Wind: 10 knots from w at 10 meters
THREAT ZONE:
Model Run: Heavy Gas
Red : 913 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1420 yards --- (13 ppm = AEGL-2 [60 min])
Yellow: 4.8 miles --- (0.1 ppm = AEGL-1 [60 min])



- greater than 35 ppm (AEGL-3 [60 min])
- greater than 13 ppm (AEGL-2 [60 min])
- greater than 0.1 ppm (AEGL-1 [60 min])
- wind direction confidence lines

Figure 0-3: Test Case 3 - Nominal Propellant, Anytime Landing, High Cloud Cover and Wind Speed

Appendix D: 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 its decent to the landing site.

The Starliner could approach the landing site from two directions. One is from the southwest (entry from a descending node of the Starliner orbit) and the other 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 Willcox. Figure D-2 shows both the wide area and zoomed in sonic boom footprint for this trajectory.

Figure D-3 shows the ascending node trajectory to Willcox. Figure D-4 shows both the wide area and zoomed in sonic boom footprint for this trajectory.

The resulting sonic boom would have a C-weighted DNL= 24 dB (Annual CDNL)¹

The Mach 1 transition takes place at approximately 60,000 feet altitude above sea level. The Starliner is already over the playa when this transition takes place.

¹ Assumptions/References:

- 1) 0.5 PSF boom, 2 booms/year.
- 2) Boom would approximate an N-wave.
- 3) Method based on -Galloway, W.J., Studies to Improve Environmental Assessments of Sonic Booms Produced During Air Combat Maneuvering, AFAMRL-TR-83-078, October, 1983
- 4) CDNL 24 corresponds to a slightly higher DNL value according to: CHABA, Assessment of Community Noise response to High-Energy Impulsive Sounds, Report of Working Group 84, Committee on Hearing, Bioacoustics and Bio mechanics, Assembly of Behavioral and Social Sciences. National Research Council, National Academy of Sciences, 1981
- 5) Low frequency of events may or may not correlate well with long-term annoyance vs. DNL relationships.

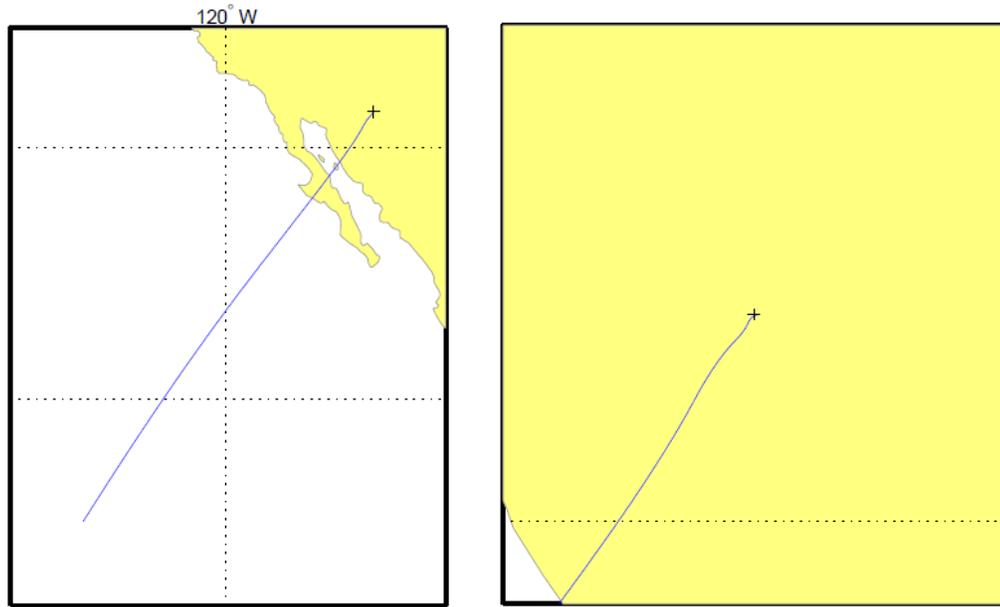


Figure 0-1: Willcox Descending Node Trajectory

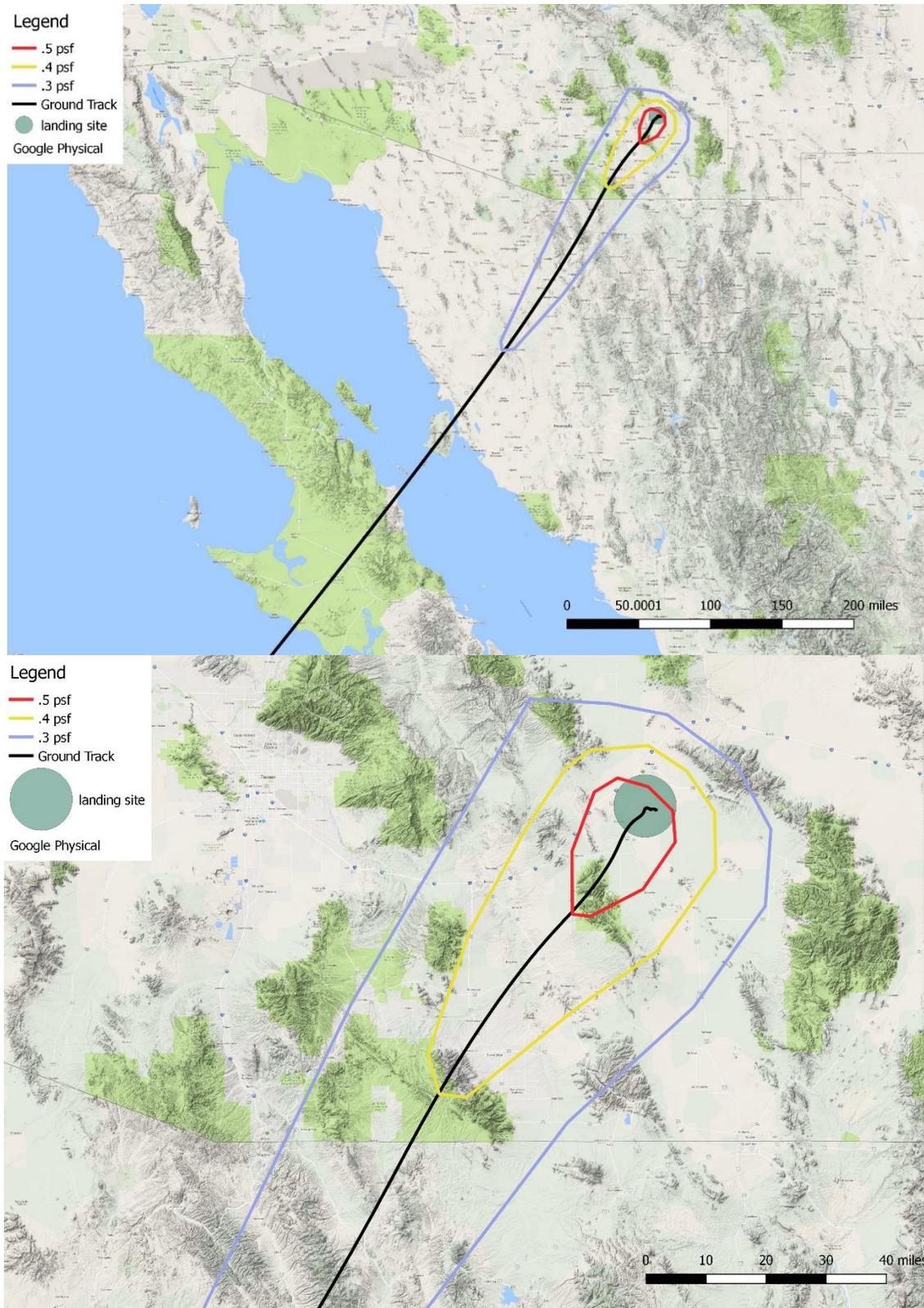


Figure 0-2: Willcox Descending Node Trajectory Sonic Boom Footprint

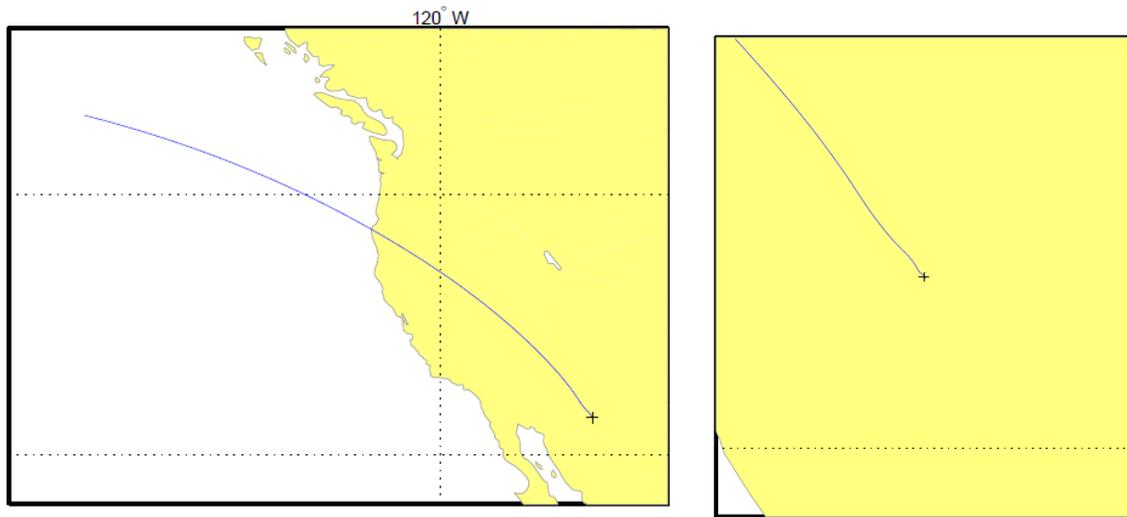


Figure 0-3: Willcox Ascending Node Trajectory

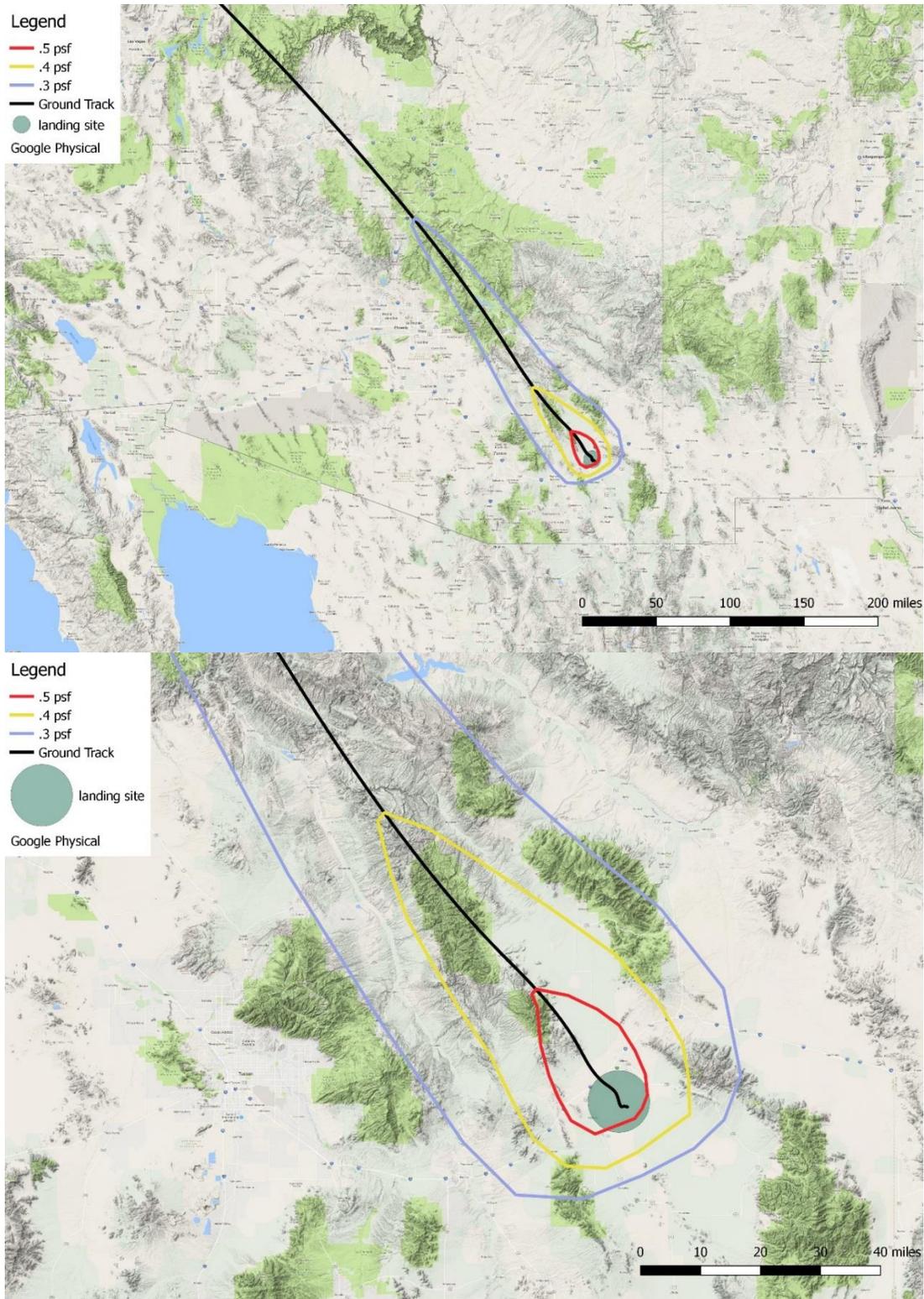


Figure 0-4: Willcox Ascending Node Trajectory Sonic Boom Footprint

Appendix E: Biological and Physical Resources Report

Below is the Biological and Physical Resources Report

Biological Report

*Willcox Playa Biological Assessment:
Boeing Starliner Landing Site*

Special Aerospace Services
Harris Environmental Group

3rd Submittal Date: 2/13/17

Biological Report

Willcox Playa Biological Assessment: Boeing Starliner Landing Site

PREPARED FOR:
Special Aerospace Services, LLC
3005 30th St
Boulder, CO 80301



PREPARED BY:
Harris Environmental Group, Inc.
650 N. 6th Ave.
Tucson, AZ 85705
HEG Project No. 16-051



February 2017

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1. INTRODUCTION

Special Aerospace Services (SAS), on behalf of Boeing and the National Aeronautics and Space Administration (NASA), is conducting an Environmental Assessment (EA) in order to meet National Environmental Policy Act (NEPA) requirements necessary to obtain permission to perform landing and recovery operations of the Commercial Crew Transportation System Starliner spacecraft at the Willcox Range. NASA is the lead agency for the EA. The Army and FAA are cooperating agencies. Harris Environmental Group, Inc. (Harris Environmental) is providing environmental services, and more specifically a biological assessment, to evaluate impacts to species or habitat potentially occurring within the proposed project limits.

The project is located approximately five mi south of Willcox, Arizona (AZ) in Cochise County, AZ (Figure 1). The cadastral location is Township 14 South, Range 24 and 25 East; and Township 15 South, Range 24 and 25 East; Gila and Salt River Baseline and Meridian. The project footprint is a four-kilometer (4-km) circle located almost exclusively on land owned by the US Army (Department of Defense [DOD]), with two small sections to the north within Arizona State Trust Land (State) (Figure 2). Land surrounding the project limits is owned both privately and by the US Bureau of Land Management (BLM) (Figure 2).

Throughout this Biological Report, the term “project limits” is represented by a 4-km area centered on the Willcox Playa while the term “project area” includes lands immediately adjacent to the 4-km circle. The term “project vicinity” is the expansive landscape, which includes the surrounding mountain ranges within the region (Figure 1). While this report focuses on state and federally protected flora and fauna, a summary of other sensitive species within the state of Arizona and an overview of physical resources within the project area are summarized in Appendix A and Appendix B, respectively. In addition, a review of state-protected plants and migratory birds are provided in Appendix C and Appendix D, respectively.

2. PROJECT DESCRIPTION

A future NASA mission will visit the International Space Station and upon re-entry, the Boeing Starliner spacecraft will parachute to earth at one of five landing sites. Willcox Playa is one of the proposed landing sites. The spacecraft, and more specifically the Crew Module (CM) with three accompanying landing parachutes (160-ft diameter), will be targeted to land within a 1-km radius circle centered at latitude 32.140 degrees and longitude -109.850 degrees. Several pieces of the spacecraft; including the Forward Heat Shield (FHS, 106-in diameter, 300 lbs) and accompanying pilot chutes (10-ft diameter, 10 lbs), two CM drogue parachutes (24-ft diameter, 67.5 lbs), three pilot parachutes (106-in diameter, 300 lbs), seven mortar lids (12-in diameter), several mortar sabots (4- to 16-in diameter, 1-4 lbs), and the Base Heat Shield (BHS, 176-in diameter, 1,400 lbs) will be jettisoned during the landing phase and parachute or free fall to the ground within a 4-km radius circle centered at this location. A landing and recovery convoy consisting of several trucks, all terrain vehicles (ATVs), and a crane for lifting the spacecraft onto a recovery truck will

stage just outside the 4-km circle. All vehicles will deploy as a convoy to the spacecraft after landing for recovery operations. In addition, two days prior to the planned landing, a simulation would take place involving movement of all vehicles, equipment, and personnel to the landing zone to practice crew and Starliner recovery operations. Temporary tents will be set up near the proposed landing site for personnel use and as a temporary medical facility for astronaut evaluations after they exit the spacecraft. After recovery operations are complete, all equipment and the spacecraft will exit the landing site. All jettisoned pieces will be located and recovered.

In order to have a clear landing zone, remnants of the Electronic Proving Ground (EPF) infrastructure, currently present and decommissioned on the Willcox Playa, will require removal. This consists of over 50 concrete pillars (4-ft diameter, 5-ft tall), some with remaining wood framing attached. Removal would require use of heavy machinery and large vehicles to remove remnants from the landing zone.

3. ACTION AREA

The action area is synonymous with the project limits and is defined by the 4-km radius circle for which the spacecraft and all associated jettison materials will land.

The project is located within the Basin and Range physiographic province, characterized by mountain ranges on a northwest-southeast axis separated by broad alluvial valleys. The project vicinity includes the Dragoon Mountains approximately 10 miles to the southwest, the Winchester Mountains approximately 15 miles to the northwest, the Dos Cabezas Mountains approximately 7 miles to the east, and the large Chiricahua Mountain range approximately 25 mi to the southeast (Figure 1). The San Pedro River approximately 25 miles to the west and the Gila River is approximately 45 mi to the north of the project limits.

The project area is located within the Arizona Upland Subdivision of the Sonoran Desertscrub Biotic Community (Brown 1982), and is characterized by a diversity of low shrubland of legume trees and many succulents. The Willcox Playa, however, is an endorheic dry lake with high alkalinity. The largely barren playa spans approximately eight by ten miles with an elevation documented between 4,135-4,136 ft (1,260 m) above mean sea level (amsl) (Schreiber 1978).

The only significant shrub that grows within the playa is Mohave seablite (*Suaeda moquinii*), a highly drought- and salt-tolerant species. A biological survey of the project area revealed species commonly observed around the perimeter of the playa (Appendix G). Shrubs included Mohave seablite (see photos Appendix H), fourwing saltbush (*Atriplex canescens*), and Griffith's saltbush (*A. griffithsii*). Common grasses included sacaton (*Sporobolus airoides* and *S. wrightii*), saltgrass (*Distichlis spicata*) and bluestem (*Bothriochloa* spp.) (see photos Appendix H). Plant diversity was dramatically reduced moving closer toward the playa until only saltgrass and Mohave seablite were present. Perimeter vegetation also included invasive saltcedar (*Tamarix ramosissima*), Russian

Biological Assessment, Willcox Playa, Starliner Landing Site

thistle (*Salsola tragus*), and various grasses (e.g.; Bermuda grass [*Cynodon dactylon*], stinkgrass [*Chlorus virgata*], and soft-feather pappusgrass [*Enneapogon cenchroides*]).

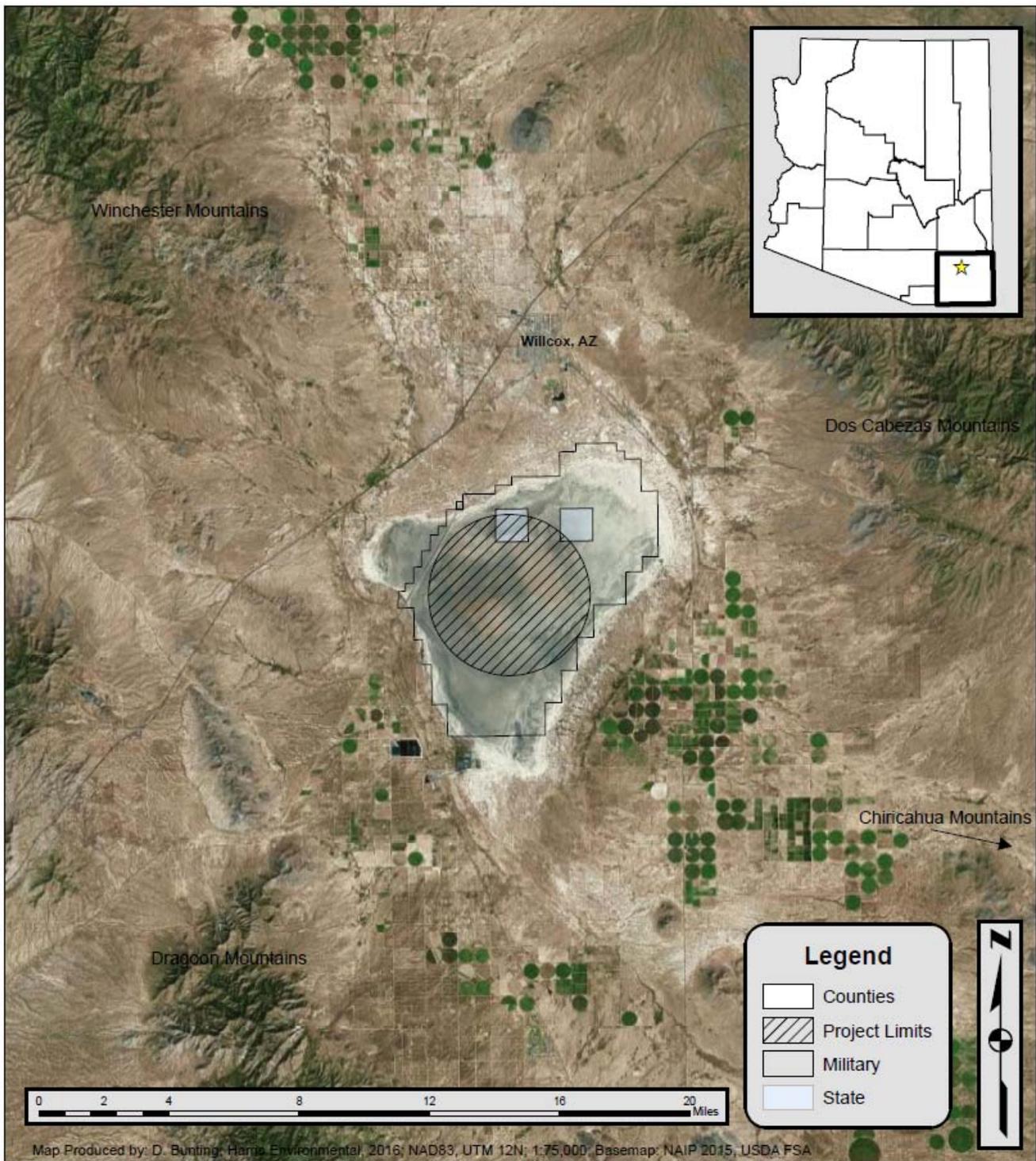


Figure 1. Project Vicinity. Willcox Playa, Cochise County, AZ.

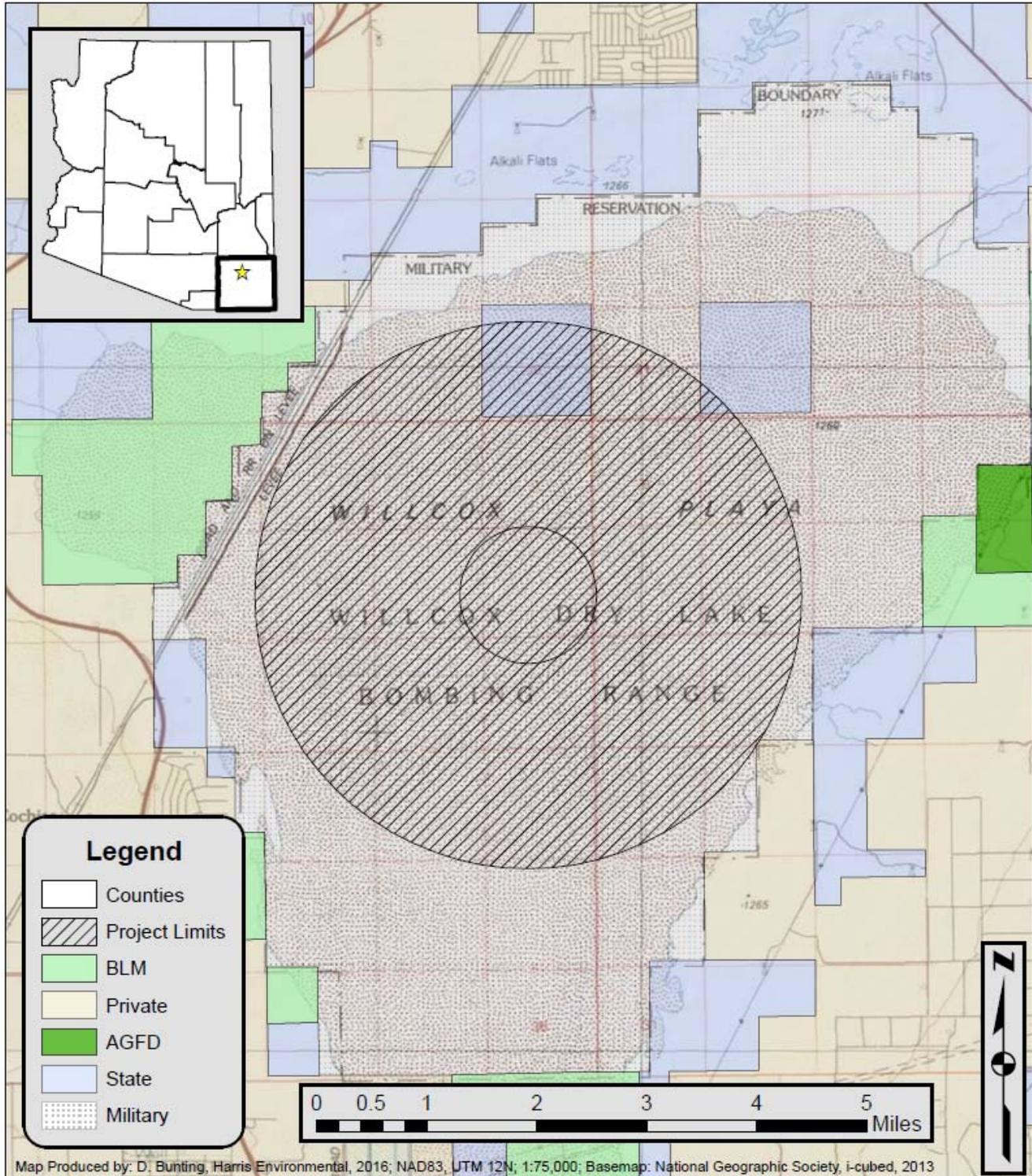


Figure 2. Project Location. 1- and 4-km project limits (co-centric circles) delineated within Willcox Playa and the surrounding land ownership.

4. SPECIES/CRITICAL HABITAT CONSIDERED

Harris Environmental qualified biologists queried the USFWS Information, Planning, and Conservation (IPaC) system (accessed by Daniel Bunting on 7 December 2016, Consultation Code: 02EAAZ00-2017-SLI-0121) to obtain a list of threatened, endangered, proposed, and candidate flora and fauna species, and designated and proposed critical habitat that are within one, 7.5-minute quadrangle of the project area (Appendix E). In addition, we queried the Arizona Game and Fish Department’s (AGFD) Heritage Data Management System (HDMS) (accessed by Daniel Bunting on 7 December 2016 under Project ID: HGIS-04574) to determine: 1) whether any special status species have been documented within close proximity (i.e., 3-5 miles) to the project limits; or 2) whether any species of greatest conservation need (based on predicted range models) are within the project vicinity (Appendix F). The Chiricahua leopard frog (*Lithobates chiricahuensis*) was the only federal status species documented within five miles of the project area. There are no proposed or critical habitat designations within the project limits.

Federal species analyzed in detail in this document include:

<u>Common Name</u>	<u>Scientific Name</u>	<u>Status</u>
Chiricahua leopard frog	<i>Lithobates chiricahuensis</i>	Threatened (2002)

Species included in the USFWS project list as well as others known to occur within Cochise County are addressed in Table 1. These species will not be affected by project activities and are excluded from further evaluation. Exclusion justifications are provided for each species.

Table 1. Federally listed, candidate, and proposed species from Cochise County that are excluded from further evaluation.

Species*	Status**	Habitat Requirements	Exclusion Justification
Mammals			
Jaguar (<i>Panthera onca</i>)	E	Sonoran desert scrub through pine-oak woodland, with recent sightings in southeastern Arizona borderlands and Sky Island region (AGFD 2004a) Elevation: 1,600 – 9,800 ft	Uncommon species with no known breeding populations in the U.S. (NatureServe 2005; USFWS 2000). Project limits do not meet habitat requirements due to low cover and resources; Willcox Playa has been excluded as habitat in the past (JAGCT 1998)
Lesser long-nosed bat (<i>Leptonycteris curasoae yerbabuena</i>)	E	Desertscrub habitat with columnar cactus and paniculate agaves present as nectar-forage plants (USFWS 2007a). Elevation: 1,600 – 11,500 ft	No suitable roosting sites or saguaro or agave food sources are present within the project limits; no direct impacts to the species or its habitat
Ocelot (<i>Leopardus pardalis</i>)	E	Dense shrub or thornscrub communities; require dense canopy cover with high prey populations (Sunquist 2002); Elevation: <4,000 ft	Uncommon species, most recent sightings have occurred on east side of Huachuca Mountains; project limits do not meet habitat requirements due to low cover

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Table 1. Federally listed, candidate, and proposed species from Cochise County that are excluded from further evaluation.

Species*	Status**	Habitat Requirements	Exclusion Justification
Birds			
Mexican Spotted Owl (<i>Strix occidentalis lucida</i>)	T	Old growth conifer forests and canyons from 4,500 to 10,000 feet amsl (AGFD 2005). Elevation: 4,500 - 10,000 ft	Project limits do not contain old-growth conifer forests and is outside the known geographic and elevational range; designated critical habitat is located in mountain ranges over 15 mi (Winchester Mtns) and 25 mi (Chiricahua Mtns) away.
Northern Aplomado Falcon (<i>Falco femoralis septentrionalis</i>)	EXPN	Habitat is dry grasslands, savannahs, and marshes; in US, desert grasslands with scattered yuccas and other shrubs (TPWD 2002) Elevation: 100 - 10,000 ft	Last reported nest in Arizona was in 1940; mostly observed in US in Chihuahuan deserts of the west and southern Texas regions; an experimental, non-essential population was reintroduced to NM beginning in 2006.
Southwestern Willow Flycatcher (<i>Empidonax trailii extimus</i>)	E	Dense, structurally complex riparian scrub with willow, cottonwood, and tamarisk from 75 to 9,180 feet amsl (AGFD 2002b; Davis and Russell 1990; Monson and Philips 1981). Elevation: 75 - 9,180 ft	Project limits do not contain dense cottonwood, willow, or tamarisk riparian habitat, or associated shallow water sources.
Western Yellow-billed Cuckoo (<i>Coccyzus americanus occidentalis</i>)	T	Sonoran riparian woodlands and forests comprised of cottonwood, willow, and/or tamarisk galleries (AGFD 2002c). Elevation: 90 - 6,710 ft	Project limits do not contain riparian woodland habitat; lacks cottonwood, willow or tamarisk galleries.
Reptiles			
New Mexican Ridge-nosed Rattlesnake (<i>Crotalus willardi obscurus</i>)	T	Madrean evergreen woodlands and Petran montane forests (Holycross and Douglas 1997); often near drainages with abundant litter (AGFD 2001a) Elevation: > 5,000 ft	Project limits are below elevational range and outside geographical range (mountains)
Northern Mexican gartersnake (<i>Thamnophis eques megalops</i>)	T	Riparian habitats from Sonoran desertscrub and semidesert grassland to Madrean evergreen woodlands (Rosen & Schwalbe 1988) Elevation: 2,500 - 5,000 ft	No natural or man-made ponds, cienegas, rivers, or riparian forests are present within the project limits; proposed critical habitat is over 20 mi to the west within the San Pedro River.
Amphibians			
Chiricahua Leopard Frog (<i>Lithobates chiricahuensis</i>)	(none)		
	T	See Effects Analysis	See Effects Analysis

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Table 1. Federally listed, candidate, and proposed species from Cochise County that are excluded from further evaluation.

Species*	Status**	Habitat Requirements	Exclusion Justification
Sonora Tiger Salamander (<i>Ambystoma tigrinum stebbinsi</i>)	E	Lakes, ponds, and cattle tanks in desert grassland areas of southern Arizona and northern Mexico (AGFD 2003); requires standing water from Jan-June (USFWS 1999) Elevation: 4,650 - 6,220 ft	In Arizona, only known in San Rafael Valley, west side of Huachuca Mountains over 50 mi from project limits; no semi-permanent waters within project limits
Fish			
Beautiful Shiner (<i>Cyprinella formosa</i>)	T	Pools of small to medium streams with sand, gravel, or rock bottoms; often prefer riffles or pools within creeks with abundant riffles (Hendrickson et al 1980) Elevation: 2,625 - 5,580 ft	Known in Arizona only within Rio Yaqui on San Bernardino NWR; project limits do not contain perennial waters or aquatic habitat suitable for fish
Desert Pupfish (<i>Cyprinodon macularius</i>)	E	Shallow waters of springs, small streams, or marshes (AGFD 2011) Elevation: 1,200 - 3,450 ft	No naturally occurring populations remain in Arizona; no perennial waters or aquatic habitat suitable for fish within project limits
Gila Chub (<i>Gila intermedia</i>)	E	Pools, springs, cienegas, and streams from 2,000 to 3,500 feet amsl (AGFD 2002d). Elevation: 2,000 - 3,500 ft	Project limits do not contain perennial waters or aquatic habitat suitable for fish
Gila Topminnow (<i>Poeciliopsis occidentalis occidentalis</i>)	E	Slow waters of small streams, springs, and cienegas from 1,320 to 7,510 (usually <5000) feet amsl (AGFD 2001c). Elevation: 1,320 - 7,510 ft	Project limits do not contain perennial waters or aquatic habitat suitable for fish
Loach minnow (<i>Tiaroga cobitis</i>)	E	Small to large perennial streams with shallow, turbulent riffles (Minckley 1973). Primarily cobble substrate and swift currents (Propst and Bestgen 1991) Elevation: 2,325 - 8,240 ft	Project limits do not contain streams or aquatic habitat suitable for fish
Spikedace (<i>Meda fulgida</i>)	E	Shallow streams with runs, pools, and eddies; prefers slow-moving water, less than 1 m deep (Rinne and Minckley 1991) Elevation: 1,620 - 4,500 ft	Project limits do not contain perennial waters or aquatic habitat suitable for fish
Yaqui Catfish (<i>Ictalurus pricei</i>)	T	Primarily in larger rivers with sand/rock bottoms; or quiet, clear pools within smaller streams (AGFD 2001b) Elevation: 50 - 6,890 ft	Known in Arizona only within Rio Yaqui on San Bernardino NWR; project limits do not contain perennial waters or aquatic habitat suitable for fish

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Table 1. Federally listed, candidate, and proposed species from Cochise County that are excluded from further evaluation.

Species*	Status**	Habitat Requirements	Exclusion Justification
Yaqui Chub (<i>Gila purpurea</i>)	E	Deeper pools of small streams with dense aquatic vegetation; or swift areas with abundant algae (AGFD 2001c) Elevation: 3,730 - 4,620 ft	Known locations in Cochise County are within Leslie Creek and Turkey Creek, and surrounding ponds; project limits do not contain perennial waters or aquatic habitat suitable for fish
Flowering Plants			
Canelo Hills Ladies'-tresses (<i>Spiranthes delitescens</i>)	E	Grows on slopes of marshy wetlands or cienegas intermixed with tall grasses and sedges Elevation: 4,585 - 4,970 ft	Only known in four cienegas in Southern Arizona (1 in Cochise, 3 in Santa Cruz); no wetland habitat within project limits
Cochise Pincushion Cactus (<i>Coryphantha robbinsiorum</i>)	T	Rolling gray, limestone slopes in transition between Chihuahuan desertscrub and semidesert grassland; rooted in bedrock or thin soil (AGFD 2001d) Elevation: 4,200 - 4,650 ft	Only known from limestone hills in southwestern and southeastern Cochise County; project limits lack habitat requirements
Huachuca Water-umbel (<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>)	E	Cienegas or marshy wetlands within Sonoran desertscrub, grassland, oak woodland, or conifer forest (AGFD 2003) Elevation: 2,000 - 7,100 ft	Only known from Huachuca Mountains and within San Pedro River Conservation Area; no wetland habitat within project limits
Wright's Marsh Thistle (<i>Cirsium wrightii</i>)	C	Wet, alkaline soils in spring seeps, cienegas, and marshy edges of streams and ponds (AGFD 2010) Elevation: 3,450 - 8,500 ft	Extirpated from Arizona, only known specimen from 1851 collection at San Bernardino NWR; no cienegas within project limits

*Species in bold were obtained from the USFWS IPaC query, which is based on the intersection of the defined project limits and any 7.5-min USGS quadrangles for which protected species may occur.

**USFWS: E= Endangered, T = Threatened, C= Candidate for listing, CA= Conservation Agreement, DL = Delisted, DPS = Distinct Population Status

5. EFFECTS ANALYSIS & DETERMINATION OF EFFECTS FOR EACH PROTECTED RESOURCE

CHIRICAHUA LEOPARD FROG (Lithobates chiricahuensis)

Life History Information

The Chiricahua Leopard Frog (CHLF) is a medium to large, stocky frog with adult lengths snout to vent from 5.0- 13.5 cm (2.0-5.4 in). The thigh consists of small, raised, cream-colored spots or tubercles on a dark background; which are more distinct, generally smaller, and more numerous than in other leopard frogs (AGFD 2015). The posterior surfaces of thighs have numerous small papilla, each surrounded by cream colored skin (Platz 1988). Dorsolateral folds are broken toward the rear of the body and the eyes are higher on the head and more upturned than other Arizona leopard frogs (AGFD 2015).

The CHLF is a habitat generalist that historically was found in a variety of aquatic habitat types, but is now limited to the comparatively few aquatic systems that support few or no, non-native predators (e.g. bullfrogs, fishes, crayfishes, and salamanders). Currently, CHLF inhabit cienegas, pools, livestock tanks, lakes, reservoirs, streams, and rivers within elevations ranging from 3,280 to 8,890 feet in central and southeastern Arizona; west-central and southwestern New Mexico. Major threats to CHLF and its habitat include increases in non-native predators and the devastating chytrid fungus. Recurring drought and impacts from climate change exacerbate threats and land uses including mining, livestock grazing, water diversion, groundwater pumping, development, and altered fire regimes complicate management strategies.

The CHLF was listed as a federally threatened species by the US Fish and Wildlife Service (USFWS) in 2002. As a result of the ability of non-native predators to thrive in perennial water sources, CHLF are increasingly restricted to environments that tend to be ephemeral and unpredictable. This increasingly narrow realized niche is a primary reason for the threatened status of the CHLF (USFWS 2007). In 2012, approximately 10,346 acres (4,187 hectares) was designated as CHLF critical habitat in Apache, Cochise, Gila, Graham, Greenlee, Pima, Santa Cruz, and Yavapai Counties, Arizona; and Catron, Grant, Hidalgo, Sierra, and Socorro Counties, New Mexico (USFWS 2012).

The Arizona range is divided into two areas, the northern population (Mogollon Rim population), which extends from montane areas in central Arizona, east and south along the Mogollon Rim to montane parts of west-southwestern New Mexico (AGFD 2015). The second population is located in the mountains and valleys south of the Gila River in southeastern Arizona and southwestern New Mexico, and extends into Mexico (adjacent Sonora) along the eastern slopes of the Sierra Madre Occidental (AGFD 2015).

Survey History

According to the AGFD HDMS online query, CHLFs have been documented within five miles of the project limits. No surveys have been conducted within the project limits to our knowledge.

Habitat Evaluation and Suitability

Aquatic breeding habitat is essential for providing space, food, and cover necessary to sustain all life stages of CHLF and consists of permanent to nearly permanent aquatic habitats from about 3,200-8,900 ft elevation with deep (> 20 in [0.5 m]) pools in which non-native predators are absent or occur at low densities (USFWS 2010c). Known CHLF populations within the project vicinity are located in higher elevations in the upper portions of the watershed where streams and ponds are common, reliable, and have limited non-native predators. The nearest designated habitat for CHLFs is in the Dragoon Mountains approximately 15 miles away, and others are located in mountains over 50 miles from the project limits. The only permanent water source near the Willcox Playa appears to be ponds constructed within the AGFD Willcox Playa Wildlife Area, approximately 1.5 miles outside the project limits. These ponds could be observed from afar, but could not be assessed due to seasonal closure for migratory waterfowl (e.g., sandhill cranes) management.

The Willcox Playa itself does not appear to have attributes suitable for CHLF habitat. Inundation after heavy rains could create temporary puddles, but ponding would not be deep and vegetative resources are lacking. Furthermore, the high alkaline content of the soils may not promote the presence of prey species that CHLF would rely on to survive at all life stages. Known CHLF populations and designated critical habitat are located in the surrounding mountain ranges and drainages extending from these mountains toward the Willcox Playa lack connectivity due to agricultural operations along the perimeter of the playa. Cumulatively, these factors exclude the project limits as suitable habitat for the CHLF.

Analysis and Determination of Effects

Direct, Indirect, and Cumulative Effects: No direct effects are anticipated to impact CHLF or its habitat. Disturbance from the CM would be limited to native soil displacement resulting from the 179.5-in, 1,600 lb capsule impact. The jettison materials would have minimal ground disturbance. Impacts from the Starliner simulation and actual retrieval mission would consist mostly of ground disturbance during convoy transit to and from the landing site. A temporary staging area located just outside the 4-km project limits will stage vehicles prior to the recovery mission. In addition, temporary tents and a medical facility will be set up close to the proposed CM landing site. These temporary impacts are not anticipated to affect vegetation or other natural resources. Activities also would avoid areas subject to temporary inundation after precipitation, thus precluding impacts to water resources.

If the Willcox Playa was used as the landing zone, the EPF infrastructure, consisting of over 50 concrete pillars would be removed prior to the mission. These indirect effects would not have impacts to the CHLF or its habitat for the same reasons described above. Removal of these objects would require heavy machinery and vehicles to enter and exit the playa, but disturbance would be limited to ground disturbance from vehicle tracks and the dismantling of EPG infrastructure, which is composed mostly of cement and wooden materials.

Effect Determination: It is highly unlikely that CHLF would be present within or near the project limits. Reliable wetland or riparian resources needed to support CHLF are lacking and areas that may be temporarily inundated after rains would be avoided. Therefore, the project will have “no effect” on the Chiricahua leopard frog or its federally designated critical habitat.

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7. LIST OF PREPARERS

This biological assessment was developed by Daniel Bunting; PhD, Watershed Management; MS, Natural Resources; BS, Biology. Dr. Bunting has managed multiple projects that require National Environmental Policy Act (NEPA) compliance as well as adherence to State environmental laws and regulations. He has extensive experience in environmental documentation including drafting sections within Environmental Impact Statements; Environmental Assessments; and completion of various Biological Evaluations, Reviews, and Short Forms.

8. SIGNATURE PAGE

Prepared and Submitted by:



Daniel Bunting, PhD
Biologist

Date: 13 February 2017

APPENDIX A – ARIZONA GAME AND FISH DEPARTMENT SPECIES OF GREATEST CONSERVATION NEED

Review of State Sensitive Species

The Arizona Game and Fish Department (AGFD) Heritage Data Management System (HDMS) query was accessed on 7 December 2016 under Project ID: HGIS-04574 (*see* Appendix E) to determine special status species known to occur in the project vicinity. The list of Species of Greatest Conservation Need (SGCN) was reviewed and all 1A species were evaluated.

A species is ranked vulnerable and given a “1” if one or more of the following vulnerability criteria are met: Extirpated from Arizona, Federal or State status, Declining status, Disjunct status, Demographic status, Concentration status, Fragmentation status, Distribution status.

The 1A tier further classifies species that match at least one of the following: federally listed as endangered or threatened under the Endangered Species Act (ESA); candidate species under ESA; is specifically covered under a signed conservation agreement (CCA) or a signed conservation agreement with assurances (CCAA); or was recently removed from the ESA and required monitoring.

All 1A species listed on the HDMS query, which used the project limits as the input, are summarized below (Table 1). This table includes exclusion justifications to briefly explain why these species were excluded from further evaluation. While many of these species do not warrant federal protection under the Endangered Species Act (ESA), they are considered Species of Greatest Conservation Need (SGCN) by AGFD and are included in the consideration of potential impacts that may occur from project activities.

Table 1. Vulnerable AGFD SGCN 1A list from HDMS query.

Scientific Name – Common Name	Exclusion Justification
<i>Lithobates chiricahuensis</i> - Chiricahua Leopard Frog ^{F5}	See federal species evaluation
<i>Coccyzus americanus</i> - Yellow-billed Cuckoo (Western DPS) ^F	See federal species evaluation
<i>Falco peregrinus anatum</i> - American Peregrine Falcon ^F	See federal species evaluation
<i>Leptonycteris curasoae yerbabuena</i> - Lesser Long-nosed Bat ^F	See federal species evaluation
<i>Panthera onca</i> - Jaguar ^F	See federal species evaluation
<i>Strix occidentalis lucida</i> - Mexican Spotted Owl ^F	See federal species evaluation
<i>Lithobates blairi</i> - Plains Leopard Frog ⁵	Reliable water sources are outside the 4-km project limits
<i>Terrapene ornata luteola</i> - Desert Box Turtle ⁵	Prefers low valleys, plains, and gentle bajadas in semidesert grasslands or desertscrub; Limited resources or cover within 4-km project area; not likely to travel across barren playa
<i>Anthus spragueii</i> - Sprague's Pipit	Recently, removed from federal Candidate list; Sulphur Springs grasslands and agricultural lands important for wintering

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Scientific Name - Common Name	Exclusion Justification
	grounds are outside of the 4-km project limits
<i>Crotalus lepidus</i> - Rock Rattlesnake	Species prefers higher elevations of the surrounding mountain ranges; limited resources within 4-km project area; no suitable habitat
<i>Cynomys ludovicianus</i> - Black-tailed Prairie Dog	Extirpated in 1961; project limits are far from reintroduction locations within the Las Cienegas Conservation Area
<i>Haliaeetus leucocephalus</i> - Bald Eagle	Limited resources within 4-km project area; minimal likelihood of project impacting species or habitat
<i>Heloderma suspectum</i> - Gila Monster	Limited resources within 4-km project area; not likely to travel across barren playa
<i>Leopardus pardalis</i> - Ocelot	Requires dense vegetation cover; limited resources within 4-km project area; not likely to travel across barren playa
<i>Terrapene ornata</i> - Ornate Box Turtle	Limited resources or cover within 4-km project area; not likely to travel across barren playa; less adapted than Desert box turtle to arid conditions

^F included on the federal list and evaluated within the Biological Report

⁵ has been documented within 5 five (5) miles of the project area

The AGFD on-line environmental review tool included a standard response regarding local or regional needs of wildlife movement, connectivity, access to habitat needs. Loss of this permeability prevents wildlife from accessing resources, finding mates, reduces gene flow, prevents wildlife from re-colonizing areas where local extirpations may have occurred, and ultimately prevents wildlife from contributing to ecosystem functions, such as pollination, seed dispersal, control of prey numbers, and resistance to invasive species. In many cases, streams and washes provide natural movement corridors for wildlife and should be maintained in their natural state. Uplands also support a large diversity of species, and should be contained within important wildlife movement corridors. Activities associated with the Starliner mission are not anticipated to impact wildlife movement, corridors, or habitat needs. Drainage corridors will not be impacted and surrounding uplands will be minimally impacted and limited to the barren Willcox Playa.

APPENDIX B – PHYSICAL RESOURCES WITHIN THE WILLCOX PLAYA

In support of the Environmental Assessment being prepared for the Starliner mission, and more specifically the proposed Starliner Landing Site at Willcox Playa, physical resources were reviewed within the project area. Results from both literature review and qualitative notes documented during the 14 December 2016 site visit are summarized below.

Soils

The project is located within the Basin and Range physiographic province, characterized by mountain ranges on a northwest-southeast axis separated by broad alluvial valleys. The Willcox Playa is roughly 8-mi by 10-mi and is surrounded by multiple mountain ranges. These include the Dragoon Mountains approximately 10 miles to the southwest, the Winchester Mountains approximately 15 miles to the northwest, the Dos Cabezas Mountains approximately 7 miles to the east, and the Chiricahua Mountain range approximately 25 miles to the southeast. The Willcox Playa is the drainage terminus for many of the surrounding mountain ranges and has accumulated sediments over thousands of years.

In the 1960s, the Willcox Playa was studied by Texas Tech University professor Dr. Schreiber and his students. Sediments from a 43-m auger hole and from other auger holes located in the west-central playa consisted exclusively of clay and some mud (Schreiber 1978). Sand was more common in sediments deposited near the historic shorelines, and sand, gravelly sand, and sandy gravel are more abundant at the north and south ends of the playa where the main streams contributed fluvial sediment loads. It is no surprise that fine silt and clay, easily transferred as suspended solids during runoff events, is the most common surface soil on the playa.

The project limits for the Starliner mission are centered near the middle of the playa, thus soils within the project footprint are surface clay deposits. The characteristic cracked soil surface results from clay particles undergoing shrink-swell cycles between wet and dry periods (see photos below). The exposed interior portion of the playa is not stabilized by vegetation. These areas are, however, stabilized in part by clay-crusts. Varying levels of salt, calcium carbonate, organic content, etc, as well as crust thickness and affinity to rupturing all impact susceptibility of soil crust to wind erosion (Gillette et al. 1982). Solar heating can produce dust devils and thunderstorms can produce dust storms, both strong enough to displace and carry away surface soils. Both of these phenomena are common within the Willcox Playa region; however, the largest dust storms, or “haboobs,” have been caused by fallow, denuded, or retired agricultural lands near the towns of San Simon and Willcox, AZ.

Soil and wind erosion within the playa can be exacerbated by ground disturbance such as offroading, which may break up clay fragments, increasing the volatility of dust particles. However, studies also have shown that thick, hardened clay-crusts are resistant to wind erosion even after disturbances (e.g., passes with a one-quarter ton pickup truck; Gillette et al. 1982). While detailed soil analyses were not conducted within the project

limits, it was noted that the surface soils were composed mostly of clay-crusteds soils of variable thickness (see photos below). The variability of clay thickness and desiccation patterns across the playa would likely result in variable degrees of disturbance from the vehicle convoy required to enter and exit the playa during Starliner simulation and recovery operations. As evident during our site visit, single passes with quarter-ton pickup trucks during the site visit imprinted surface soils, but did not appear to heavily damage soil crusts (see photo below). A convoy of heavy vehicles and machinery, however, would have potential to cause significantly more disturbance. Therefore, fugitive dust is likely to be generated, but also is dependent on wind conditions. While the convoy should travel single file through the sandy access points where vegetation is present, fugitive dust could be limited once arriving on the barren playa by creating multiple routes (e.g., traveling in parallel) to and from the landing site. Disturbance on the floodplain would be temporary. Furthermore, a water truck could also reduce dust and mitigate potential air pollution.

The Willcox Playa, when dry, can be traversed by vehicle with little risk of getting stuck. The sandier buffer regions extending from the main roads to the shoreline, however, can present hazards due to the presence of thick sand. Generally, a vehicle with four-wheel-drive capability should not have a problem entering and exiting the playa. It should be noted, however, that clay soils can be very hazardous after precipitation events. Clay accumulating on vehicle tires often reduces traction increasing the risk of vehicles getting stuck. It is not recommended to enter the playa after significant rainfall, thus the Starliner mission should review weather conditions closely and be prepared should precipitation become an issue. The Willcox Playa region receives over half of its precipitation from convective thunderstorms produced during the Monsoon season (July-September), with the remainder coming from frontal winter storms extending from the Pacific Ocean.



Photos. Typical clay-cracked surface soil crust on Willcox Playa (left); and single pass truck vehicle tracks on Willcox Playa, minimal imprint and disturbance of cracked soils (right).

In addition to literature and technical report reviews, the Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA) Web Soil Survey was used to analyze soil types characterized within the Willcox Playa. The Area of Interest (AOI) selected was an arbitrary ~11-mi x 11-mi square polygon (~80,000 ac) that encompassed the entire Willcox Playa and surrounding landscape (Figure 1). The majority of the Willcox Playa and over 90% of the project limits are considered by the USDA to be “Water.”

Water Resources

15,000 years ago, maintained by the relatively cool, moist Pleistocene climate, the Willcox Playa reached a maximum depth of 46 feet covering 140 square miles (Stevens and Ledbetter 2011). In modern day, the playa is an endorheic dry lake, or sink, with multiple inflows and no natural outflows, although some have been manually constructed to drain portions of the playa. Although many streams flow from the surrounding mountains toward the playa today, only a few deliver water to the playa surface because water is lost to infiltration of streambeds and porous slope alluvium, retention in tanks and behind dams, or evaporation (Schreiber 1978). In addition, agricultural lands bordering the playa now disconnect many of the historical drainages from entering the playa.

The Willcox Playa is dry the majority of the year and lacks perennial water resources. With a mean annual rainfall of 12-14 inches per year and average high temperatures reaching high 90s F in the summer, the playa only supports shallow, ephemeral ponds that form after heavy rains or snows. In more extreme scenarios (e.g. large, low-frequency, intense thunderstorms), the playa has the potential to be inundated for longer periods of time. According to the Federal Emergency Management Agency (FEMA), the entire playa is within the 100-yr floodplain (i.e., 1% Annual Chance Flood Hazard, Figure 2).

Perennial water resources that surround the Willcox Playa include: 1) Cochise Lakes and surrounding ponds; 2) Crane Lake and surrounding ponds; and 3) the Apache Station Wildlife Viewing Area (Figure 2). Cochise Lakes is located just over 3.5 miles to the north of the 4-km project limits and is adjacent to Twin Lakes Golf Course in Willcox, AZ. Cochise Lake is a large treated effluent pond for the town of Willcox, Arizona. The lake and surrounding smaller ponds adjacent to and within the golf course are used seasonally by shorebirds. Crane Lake is a 30-ac constructed pond within the AGFD Wildlife Viewing Area located just over two miles from the 4-km project limits. This site is primarily managed for optimizing waterfowl habitat and providing for hunting opportunities. Additionally, there are ten pot-hole ponds within the wildlife viewing area. The Apache Station Wildlife Viewing Area is located just over 2.5 miles to the south of the 4-km project limits and is adjacent to the Apache Generating Station. AEPSCO established the wildlife area in 1997 operating under a stewardship agreement with the AGFD. The site is a primary wintering roost location for sandhill cranes.

All of the aforementioned water resources are outside of the 4-km project limits and the Starliner mission will have no impacts to these resources. Furthermore, no perennial waters or wetlands exist within the project limits as defined by the 4-km circle.

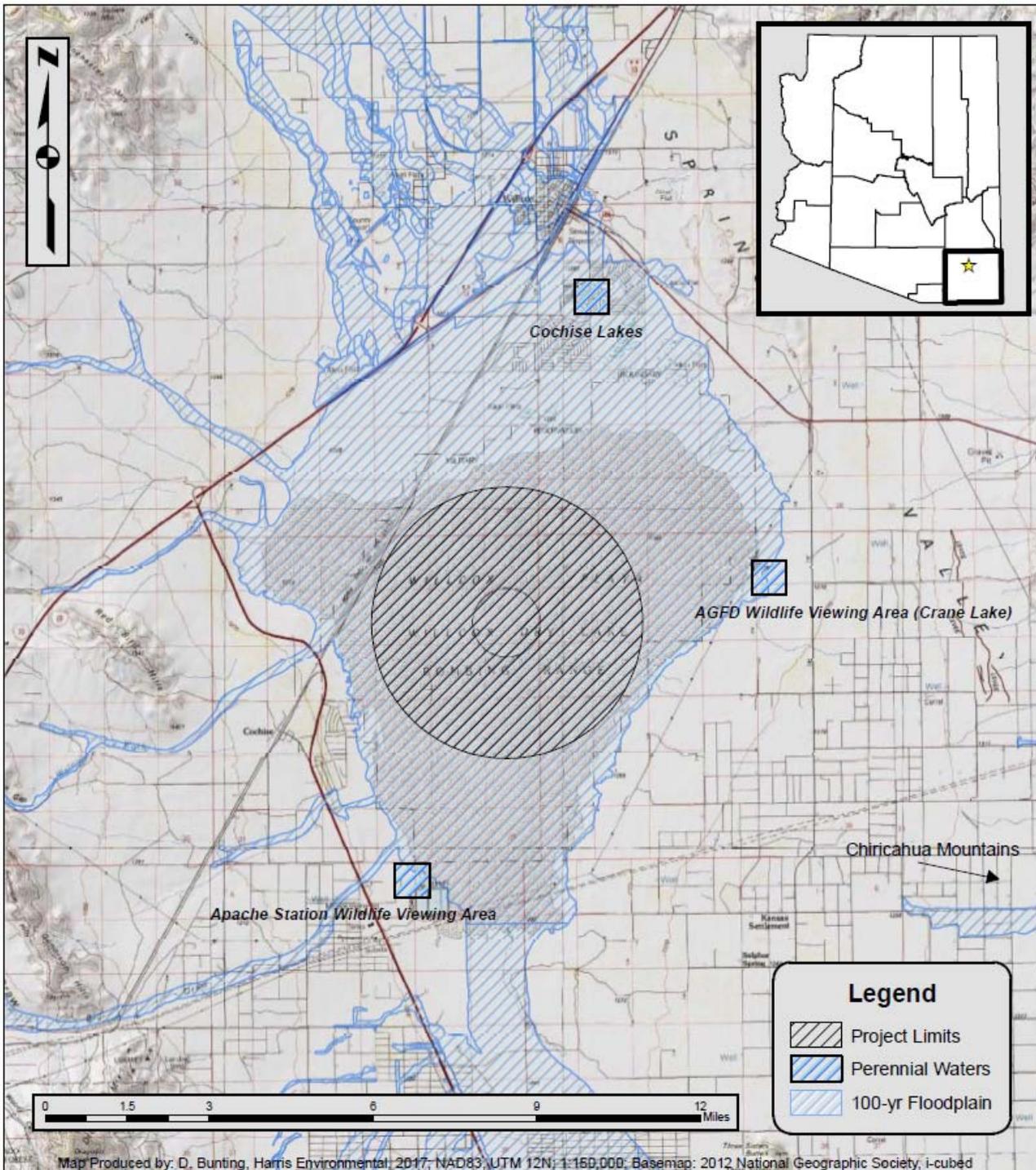


Figure 2. Water resources located within and in close proximity to the project limits (100-yr floodplain obtained from FEMA: <http://fema.maps.arcgis.com/home/webmap/viewer.html>)

Literature Cited

Gillette, D. A., J. Adams, D. Muhs, and R. Kihl. 1982. Threshold friction velocities and rupture moduli for crusted desert soils for input of soil particles into the air. *Journal of Geophysical Research* C11:9003-9015

Schreiber, J.F. 1978. Geology of the Willcox Playa, Cochise County, Arizona. New Mexico Geological Society Guidebook, 29th Field Conference.

Stevens, L.E. and J. Ledbetter. 2011. Arizona Heritage Waters. Northern Arizona University. http://www.azheritagewaters.nau.edu/loc_wilcox_playa.html

Natural Resource Conservation Service. 2016. Web Soil Survey. <https://websoilsurvey.nrcs.usda.gov/>. Accessed 1/23/17.

APPENDIX C – PLANT EVALUATION: SPECIES PROTECTED UNDER THE ARIZONA DEPARTMENT OF AGRICULTURE NATIVE PLANT LAW

Arizona Department of Agriculture Protected Native Plants

This project is on state lands and, therefore, requires a detailed evaluation of plants listed as protected under Arizona Department of Agriculture's (ADA) regulations. The following evaluation covers all plants listed as protected under ADA regulations. Should final designs be augmented, appropriate personnel will be consulted to approve a vegetation mitigation plan.

Protected Native Plants Evaluation

The Arizona Department of Agriculture's website was referenced to obtain a list of native plants protected within the state of Arizona. The project area was informally surveyed for the presence of protected native plants on 14 December 2016 by pedestrian survey. A list of common plants observed and project photographs are provided in Appendix G and Appendix H, respectively. The following is a list of plants found within the project area that are protected by the Arizona Department of Agriculture:

A. Highly Safeguarded Protected Native Plants

- *none*

B. Salvage Restricted Protected Native Plants

- *Cylindropuntia imbricate*, cane cholla
- *Opuntia engelmannii*, Engelmann's prickly pear
- *Yucca elata*, soap tree yucca

C. Salvage Assessed Protected Native Plants

- *Prosopis velutina*, velvet mesquite

D. Harvest Restricted Protected Native Plants

- *Prosopis velutina*, velvet mesquite

This list reflects vegetation noted within the project area, which includes the area immediately surrounding the Willcox Playa. The only species observed within the project limits was Mohave seablite (*Suaeda moquinii*), which is not a protected species.

No *Highly Safeguarded Protected Native Plants* were documented within the project area and we do not anticipate the project impacting any *Salvage Restricted Protected Native Plants*, *Salvage Assessed Protected Native Plants*, or *Harvest Restricted Protected Native Plants*; thus notification to the ADA prior to the Starliner mission is not required.

APPENDIX D – BIRD EVALUATION: BIRDS PROTECTED UNDER THE MIGRATORY BIRD TREATY ACT AND BIRDS OF CONSERVATION CONCERN

Migratory Bird Treaty Act and Birds of Conservation Concern Evaluation

With the exception of domestic pigeons (*Columba livia*), house sparrows (*Passer domesticus*), and European starlings (*Sturnus vulgaris*), all birds in the project area are protected under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712; USFWS 2013). The Migratory Bird Treaty Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. The Bald and Golden Eagle Protection Act also protects these two birds of prey species.

In addition to the provisions of the Migratory Bird Treaty Act, all federal agencies are required to consider in planning documents, the effect of actions on all Birds of Conservation Concern (BCC) by Executive Order 13186. Birds of Conservation Concern include some species not protected by the Migratory Bird Treaty Act.

As defined by BirdLife International and administered by the National Audubon Society, the Willcox Playa itself is considered an Important Bird Area (IBA). The Audubon Society states that the Willcox Playa and Crane Lake (within the AGFD Wildlife Viewing Area), within the northern portion of the Sulphur Springs Valley of Southeast Arizona, supports the second largest over-wintering concentration of Sandhill Cranes (*Grus canadensis*) in Arizona, typically 4,000 to 9,000 birds. Whitewater Draw, located approximately 35 mi south of Willcox Playa hosts the largest number of over-wintering cranes; 10,000 to 22,000 and increasing. Another significant roosting area is located at Crane Lake (4,000 to 5,000 birds) located less than five miles to the north of Willcox Playa and adjacent to Twin Lakes Golf Course in Willcox, AZ. Sandhill Cranes arrive in this region in October and depart for their northern migration anywhere between March and early April.

Hundreds to thousands of ducks and grebes also over-winter at these sites and also may pass through during spring and fall. Hundreds of shorebirds may be present during spring migration, using the water sources as stop-over habitat.

No formal bird surveys were conducted within the project area, but all birds observed during the site visit on 14 December 2016 were documented in field notes (Table 1). Birds were largely absent from the Willcox Playa, and the birds presented in the table were observed during visits to the AGFD Wildlife Viewing Area and Cochise Lake. The Apache Station Wildlife Viewing Area also was visited but the area was dry and observations were limited to sparrows, hawks, and some large flocks of sandhill cranes passing by many hundred feet above.

While it is possible that protected birds may inhabit or travel through the project area or wander within the project limits, we do not anticipate any protected birds to be injured

during the Starliner mission. However, avoiding seasonal migration windows would considerably reduce the likelihood of mission activities impacting birds; and likewise, would reduce risks involving potential bird-strike hazards. It is recommended to review shorebird migration windows, and to especially consider the potential of high sandhill crane numbers during wet winters. Flocks of these large birds may number in the thousands from October through March. When present, sandhill cranes are most active outside of roost sites about an hour after daylight when they leave to feed for the morning. They may also feed in the afternoon and return near dusk. Most of the feeding in the Willcox Playa region is supported by agricultural corn fields to the east and southeast of Willcox Playa. Direct bird-flight patterns from Cochise Lakes (near Willcox, AZ) to these agricultural fields may cross over the northeast side of the Willcox Playa; but flights from the AGFD Wildlife Viewing Area, Apache Station Wildlife Viewing Area, and Whitewater Draw would largely avoid the proposed project limits.

Table 1. Bird species documented during biological assessment at the Willcox Playa and surrounding areas.

Birds Observed During Biological Assessment (12/14/16)	
<u>AGFD Wildlife Area; Willcox Playa</u>	<u>Cochise Lake; Willcox, AZ</u>
Common Raven	Ruddy Duck
Western Meadowlark	American Coot
Chipping Sparrow	Sandhill Crane
Sandhill Crane	American Widgeon
Red-tailed Hawk	Vermillion Flycatcher
American Kestrel	Green-wing Teal
Northern Harrier	Long-billed Dowitcher
Killdeer	Long-billed Curlew
Northern Shoveler	Least Sandpiper
Ring-necked Duck	Snow Goose
Loggerhead Shrike	Mallard
Cooper's Hawk	American Avocet
White-crowned Sparrow	Northern Shoveler
Gambel's Quail	
Greater Roadrunner	
Mourning Dove	

APPENDIX E – US FISH AND WILDLIFE SERVICE: INFORMATION, PLANNING,
AND CONSERVATION QUERY RESULTS

APPENDIX D – USFWS Information, Planning, and Conservation System Query



United States Department of the Interior

FISH AND WILDLIFE SERVICE

Arizona Ecological Services Field Office

9828 NORTH 31ST AVE, #C3

PHOENIX, AZ 85051

PHONE: (602)242-0210 FAX: (602)242-2513

URL: www.fws.gov/southwest/es/arizona/;

www.fws.gov/southwest/es/EndangeredSpecies_Main.html



Consultation Code: 02EAAZ00-2017-SLI-0121

December 06, 2016

Event Code: 02EAAZ00-2017-E-00180

Project Name: SAS_NASA_HEG_WillcoxLanding

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The Fish and Wildlife Service (Service) is providing this list under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). The list you have generated identifies threatened, endangered, proposed, and candidate species, and designated and proposed critical habitat, that *may* occur within one or more delineated United States Geological Survey 7.5 minute quadrangles with which your project polygon intersects. Each quadrangle covers, at minimum, 49 square miles. Please refer to the species information links found at http://www.fws.gov/southwest/es/arizona/Docs_Species.htm or <http://www.fws.gov/southwest/es/arizona/Documents/MiscDocs/AZSpeciesReference.pdf> for a quick reference, to determine if suitable habitat for the species on your list occurs in your project area.

The purpose of the Act is to provide a means whereby threatened and endangered species and the habitats upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of Federal trust resources and to determine whether projects may affect federally listed species and/or designated critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If the Federal action agency determines that listed species or critical habitat *may be affected* by a federally funded, permitted or authorized activity, the agency must consult with us pursuant to 50 CFR 402. Note that a "may affect" determination includes effects that may not be adverse and that may be beneficial, insignificant, or discountable. An effect exists even if only one individual or habitat segment may be affected. The effects analysis should include the entire action area, which often extends well outside the project boundary or "footprint" (e.g., downstream). If the Federal action agency determines that the action may jeopardize a *proposed* species or adversely modify *proposed* critical habitat, the agency must enter into a section 7 conference. The agency may choose to confer with us on an action that may affect proposed species or critical habitat.

Candidate species are those for which there is sufficient information to support a proposal for listing. Although candidate species have no legal protection under the Act, we recommend that they be considered in the planning process in the event they become proposed or listed prior to project completion. More information on the regulations (50 CFR 402) and procedures for section 7 consultation, including the role of permit or license applicants, can be found in our Endangered Species Consultation Handbook at: <http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF>.

In addition to species listed under the Act, we advise you to consider species protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712) and the Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. 668 *et seq.*). Both laws prohibit the take of covered species. The list of MBTA-protected birds is in 50 CFR 10.13 (for an alphabetical list see <http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/MBTANDX.HTML>). The Service's Division of Migratory Birds is the lead for consultations under these laws (Southwest Regional Office phone number: 505/248-7882). For more information regarding the MBTA, BGEPA, and permitting processes, please visit the following web site: <http://www.fws.gov/migratorybirds/mbpermits.html>. Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g. cellular, digital television, radio, and emergency broadcast) can be found at: <http://www.fws.gov/southwest/es/arizona/CellTower.htm>

Although bald eagles (*Haliaeetus leucocephalus*) are no longer listed under the Act, they are protected under both the BGEPA and the MBTA. If a bald eagle nest occurs in or near the proposed project area, our office should be contacted. An evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles (see <http://www.fws.gov/southeast/es/baldeagle/>) and the Division of Migratory Birds consulted if necessary. The National Bald Eagle Management Guidelines provide recommendations to minimize potential project impacts to bald eagles (see <http://www.fws.gov/midwest/eagle/pdf/NationalBaldEagleManagementGuidelines.pdf>).

Activities that involve streams and/or wetlands are regulated by the U.S. Army Corps of Engineers (Corps). We recommend that you contact the Corps to determine their interest in proposed projects in these areas. For activities within a National Wildlife Refuge, we recommend that you contact refuge staff for specific information about refuge resources.

If your action is on Indian land or has implications for off-reservation tribal interests, we encourage you to contact the tribe(s) and the Bureau of Indian Affairs (BIA) to discuss potential

tribal concerns, and to invite any affected tribe and the BIA to participate in the section 7 consultation. In keeping with our tribal trust responsibility, we will notify tribes that may be affected by proposed actions when section 7 consultation is initiated. For more information, please contact our tribal coordinator, John Nystedt, at (928) 556-2160 or John_Nystedt@fws.gov.

The State of Arizona protects some species not protected by Federal law. We recommend you contact the Arizona Game and Fish Department (AGFD) for animals and Arizona Department of Agriculture for plants to determine if species protected by or of concern to the State may occur in your action area. The AGFD has an Environmental Review On-Line Tool that can be accessed at <http://www.azgfd.gov/hgis/>. We also recommend that you coordinate with the AGFD regarding your project.

For additional communications regarding this project, please refer to the consultation Tracking Number in the header of this letter. We appreciate your concern for threatened and endangered species. If we may be of further assistance, please contact Brenda Smith at 928/556-2157 for projects in Northern Arizona, our general Phoenix number (602/242-0210) for central Arizona, or Jean Calhoun at 520/670-6150 (x223) for projects in southern Arizona.

Sincerely,

/s/

Steven L. Spangle

Field Supervisor

Attachment



United States Department of Interior
Fish and Wildlife Service

Project name: SAS_NASA_HEG_WillcoxLanding

Official Species List

Provided by:

Arizona Ecological Services Field Office

9828 NORTH 31ST AVE

#C3

PHOENIX, AZ 85051

(602) 242-0210

<http://www.fws.gov/southwest/es/arizona/>

http://www.fws.gov/southwest/es/EndangeredSpecies_Main.html

Consultation Code: 02EAAZ00-2017-SLI-0121

Event Code: 02EAAZ00-2017-E-00180

Project Type: ** OTHER **

Project Name: SAS_NASA_HEG_WillcoxLanding

Project Description: HEG is being retained by SAS to conduct environmental research in support of an EA being produced to evaluate potential impacts from the proposed landing and recovery of a Boeing crew transportation system. The Willcox Playa is one of three locations being investigated as a potential landing site for the Starliner mission.

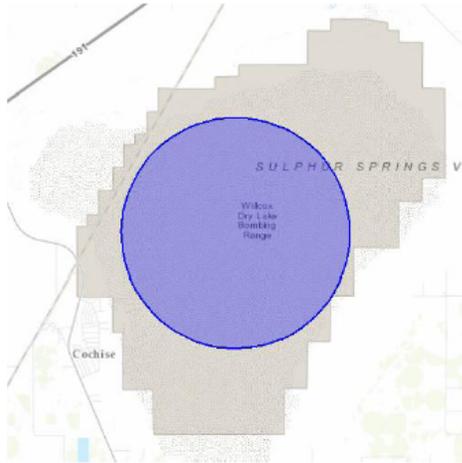
Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.



United States Department of Interior
Fish and Wildlife Service

Project name: SAS_NASA_HEG_WillcoxLanding

Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: Cochise, AZ



United States Department of Interior
Fish and Wildlife Service

Project name: SAS_NASA_HEG_WillcoxLanding

Endangered Species Act Species List

There are a total of 8 threatened, endangered, or candidate species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	Status	Has Critical Habitat	Condition(s)
Chiricahua leopard frog (<i>Lithobates chiricahuensis</i>) Population: Wherever found	Threatened	Final designated	
Birds			
Mexican Spotted owl (<i>Strix occidentalis lucida</i>) Population: Wherever found	Threatened	Final designated	
northern aplomado falcon (<i>Falco femoralis septentrionalis</i>) Population: U.S.A (AZ, NM)	Experimental Population, Non-Essential		
Yellow-Billed Cuckoo (<i>Coccyzus americanus</i>) Population: Western U.S. DPS	Threatened	Proposed	
Flowering Plants			
Wright's Marsh thistle (<i>Cirsium wrightii</i>) Population: Wherever found	Candidate		
Mammals			



United States Department of Interior
Fish and Wildlife Service

Project name: SAS_NASA_HEG_WillcoxLanding

jaguar (<i>Panthera onca</i>) Population: Wherever found	Endangered	Final designated	
Lesser Long-Nosed bat (<i>Leptonycteris curasoae yerbabuena</i>) Population: Wherever found	Endangered		
Reptiles			
Northern Mexican gartersnake (<i>Thamnophis eques megalops</i>) Population: Wherever found	Threatened	Proposed	



United States Department of Interior
Fish and Wildlife Service

Project name: SAS_NASA_HEG_WillcoxLanding

Critical habitats that lie within your project area

There are no critical habitats within your project area.

APPENDIX F – ARIZONA GAME AND FISH DEPARTMENT: HERITAGE DATA
MANAGEMENT SYSTEM QUERY RESULTS

APPENDIX E – Arizona Game and Fish Department Heritage Data Management System Query

Arizona Environmental Online Review Tool Report



*Arizona Game and Fish Department Mission
To conserve Arizona's diverse wildlife resources and manage for safe, compatible outdoor recreation opportunities for current and future generations.*

Project Name:
SAS_NASA_HEG LandingZone

User Project Number:
HEG_16-051

Project Description:
EG is being retained by SAS to conduct environmental research in support of an EA being produced to evaluate potential impacts from the proposed landing and recovery of a Boeing crew transportation system. The Willcox Playa is one of three locations proposed for a potential landing zone.

Project Type:
Habitat Conservation and Restoration, Land Use Planning

Contact Person:
Daniel Bunting

Organization:
Harris Environmental Group, Inc.

On Behalf Of:
OTHER_FED

Project ID:
HGIS-04574

Please review the entire report for project type and/or species recommendations for the location information entered. Please retain a copy for future reference.

Disclaimer:

1. This Environmental Review is based on the project study area that was entered. The report must be updated if the project study area, location, or the type of project changes.
2. This is a preliminary environmental screening tool. It is not a substitute for the potential knowledge gained by having a biologist conduct a field survey of the project area. This review is also not intended to replace environmental consultation (including federal consultation under the Endangered Species Act), land use permitting, or the Departments review of site-specific projects.
3. The Departments Heritage Data Management System (HDMS) data is not intended to include potential distribution of special status species. Arizona is large and diverse with plants, animals, and environmental conditions that are ever changing. Consequently, many areas may contain species that biologists do not know about or species previously noted in a particular area may no longer occur there. HDMS data contains information about species occurrences that have actually been reported to the Department. Not all of Arizona has been surveyed for special status species, and surveys that have been conducted have varied greatly in scope and intensity. Such surveys may reveal previously undocumented population of species of special concern.
4. HabiMap Arizona data, specifically Species of Greatest Conservation Need (SGCN) under our State Wildlife Action Plan (SWAP) and Species of Economic and Recreational Importance (SERI), represent potential species distribution models for the State of Arizona which are subject to ongoing change, modification and refinement. The status of a wildlife resource can change quickly, and the availability of new data will necessitate a refined assessment.

Locations Accuracy Disclaimer:

Project locations are assumed to be both precise and accurate for the purposes of environmental review. The creator/owner of the Project Review Report is solely responsible for the project location and thus the correctness of the Project Review Report content.

Recommendations Disclaimer:

1. The Department is interested in the conservation of all fish and wildlife resources, including those species listed in this report and those that may have not been documented within the project vicinity as well as other game and nongame wildlife.
2. Recommendations have been made by the Department, under authority of Arizona Revised Statutes Title 5 (Amusements and Sports), 17 (Game and Fish), and 28 (Transportation).
3. Potential impacts to fish and wildlife resources may be minimized or avoided by the recommendations generated from information submitted for your proposed project. These recommendations are preliminary in scope, designed to provide early considerations on all species of wildlife.
4. Making this information directly available does not substitute for the Department's review of project proposals, and should not decrease our opportunity to review and evaluate additional project information and/or new project proposals.
5. Further coordination with the Department requires the submittal of this Environmental Review Report with a cover letter and project plans or documentation that includes project narrative, acreage to be impacted, how construction or project activity(s) are to be accomplished, and project locality information (including site map). Once AGFD had received the information, please allow 30 days for completion of project reviews. Send requests to:
Project Evaluation Program, Habitat Branch
Arizona Game and Fish Department
5000 West Carefree Highway
Phoenix, Arizona 85086-5000
Phone Number: (623) 236-7600
Fax Number: (623) 236-7366
Or
PEP@azgfd.gov
6. Coordination may also be necessary under the National Environmental Policy Act (NEPA) and/or Endangered Species Act (ESA). Site specific recommendations may be proposed during further NEPA/ESA analysis or through coordination with affected agencies

SAS_NASA_HEG LandingZone Aerial Image Basemap With Locator Map



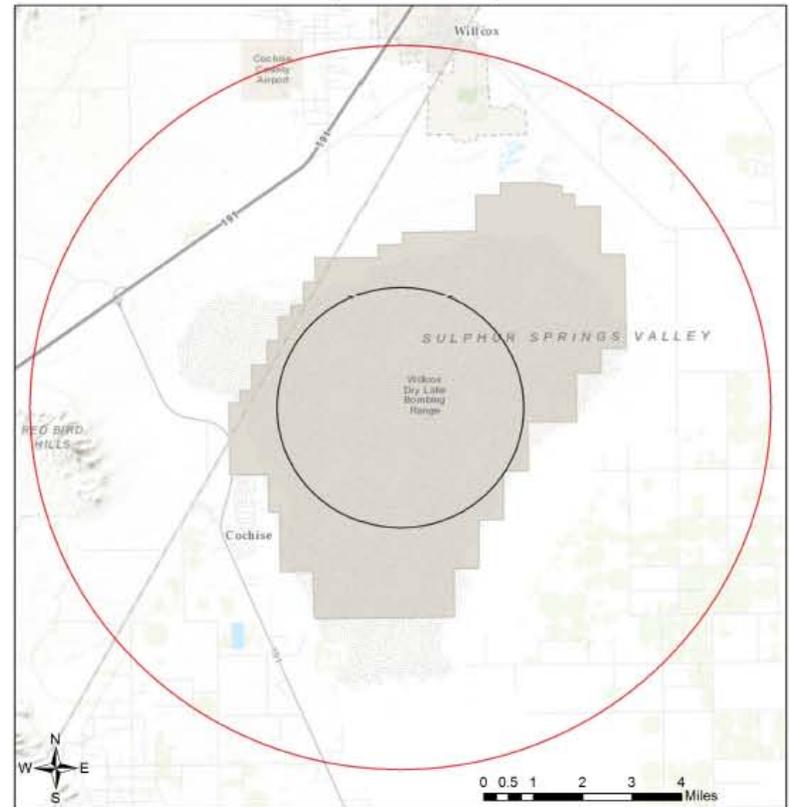
- Project Boundary
- Buffered Project Boundary

Project Size (acres): 12,400.97
Lat/Long (DD): 32.1424 / -109.8519
County(s): Cochise
AGFD Region(s): Tucson
Township/Range(s): T14S, R25E; T14S, R24E; T15S, R25E +
USGS Quad(s): WILLCOX SOUTH; RED BIRD HILLS +

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong),



SAS_NASA_HEG LandingZone Web Map As Submitted By User

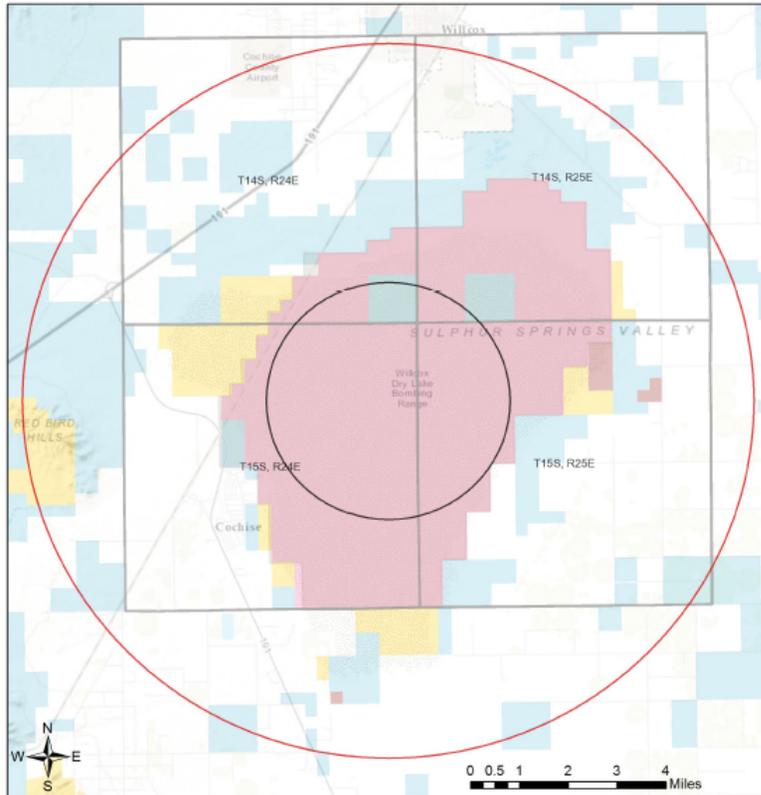


- Project Boundary
- Buffered Project Boundary

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USGS Quad(s): WILLCOX SOUTH; RED BIRD HILLS +

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapbox, © OpenStreetMap contributors, and the GIS User Community

SAS_NASA_HEG LandingZone
Topo Basemap With Township/Ranges and Land Ownership



- | | | |
|---------------------------|--------------------------|---|
| Project Boundary | Mixed/Other | Project Size (acres): 12,400.97 |
| Buffered Project Boundary | National Park/Mon. | Lat/Long (DD): 32.1424 / -109.8519 |
| Township/Ranges | Private | County(s): Cochise |
| AZ Game and Fish Dept. | State and Regional Parks | AGFD Region(s): Tucson |
| BLM | State Trust | Township/Range(s): T14S, R25E; T14S, R24E; T15S, R25E + |
| BOR | US Forest Service | USGS Quad(s): WILLCOX SOUTH; RED BIRD HILLS + |
| Indian Res. | Wildlife Area/Refuge | Sources: Esri, HERE, DeLorme, Intermap, Inrament P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community |
| Military | | |

Special Status Species and Special Areas Documented within 5 Miles of Project Vicinity

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
<i>Allium glandulosum</i>	Gland Onion					SR
<i>Aquila chrysaetos</i>	Golden Eagle	BGA		S		1B
<i>Aspidoscelis arizonae</i>	Arizona Striped Whiptail				S	1B
<i>Athene cucularia hypugaea</i>	Western Burrowing Owl	SC	S	S		1B
<i>Lithobates blairi</i>	Plains Leopard Frog				S	1A
<i>Lithobates chiricahuensis</i>	Chiricahua Leopard Frog	LT				1A
<i>Phrynosoma comutum</i>	Texas Horned Lizard	SC				
<i>Plegadis chihi</i>	White-faced Ibis	SC				
<i>Terrapene ornata luteola</i>	Desert Box Turtle				S	1A
Willcox Playa/Cochise Lakes IBA						

Note: Status code definitions can be found at <https://www.azgfd.com/wildlife/planning/wildlife/guidelines/statusdefinitions/>

Species of Greatest Conservation Need
Predicted within Project Vicinity based on Predicted Range Models

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
<i>Aix sponsa</i>	Wood Duck					1B
<i>Ammodramus savannarum ammodramus</i>	Arizona grasshopper sparrow		S	S		1B
<i>Ammodramus savannarum perpallidus</i>	Western Grasshopper Sparrow					1B
<i>Ammospermophilus harrisi</i>	Harris' Antelope Squirrel					1B
<i>Anthus spragueii</i>	Sprague's Pipit	C*				1A
<i>Antilocapra americana americana</i>	American Pronghorn					1B
<i>Aquila chrysaetos</i>	Golden Eagle	BGA		S		1B
<i>Aspidoscelis arizonae</i>	Arizona Striped Whiptail				S	1B
<i>Athene cucularia hypugaea</i>	Western Burrowing Owl	SC	S	S		1B
<i>Buteo regalis</i>	Ferruginous Hawk	SC		S		1B
<i>Charadrius nivosus nivosus</i>	Western Snow Plover					1B
<i>Chordeiles minor</i>	Common Nighthawk					1B
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo (Western DPS)	LT	S			1A
<i>Coluber bilineatus</i>	Sonoran Whipsnake					1B
<i>Corynorhinus townsendii pallescens</i>	Pale Townsend's Big-eared Bat	SC	S	S		1B
<i>Crotalus lepidus</i>	Rock Rattlesnake					1A
<i>Crotalus tigris</i>	Tiger Rattlesnake					1B
<i>Cyananthus latirostris</i>	Broad-billed Hummingbird		S			1B
<i>Cynomys ludovicianus</i>	Black-tailed Prairie Dog	SC		S		1A
<i>Dipodomys spectabilis</i>	Banner-tailed Kangaroo Rat				S	1B
<i>Euderma maculatum</i>	Spotted Bat	SC	S	S		1B
<i>Eumops perotis californicus</i>	Greater Western Bonneted Bat	SC		S		1B

**Species of Greatest Conservation Need
Predicted within Project Vicinity based on Predicted Range Models**

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Falco peregrinus anatum	American Peregrine Falcon	SC	S	S		1A
Glaucidium gnoma gnoma	Northern Pygmy-owl					1B
Haliaeetus leucocephalus	Bald Eagle	SC, BGA	S	S		1A
Helodermas suspectum	Gila Monster					1A
Hypsiglena sp. nov.	Hooded Nightsnake					1B
Idionycteris phyllotis	Allen's Lappet-browed Bat	SC	S	S		1B
Inciilius alvarius	Sonoran Desert Toad					1B
Kinostemon sonoriense sonoriense	Desert Mud Turtle			S		1B
Lampornis clemenciae	Blue-throated Hummingbird					1B
Lasiurus blossevillii	Western Red Bat		S			1B
Lasiurus xanthinus	Western Yellow Bat		S			1B
Leopardus pardalis	Ocelot	LE				1A
Leptonycteris curasoae yerbabuena	Lesser Long-nosed Bat	LE				1A
Lepus alleni	Antelope Jackrabbit					1B
Lithobates blairi	Plains Leopard Frog			S		1A
Lithobates chiricahuensis	Chiricahua Leopard Frog	LT				1A
Megascops trichopsis	Whiskered Screech-owl		S			1B
Melanerpes uropygialis	Gila Woodpecker					1B
Meleagris gallopavo mexicana	Gould's Turkey		S			1B
Melospiza lincolni	Lincoln's Sparrow					1B
Melospiza aberti	Abert's Towhee		S			1B
Micruroides euryxanthus	Sonoran Coralsnake					1B
Myotis occultus	Arizona Myotis	SC		S		1B
Myotis velifer	Cave Myotis	SC		S		1B
Myotis yumanensis	Yuma Myotis	SC				1B
Nyctinomops femorosaccus	Pocketed Free-tailed Bat					1B
Panthera onca	Jaguar	LE				1A
Passerculus sandwichensis	Savannah Sparrow					1B
Peromyscus nasutus	Northern Rock Mouse					1B
Peucaea botteri arizonae	Arizona Botteri's Sparrow			S		1B
Phrynosoma solare	Regal Horned Lizard					1B
Picoides arizonae	Arizona Woodpecker		S			1B
Setophaga petechia	Yellow Warbler					1B
Strix occidentalis lucida	Mexican Spotted Owl	LT				1A
Tadarida brasiliensis	Brazilian Free-tailed Bat					1B
Terrapene omata	Ornate Box Turtle					1A
Troglodytes pacificus	Pacific Wren					1B

**Species of Greatest Conservation Need
Predicted within Project Vicinity based on Predicted Range Models**

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Trogon elegans	Elegant Trogon		S			1B
Vireo bellii arizonae	Arizona Bell's Vireo					1B
Vulpes macrotis	Kit Fox					1B

Species of Economic and Recreation Importance Predicted within Project Vicinity

Scientific Name	Common Name	FWS	USFS	BLM	NPL	SGCN
Antilocapra americana americana	American Pronghorn					1B
Callipepla gambelii	Gambel's Quail					
Callipepla squamata	Scaled Quail					1C
Odocoileus hemionus	Mule Deer					
Patagioenas fasciata	Band-tailed Pigeon					1C
Pecari tajacu	Javelina					
Puma concolor	Mountain Lion					
Zenaidura macroura	White-winged Dove					
Zenaidura macroura	Mourning Dove					

Project Type: Habitat Conservation and Restoration, Land Use Planning

Project Type Recommendations:

Fence recommendations will be dependant upon the goals of the fence project and the wildlife species expected to be impacted by the project. General guidelines for ensuring wildlife-friendly fences include: barbless wire on the top and bottom with the maximum fence height 42", minimum height for bottom 16". Modifications to this design may be considered for fencing anticipated to be routinely encountered by elk, bighorn sheep or pronghorn (e.g., Pronghorn fencing would require 18" minimum height on the bottom). Please refer to the Department's Fencing Guidelines located on Wildlife Friendly Guidelines page, which is part of the Wildlife Planning button at <https://www.azgfd.com/wildlife/planning/wildlifeguidelines/>.

During the planning stages of your project, please consider the local or regional needs of wildlife in regards to movement, connectivity, and access to habitat needs. Loss of this permeability prevents wildlife from accessing resources, finding mates, reduces gene flow, prevents wildlife from re-colonizing areas where local extirpations may have occurred, and ultimately prevents wildlife from contributing to ecosystem functions, such as pollination, seed dispersal, control of prey numbers, and resistance to invasive species. In many cases, streams and washes provide natural movement corridors for wildlife and should be maintained in their natural state. Uplands also support a large diversity of species, and should be contained within important wildlife movement corridors. In addition, maintaining biodiversity and ecosystem functions can be facilitated through improving designs of structures, fences, roadways, and culverts to promote passage for a variety of wildlife. Guidelines for many of these can be found at: <https://www.azgfd.com/wildlife/planning/wildlifeguidelines/>.

Minimize potential introduction or spread of exotic invasive species. Invasive species can be plants, animals (exotic snails), and other organisms (e.g., microbes), which may cause alteration to ecological functions or compete with or prey upon native species and can cause social impacts (e.g., livestock forage reduction, increase wildfire risk). The terms noxious weed or invasive plants are often used interchangeably. Precautions should be taken to wash all equipment utilized in the project activities before leaving the site. Arizona has noxious weed regulations (Arizona Revised Statutes, Rules R3-4-244 and R3-4-245). See Arizona Department of Agriculture website for restricted plants, <https://agriculture.az.gov/>. Additionally, the U.S. Department of Agriculture has information regarding pest and invasive plant control methods including: pesticide, herbicide, biological control agents, and mechanical control, <http://www.usda.gov/wps/portal/usdahome>. The Department regulates the importation, purchasing, and transportation of wildlife and fish (Restricted Live Wildlife), please refer to the hunting regulations for further information <https://www.azgfd.com/hunting/regulations>.

Within sensitive riparian areas consider livestock management activities that include rotational grazing, fencing, and providing off-site water developments. Please refer to the Department's Fencing Guidelines located on the home page of this application. In endangered species habitats, guidelines may be established in Recovery Plans <http://www.fws.gov/southwest/es/arizona/>.

The Department's Landowner Relations Program works with the state's private landowners to promote and encourage incorporation of habitat creation and improvement for a variety of wildlife species. The program has grown significantly in recent years offering new alternatives and larger projects to all the cooperators. There are various options under this program to partner with the Department to enhance or restore wildlife habitat. To view specific program options and criteria, please refer to the following link: <https://www.azgfd.com/wildlife/landowners/>

The construction or maintenance of water developments should include: incorporation of aspects of the natural environment and the visual resources, maintaining the water for a variety of species, water surface area (e.g., bats require a greater area due to in-flight drinking), accessibility, year-round availability, minimizing potential for water quality problems, frequency of flushing, shading of natural features, regular clean-up of debris, escape ramps, minimizing obstacles, and minimizing accumulation of silt and mud.

Habitat and forage recommendations are community, location, and species specific. We recommend early and direct coordination with Project Evaluation Program to determine site-specific recommendations.

Minimize impacts to wildlife and wildlife habitat by staying on designated roads and trails, and by minimizing use during spring and summer breeding periods. Additional information concerning OHV use is located at <https://www.azgfd.com/OHV>.

Habitat restoration recommendations are dependant on habitat communities, target species, species located within the project area, site history, restoration goals, and treatment types. General project scoping should include defined project goals with measurable success criteria, site evaluation (e.g., soil conditions, local and watershed hydrological conditions and regimes), pre-project fish and wildlife surveys to determine project impacts and baseline data for post-project evaluation, established plan and methods for site preparation and revegetation (plant species evaluation based on current or expected site environmental conditions), consideration/incorporation of wildlife habitat features that may be secondary to project objectives (e.g., retaining snags for roost sites) and effects to habitat and wildlife at landscape scales (broader than project area), post-project monitoring plans and funding commitments, and an adaptive management plan. We recommend early coordination with Department personnel on project designs. Contact information can be found at <https://www.azgfd.com/Agency/Offices> or email our Project Evaluation Program at PEP@azgfd.gov

Pre- and post-survey/monitoring should be conducted to determine alternative access/exits to mines and to identify and/or minimize potential impacts to bat species. For further information when developing alternatives to mine closures, contact the Arizona Game and Fish Department Nongame Bat Coordinator at the Main Office in Terrestrial Branch, <https://www.azgfd.com/agency/offices> or (602) 942-3000.

Consider incorporating project components that may allow for the inclusion to promote, enhance, create, or restore wildlife habitat. Contact Project Evaluation Program for further information and opportunities, PEP@azgfd.gov or (623) 236-7600 or <https://www.azgfd.com/agency/offices/>

The Department requests further coordination to provide project/species specific recommendations, please contact Project Evaluation Program directly, PEP@azgfd.gov

Project Location and/or Species Recommendations:

HDMS records indicate that one or more native plants listed on the Arizona Native Plant Law and Antiquities Act have been documented within the vicinity of your project area. Please contact:

Arizona Department of Agriculture
1688 W Adams St.
Phoenix, AZ 85007
Phone: 602.542.4373
<https://agriculture.az.gov/environmental-services/np1>

HDMS records indicate that one or more listed, proposed, or candidate species or Critical Habitat (Designated or Proposed) have been documented in the vicinity of your project. The Endangered Species Act (ESA) gives the US Fish and Wildlife Service (USFWS) regulatory authority over all federally listed species. Please contact USFWS Ecological Services Offices at <http://www.fws.gov/southwest/es/arizona/> or:

Phoenix Main Office	Tucson Sub-Office	Flagstaff Sub-Office
2321 W. Royal Palm Rd, Suite 103	201 N. Bonita Suite 141	SW Forest Science Complex
Phoenix, AZ 85021	Tucson, AZ 85745	2500 S. Pine Knoll Dr.
Phone: 602-242-0210	Phone: 520-670-6144	Flagstaff, AZ 86001
Fax: 602-242-2513	Fax: 520-670-6155	Phone: 928-556-2157
		Fax: 928-556-2121

HDMS records indicate that Western Burrowing Owls have been documented within the vicinity of your project area. Please review the western burrowing owl resource page at: <https://www.azgfd.com/wildlife/speciesofgreatestconservneed/burrowingowlmanagement/>.

HDMS records indicate that Chiricahua Leopard Frogs have been documented within the vicinity of your project area. Please review the Chiricahua Leopard Frog Management Guidelines found at: <https://www.azgfd.com/PortalImages/files/wildlife/planningFor/wildlifeFriendlyGuidelines/FINALLithchirHabitatGdlns.pdf>

The analysis has detected one or more Important Bird Areas within your project vicinity. Please see http://aziba.org/?page_id=38 for details about the Important Bird Area(s) identified in the report.

APPENDIX G – COMMON PLANTS OBSERVED DURING BIOLOGICAL ASSESSMENT

Family	Code	Genus species	Common Names	Status	Type
Agavaceae	YUEL	<i>Yucca elata</i>	soaptree yucca	native	perennial
Amaranthaceae	AMPA	<i>Amaranthus palmeri</i>	careless weed, pigweed	native	annual
Amaranthaceae	GUMI	<i>Gutierrezia microcephala</i>	threadleaf snakeweed	native	perennial
Asteraceae	BASA2	<i>Baccharis sarothroides</i>	desert broom	native	perennial
Asteraceae	ERLA	<i>Ericameria laricifolia</i>	turpentine bush	native	perennial
Asteraceae	HEAN	<i>Helianthus annuus</i>	common sunflower	native	annual
Asteraceae	ISTE	<i>Isocoma tenuisecta</i>	burweed	native	perennial
Asteraceae	MAch spp	<i>Machaeranthera</i> spp.	tanseyster	native	perennial
Asteraceae	VEEN	<i>Verbesina encelioides</i>	golden crownbeard	native	annual
Cactaceae	CYIM	<i>Cylindropuntia imbricata</i>	cane cholla	native	perennial
Cactaceae	OPEN	<i>Opuntia engelmannii</i>	Engelmann's prickly pear	native	perennial
Chenopodiaceae	ATCA	<i>Atriplex canescens</i>	fourwing saltbush	native	perennial
Chenopodiaceae	ATGR	<i>Atriplex griffithsii</i>	Griffiths' saltbush	native	perennial
Chenopodiaceae	SATR	<i>Salsola tragus</i>	Russian thistle	non-native	annual
Chenopodiaceae	SUMO	<i>Suaeda moquinii</i>	Mohave seablite	native	perennial
Fabaceae	ACCO	<i>Acacia constricta</i>	white-thorn acacia	native	perennial
Fabaceae	PRVE	<i>Prosopis velutina</i>	velvet mesquite	native	perennial
Loasaceae	MEMU	<i>Mentzelia multiflora</i>	Adona's blazing star, stickleaf	native	perennial
Poaceae	ARPU	<i>Aristida purpurea</i>	purple three-awn	native	perennial
Poaceae	BOBA1	<i>Bothriochloa barbinodis</i>	cane bluestem	native	perennial
Poaceae	BOBA2	<i>Bouteloua barbata</i>	sixweeks grama	native	annual
Poaceae	CHVI	<i>Chloris virgata</i>	feather finger grass	native	annual
Poaceae	CYDA	<i>Cynodon dactylon</i>	Bermuda grass	non-native	perennial
Poaceae	DAPU3	<i>Dasyochloa pulchella</i>	fluff grass	native	perennial
Poaceae	DISP	<i>Distichlis spicata</i>	saltgrass	native	perennial
Poaceae	ENCE	<i>Enneapogon cenchroides</i>	soft feather pappus grass	non-native	perennial
Poaceae	ERC12	<i>Eragrostis cilianensis</i>	stink grass	non-native	annual
Poaceae	MUPO	<i>Muhlenbergia porteri</i>	bush muhly	native	perennial
Poaceae	SPAI	<i>Sporobolus airoides</i>	alkali sacaton	native	perennial
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	native	perennial
Poaceae	SPGI	<i>Sporobolus giganteus</i>	giant dropseed	native	perennial
Poaceae	SPWR	<i>Sporobolus wrightii</i>	giant sacaton	native	perennial
Salicaceae	POFR	<i>Populus fremontii</i>	Fremont cottonwood	native	perennial
Solanaceae	DAWR	<i>Datura wrightii</i>	sacred datura	native	perennial
Solanaceae	SOEL	<i>Solanum elaeagnifolium</i>	silverleaf nightshade	native	perennial
Tamaricaceae	TARA	<i>Tamarix ramosissima</i>	saltcedar	non-native	perennial

APPENDIX H – PROJECT AREA PHOTOGRAPHS



Photo 1. Typical upland vegetation along the perimeter of the Willcox Playa (sacaton grasses)



Photo 2. Edge of Willcox Playa looking toward barren playa in the distance (saltgrass and Mohave seablite)



Photo 3. Mohave seablite, only species surviving within the playa



Photo 4: Alkaline, clay, cracked soil of the Willcox Playa



Photo 5. Barren Willcox Playa (Mohave seablite plant)



Photo 6. Barren Willcox Playa within the project limits

Appendix F: Letters

Arizona State Historic Preservation Office Consultation Result



SHPO - 2017 - 0787 (1573 CB) / NHPA
ARIZONA STATE HISTORIC PRESERVATION OFFICE

DEPARTMENT OF THE ARMY
US ARMY GARRISON
DIRECTORATE OF PUBLIC WORKS
3040 BUTLER ROAD
FORT HUACHUCA ARIZONA 85613-7010



Directorate of Public Works

JUN 07 2017

Ms. Kathryn Leonard
State Historic Preservation Officer
Arizona State Parks
1300 West Washington
Phoenix, Arizona 85007

Dear Ms. Leonard,

The National Aeronautics and Space Administration and Boeing propose to use Willcox Playa for landing and recovery operations for the Commercial Crew Transportation System Starliner (CCTSS). The spacecraft will parachute into the locale, and a landing and recovery convoy of vehicles will recover the vehicle and crew. These activities will occur within a 4 km circle on Fort Huachuca land. Sixty-five concrete pillars within or just outside of the Area of Potential Effect will be removed prior to CCTSS use, and remainder of the activities will be surficial.

We consulted with Kris Powell in your office, and agreed that a cultural resources inventory was not required due to the barren nature of Willcox Playa. Harris Environmental Group (HEG) recorded Electronic Proving Ground (EPG) test features in the area, including 65 concrete pillars from the decommissioned Radar Geometric Fidelity Facility and 24 stone or metal features from the Radar Geology Test Area. After consultation with Ms. Powell, HEG recorded these features as a district due to their distribution. We are currently completing a historic context of EPG and know the facility functions and HEG fully recorded the features. The limited information from the district has been retained through field recordation, and further investigations are unlikely to yield information significant to advancing our understanding of Cold War testing in this area. Therefore, we recommend this district as not eligible for the National Register of Historic Places and that the undertaking will have no effect on significant cultural resources. We request your concurrence with these recommendations.

We consulted with the 11 Native American Tribes who claim affiliation to our area, and they had no concerns. If you have any questions, please contact Marty Tagg, Fort Huachuca Cultural Resources Manager at (520) 533-4428 or martyn.d.tagg.civ@mail.mil. Thank you for your attention to this matter.

No Historic Properties Affected

Sincerely,

Kris Powell 6-28-17
Arizona State Historic Preservation Office
Arizona State Parks Board

Dawn Rohr
Chief, Environmental and
Natural Resources Division

Enclosure

CC: Michael Fawcett, Special Aerospace Services

BLM Consultation Result



United States Department of the Interior
 BUREAU OF LAND MANAGEMENT
 Safford Field Office
 711 South 14th Avenue, Suite A
 Safford, Arizona 85546-3335
www.blm.gov/az/



September 13, 2018

In Reply, Refer To:
 2355 (G010)

Christopher Ferguson
 100 Boeing Way
 Titusville, Florida 32780

Dear Mr. Ferguson:

Thank you for providing detailed information about your proposed project (Boeing Starliner). The mission will send the Boeing Starliner spacecraft to earth at one of five landing sites, with one site (Willcox Playa) identified on public lands in Cochise County, Arizona. We have reviewed the project materials and additional information submitted via e-mail on September 5, 2018.

- The land status on the Willcox Playa is as follows; The Willcox Playa Dry Lake Bombing Range was withdrawn under Public Land Order 127, dated May 22, 1943. The intended use was for a military bombing range. The text and maps within the documents forwarded by Boeing incorrectly show the lands administered by Ft. Huachuca/Military. Even though the withdrawal was for military purposes, the Bureau of Land Management (BLM) retained management responsibilities on the withdrawn lands to issue third party use Rights-of-Way/Permits.
- On the NW side of the Playa is an Area of Critical Environmental Concern (ACEC) known as the Willcox Playa National Natural Landmark. The management prescription for that area is as follows:
 - The area is closed to Off Highway Vehicle Use
 - No woodcutting
 - No Rights-of-Way
- On the NE side of the Playa there is a Recreation and Public Purposes Patent issued to the Arizona Game and Fish for the Willcox Playa Wildlife Viewing Area. Any third party uses on that parcel could require a ROW/Permit from the BLM.

According to your e-mail, all planned activities will be taking place on lands that encompass the military withdrawal (bombing range) as shown in pink on the enclosed map with one potential exception being; six small jettisoned parts (up to 4 mortar lids and up to 2 forward heat shield doors). Depending on the wind direction, this could include jettisoned parts landing on BLM managed parcels outside of the military withdrawal. You indicated the BLM ACEC would not be impacted, as no activities are planned outside the military withdrawal. If wind models show any parts landing outside the military withdrawal on the ACEC, a no-go for landing that day would be called for.

There was no request made for staging areas on BLM lands outside the military withdrawal, as all vehicular traffic will take place entirely within the boundaries of the military withdrawal and there will be no cross country travel outside of the established boundary.

We have determined that a Right-of-Way/Permit will not be required. This decision was based on the information you provided along with the statement that Boeing has partnered with the Department of Defense (Army) in this endeavor. Please continue to coordinate with us regarding the road closure plan so that we can inform our public land users should questions arise. Thank you for providing the BLM an opportunity to review and comment on this project.

Sincerely,



Scott C. Cooke
Field Manager

Enclosure:

Willcox Surface Management map

Appendix G: List of Preparers and Reviewers

Prepared by:

Fawcett, Michael Senior Engineer
 Special Aerospace Services
 Years of Experience: 38

Reviewed by:

Baker, Nick NEPA and Technical Specialist
 ICF, FAA Environmental Support Contractor
 Years of Experience: 16

Czelusniak, Daniel Environmental Specialist
 Federal Aviation Administration
 Office of Commercial Space Transportation
 Years of Experience: 20

Dankert, Don Biological Scientist
 NASA/Kennedy Space Center
 Years of Experience: 21

Davis, Jeff Project Management Specialist
 Starliner Landing Recovery Team
 The Boeing Co.
 Years of Experience: 33

McArdle, Suzanne EHS Specialist
 Hazardous Material Manager
 The Boeing Company
 Years of Experience: 17

Murray, Shawna H&S Engineer
 The Boeing Company
 Years of Experience: 25

Phillips, Betty NEPA Coordinator
 Environmental and Natural Resources Division
 USAG Fort Huachuca
 Years of Experience: 10

Tagg, Martyn Cultural Resources Manager
 Environmental and Natural Resources Division
 USAG Fort Huachuca
 Years of Experience: 38

Appendix H: Agency Contacts and Distribution

<p>Phillips, Betty NEPA Coordinator Environmental and Natural Resources Division USAG Fort Huachuca</p>	<p>Daniel Czelusniak Environmental Specialist Federal Aviation Administration Office of Commercial Space Transportation</p>
<p>Don Dankert Biological Scientist NASA/Kennedy Space Center, FL</p>	<p>Kristin Terpening Habitat Evaluation and Lands Specialist Arizona Game and Fish Region V 555 N. Greasewood Rd. Tucson, AZ 85745</p>
<p>Matthew Behrend Cultural Resources Section Manager Arizona State Land Department 1616 W Adams St Phoenix AZ 85007</p>	<p>Fred Breedlove Natural Resources Division Director Arizona State Land Department 1616 W Adams St Phoenix AZ 85007</p>
<p>Scott Cook Bureau of Land Management 711 South 14th Avenue Safford, AZ 85546</p>	<p>Bureau of Reclamation 300 W. Congress FB37 Tucson, Arizona 85701</p>
<p>Environmental Protection Agency, Region 9 Office of Federal Activities 75 Hawthorne Street San Francisco, California 94105</p>	<p>United States Fish and Wildlife Service Arizona Ecological Services, Tucson Sub office 201 North Bonita Suite 141 Tucson, Arizona 85745</p>
<p>Cochise County Board of Supervisors 1415 Melody Lane Building G Bisbee, Arizona 85603</p>	<p>City of Willcox 101 South Railroad Ave. Ste. B Willcox AZ, 85643</p>
<p>Arizona Department of Environmental Quality 1110 W. Washington Street Phoenix, Arizona 85007</p>	<p>Arizona Department of Water Resources 3550 N. Central Avenue Phoenix, Arizona 85012</p>