

DRAFT FINDING OF NO SIGNIFICANT IMPACT

NAME OF THE PROPOSED ACTION: The National Aeronautics and Space Administration (NASA) Commercial Crew Transportation System Environmental Assessment for the CST-100 Boeing Starliner Launch from Cape Canaveral Air Force Station (CCAFS) and Landing and Recovery at the U.S Army White Sands Missile Range (WSMR).

INTRODUCTION: Pursuant to section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality Regulations (40 Code of Federal Regulations Parts 1500-1508) implementing the procedural provisions of NEPA, White Sands Test Center, gives notice that an Environmental Assessment (EA) was prepared and a Finding of No Significant Impact (FONSI) has been issued for the launch of the Boeing Starliner spacecraft from CCAFS, Florida and landing and recovery at WSMR, New Mexico. Based on the EA it has been determined that an Environmental Impact Statement (EIS) is not required for the proposed action. NASA, the Federal Aviation Administration (FAA), and the Army are all involved with this action with NASA being the lead agency. Three additional landing sites are planned for Edwards Air Force Base in California, Dugway Proving Grounds in Utah, and at the Willcox Playa in Arizona, controlled by Ft. Huachuca. Due to the limited cross-range capability of the Starliner, five landing sites are required to support the program. Separate EAs are being developed for these other landing sites. Any of the five could be utilized as the primary and backup landing site for a given Starliner mission.

DESCRIPTION OF THE PROPOSED ACTION: The proposed action is to allow the NASA Commercial Crew Transportation System initiative to launch the Boeing CST-100 Starliner spacecraft from CCAFS and to perform landing and recovery operations for two WSMR sites for two test missions, followed by subsequent missions up to two times per year. At CCAFS existing launch processing infrastructure would be utilized for integration and launch on the United Launch Alliance Atlas V rocket. At WSMR two landing sites have been selected, one in the north part of the range just west of the Trinity historic site and one at the old shuttle landing strip, that provide an adequate, 4 km radius landing zone for the Starliner. At both sites various test infrastructure (temporary buildings, instrumentation, target structures, and power lines) are located within the proposed landing zones. WSMR plans to clear the necessary terrain within the landing zones according to Army Policy, and Federal or State regulations. The action will also be used as part of Boeing's process to obtain a re-entry license for the CST-100 Starliner from the FAA.

This action will include the following:

- A. Clearing of the necessary landing zone terrain by demolition of abandoned buildings and burial or relocation of power lines per internal WSMR procedures and processes.
- B. Integration and launch of the Starliner from CCAFS.
- C. Staging of the landing recovery personnel and equipment at WSMR.
- 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, cargo, and its crew.

The EA provides additional detail regarding implementation features of the proposed action. The following two alternatives are considered: 1) the Preferred Alternative which would allow launch

from the CCAFS and the landing and recovery at WSMR (and the other three sites) up to two times per year; and 2) the no action alternative which would result in no launches or landings.

PURPOSE AND NEED: The purpose of the proposed action is to allow for the launch of the Boeing CST-100 Starliner from the CCAFS and the landing and recovery of the flight crew and International Space Station (ISS) cargo at WSMR beginning in 2018. The completion of the ISS and retirement of the Space Shuttle necessitate an innovative plan and program to fulfill the goal of returning 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 to clear the necessary terrain, as required, and support Starliner mission landing and recovery requirements at WSMR. The two test flights consist of an Orbital Flight Test (OFT) without crew in the January 2019 timeframe followed by a Crewed Flight Test (CFT) in the May 2019 timeframe. Routine missions would begin upon completion of these two test flights and take place up to times per year.

ALTERNATIVE TO BE IMPLEMENTED: The Preferred Alternative is selected for the implementation of the Proposed Action since it is the alternative that best meets the purpose and need of the Proposed Action and the EA concludes that its implementation would not significantly impact the human or natural environment.

ENVIRONMENTAL CONSEQUENCES: The EA contains the results of an impact analysis of the proposed action and alternative on the affected environment, including airspace and land use; physical resources (climate, topography, geology, soils, air quality, and water resources); aesthetics and visual resources; biological resources (flora, fauna and threatened and endangered species); cultural resources; noise and vibration; socioeconomic resources; utilities and infrastructure; hazardous and solid waste; radiation; and human health and safety. No significant impacts on the environment have been identified for the launch or landing activities and no significant cumulative impacts are expected.

CONCLUSION: Based on the analysis in this EA and consideration of the described mitigation measures and best management practices listed in Chapter 4 (for CCAFS) and Chapter 5 (for WSMR), and in accordance with the guidelines for determining the significance of proposed federal actions (40 C.F.R. 1508.27) and Environmental Protection Agency (EPA) criteria for initiating an Environmental Impact Statement (EIS) (40 C.F.R. 6.207), NASA and WSMR has concluded that the establishment of the two landing and recovery sites will not result in a significant effect on the environment. Applicable federal, state, and local laws and regulations would be followed. The NASA and WSMR have determined that an EIS pursuant to the NEPA is not required, and this Finding of No Significant Impact is hereby submitted.

DRAFT AVAILABILITY AND POC: The Draft EA is available to the public at the following information repositories:

In New Mexico:

Thomas Branigan Memorial Library - 200 E. Picacho Avenue, Las Cruces, New Mexico 88001

White Sands Missile Range Post Library - Building 465, WSMR, New Mexico 88002

Socorro Public Library - 401 Park St, Socorro, NM 87801

Alamogordo Public Library - 920 Oregon Ave. Alamogordo NM 88310 575-439-4140

In Florida:

Central Brevard Public Library & Reference Center - 308 Forrest Ave, Cocoa, FL 32922

Cocoa Beach Public Library - 550 N Brevard Ave, Cocoa Beach, FL 32931

Melbourne Public Library - 540 E Fee Ave, Melbourne, FL 32901

Merritt Island Public Library - 1195 N Courtenay Pkwy, Merritt Island, FL 32953

Port St. John Public Library - 6500 Carole Ave, Cocoa, FL 32927

Titusville Public Library - 2121 S Hopkins Ave, Titusville, FL 32780

The Draft EA is also available in Acrobat® format at

<https://environmental.ksc.nasa.gov/EnvironmentalPlanning/NEPA>

Written comments concerning the Commercial Crew Transportation System Environmental Assessment for the Boeing Starliner Launch from Cape Canaveral Air Force Station and Landing and Recovery at the U.S Army White Sands Missile Range should be sent to:

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DATES: Interested parties are invited to submit written comments on environmental concerns within 30 days from the date of this public notice.

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

March 2018

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



**Prepared by:
The Boeing Company**



DCC1-01290-01
Draft Commercial Crew Transportation
System (CCTS)
Environmental Assessment
For the Boeing Starliner Launch from
Cape Canaveral Air Force Station and
Landing and Recovery at the
U.S. Army White Sands Missile Range



28 March 2018

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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 two sites on the U.S. Army's White Sands Missile Range (WSMR) in New Mexico. 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. Three additional landing sites would be provided by Edwards Air Force Base in California, Ft. Huachuca's Willcox Playa in Arizona, and Dugway Proving Grounds in Utah. Other landing 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 Department of Defense (DoD) Army Branch acting as cooperating agencies. The first two test missions of the Starliner spacecraft would be under oversight of NASA. For follow-on operational missions, ULA intends to request an FAA-issued launch license to support Atlas V launches of the Starliner from CCAFS. In addition, Boeing intends to request an FAA-issued reentry license to support Starliner spacecraft landings at WSMR.

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, 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 651 *Environmental Analysis of Army Actions*.
- CFR Title 32, Part 989, *Air Force Environmental Impact Analysis Process (EIAP)*

The EA assesses impacts of the proposed action, discusses alternatives, and provides this information to the decision maker to make an informed decision on whether 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). A Finding of No Significant Impact (FONSI) would be issued by the agencies if this EA determines that the environmental

effects of the proposed action are not significant. A Notice of Intent to prepare an EIS would be published if this action appears to have significant impact.

The following NEPA documents analyze the potential environmental consequences of launching the Starliner atop the Atlas V rocket from 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 WSMR. These documents contain information about the affected environment that was used in the preparation of this EA. These documents also contain information about on-going activities performed by the Army and a general discussion of the affected environments present. These documents include:

- *Final Environmental Impact Statement for Development and Implementation of Range-Wide Mission and Major Capabilities at White Sands Missile Range, New Mexico*, U.S. Army, 2009
- *Integrated Natural and Cultural Resources Management Plan and Environmental Assessment*, U.S. Army, 2015
- *Final Environmental Assessment Joint Urban Test Capability White Sands Missile Range, New Mexico*, U.S. Army, 2013
- *Commercial Crew Transportation System (CCTS) Pad Abort Test, U.S. Army White Sands Missile Range Environmental Assessment*, DCC1-00755-01, Revision A, the Boeing Company, 2014

Throughout this document, the acronym “WSMR” refers to the entire White Sands Missile Range. “WSMR-649” is used when referring to just the northern landing site.

This EA only covers the landing and recovery operations for the Starliner spacecraft planned landings at the two WSMR sites. Separate EA’s are being developed for the other three landing sites.

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 would 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. None of the jettisoned spacecraft parts are recovered after an emergency water landing. All will sink. The CCTS system consists of three segments: the Starliner spacecraft, the Atlas V launching rocket, and the ground support infrastructure. The Starliner segment includes the Crew Module (CM), Service Module (SM), and Launch Abort System (LAS). This segment supports the flight crew through launch, on-orbit, and return operations. The CM is the only recovered portion of the Starliner. 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 WSMR Flight Test Integration Facility (FITF) 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.

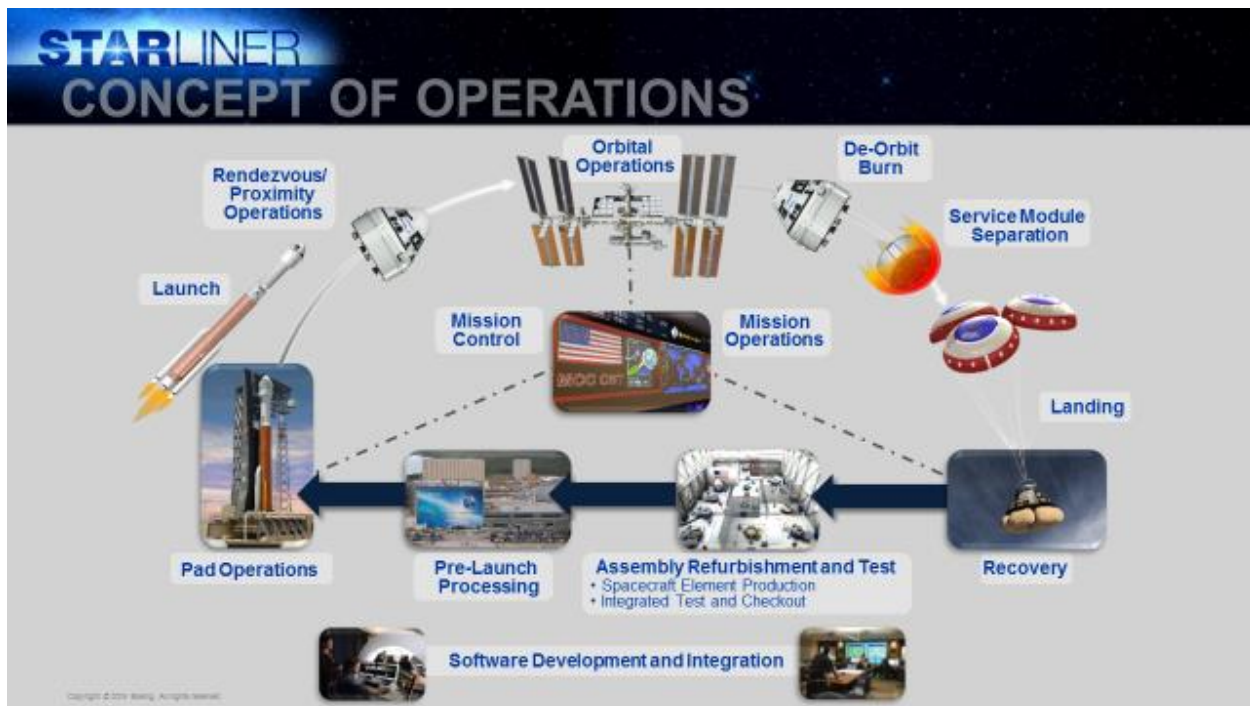


Figure 1-1: Starliner Concept of Operations

WSMR, at the request of NASA and the Boeing Corporation, is proposing to support the development of the CCTS Starliner as part of NASA's CCDev initiative by providing two landing sites for the Starliner.

WSMR is a DoD major range and test facility with headquarters located approximately 25 miles (mi) east of Las Cruces, New Mexico (Figure 1-2). The range possesses unique characteristics necessary for the U.S. Army, U.S. Navy, U.S. Air Force, NASA, and other Federal and commercial testing concerns to conduct safe, large-scale experiments on advanced weapons and space flight systems. WSMR covers approximately 8,288 square kilometers (km²) (3,200 square mi²) in south-central New Mexico. WSMR is the largest, all-overland test range in the Western Hemisphere. The range has diverse environmental attributes and resources. The primary mission of WSMR is the operation of a National Range in accordance with direction from the Army Test and Evaluation Command and DoD Directive 3200.11, *Major Range and Test Facility Base*. This mission includes range instrumentation research and

development; developmental testing of U.S. Army, U.S. Navy, and U.S. Air Force air-to-air/surface, surface-to-air, and surface-to surface weapons systems; dispense and bomb drop programs; gun system testing; target systems; meteorological and upper atmospheric probes; equipment, component, and subsystem programs; high-energy laser programs; and special tasks. WSMR also performs testing for commercial industry and foreign countries. NASA's nearby Lyndon B. Johnson White Sands Test Facility provides expertise and infrastructure to test and evaluate spacecraft materials, components, and propulsion systems.

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. WSMR is being asked to support the OFT and the CFT. In addition, the same support would also be required for NASA's follow-on Service Missions to the ISS. Two sites on WSMR (shown as blue circles on Figure 1-3), along with the three sites at EAFB, Willcox, and Dugway, would act as either the Primary Landing Site (PLS) or a Back-up Landing Site (BLS). In the case of a wave-off of a nominal landing, both a PLS and 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 WSMR to augment the LRT and an overview of the planned landing and recovery operations for all potential phases of the OFT, CFT, and follow on missions.

The northern most of the two landing sites is designated WSMR-649 (northern blue circle on Figure 1-2, shown in Figure 1-3). The southern site is designated White Sands Space Harbor (WSSH) (southern blue circle on Figure 1-2, shown in Figure 1-4). The Starliner would land within a circle with a radius of approximately 4 kilometers that provides a relatively flat surface free of any buildings or above ground obstructions that could cause a hazard to the landing spacecraft. Several pieces jettisoned during the landing sequence would normally land up to 8 km from the center of this circle however, in the event that the capsule returns to earth under a worst case wind scenario, it is possible that some jettisoned items would land up to 15 km from the center point, with some low energy mortar lids (having less than 15 joules at impact) landing up to 18 km from the center point. Figure 1-5 shows the Starliner spacecraft in its landing configuration.

WHITE SANDS MISSILE RANGE

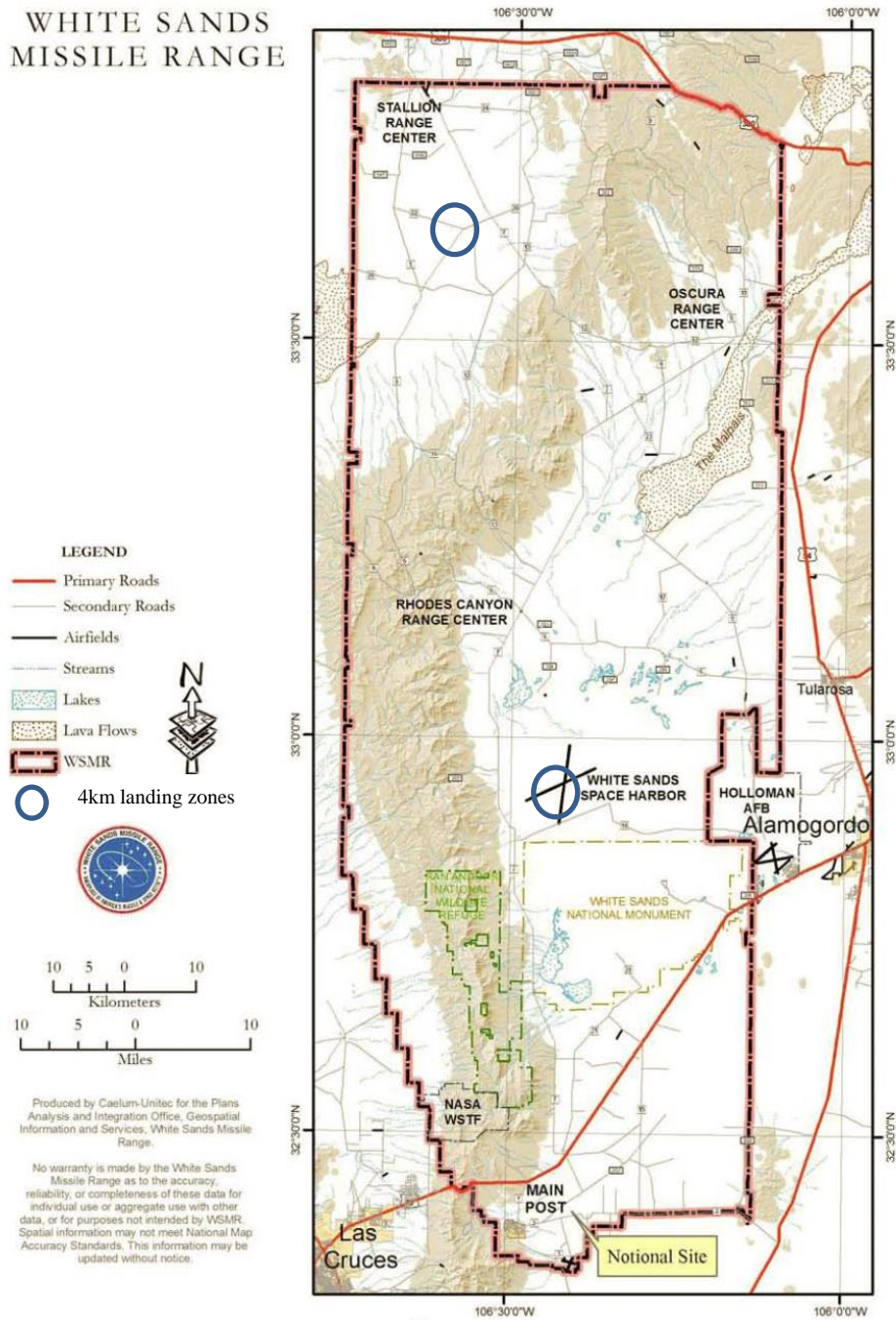


Figure 1-2: White Sands Missile Range



Figure 1-3: WSMR-649 Landing Area



Figure 1-4: WSSH Landing Area



Figure 1-5: Boeing Starliner

1.3 Proposed Action

For NASA and the DoD, the proposed action is to allow the CCTS initiative to launch from CCAFS and to perform landing and recovery operations for the Boeing Starliner at the WSRM sites for the OFT, CFT, and subsequent missions. At CCAFS existing launch processing infrastructure would be utilized for integration and launch on the Atlas V. At WSMR various test infrastructure (temporary buildings, instrumentation, target structures, and power lines) are located within the proposed landing sites. WSMR will work within existing base procedures and processes to evaluate, approve the final plan, and remove or relocate this infrastructure as is appropriate, according to Army Policy, and Federal or State regulations, in order to clear the 4 km landing zones. As a result, only high level information relative to these activities is included in this EA. The action does not involve any new construction.

As mentioned at the beginning of Section 1.1, in order for Boeing to conduct commercial Starliner missions, Boeing will have to obtain a reentry license from the FAA. In addition, ULA will have to obtain a launch license from the FAA. The FAA anticipated actions of issuing ULA a launch license for Atlas V, and issuing Boeing a reentry license for Starliner reentries and landings, are 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 reentry license application from Boeing for reentering and landing the Starliner at both WSMR sites. In addition, the FAA expects to receive a license application from ULA for Atlas V launches from LC-41 at CCAFS.. 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 two of the proposed landing sites, the Army is responsible for its real property assets and infrastructure in support of the landing and recovery of the Starliner spacecraft at WSMR. A support contract is in development between Boeing and WSMR 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 WSMR. 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
- Physical Resources (including water, topography, geology, and soil)
- Cultural Resources (Architectural, Archeological, 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 Environment

Impacts to farmland and floodplains were not assessed, as neither of these features are present at the launch site or in the landing zones. Impacts to coastal areas was only assessed at the launch site. In addition, natural resources¹ were not analyzed in detail in this EA because the proposed action would not

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

result in the development of new facilities or result in consumption of natural resources other than the fuel used during the launch operations and by the demolition and LRT vehicles.

Each environmental resource was evaluated according to a list of activities that were determined to be 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, and ensuring human safety. As discussed in chapter 3, the assessment identified no significant impacts.

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 to allow 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: the two WSMR sites in New Mexico, Dugway Proving Ground in Utah, the Willcox Playa in Arizona, and Edwards Air Force Base in California (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 two sites at WSMR met all requirements for providing an adequate landing area that are available the majority of the year. As both of these sites are located in the same geographic area and are on the same military range, both are included in this EA. 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 Willcox, Edwards, and Dugway.

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.

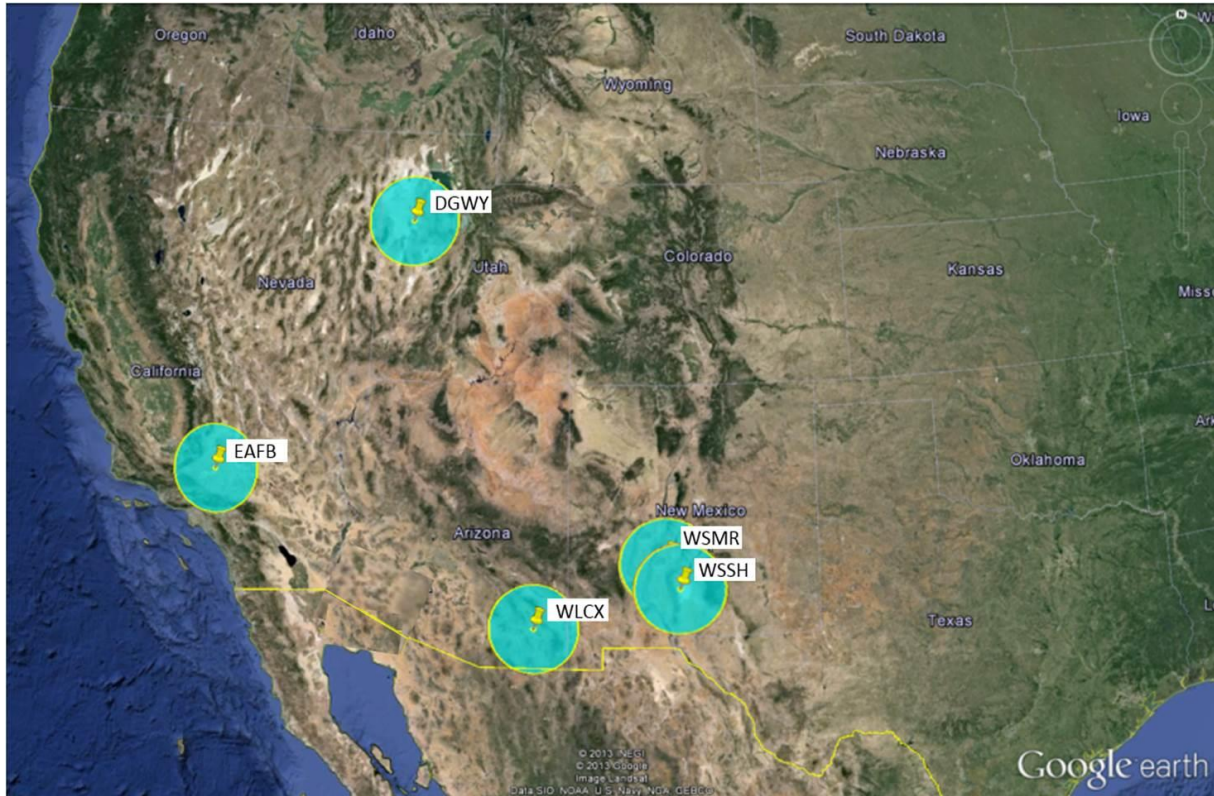


Figure 1-6: Starliner Landing Sites

1.7 No Action Alternative

Under the No Action Alternative, there would be no proposed action activities at CCAFS nor WSMR 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 launch and reentry licenses for Starliner operations.

1.8 Conclusion

This EA provides NASA, the DoD, and the FAA with the documentation of environmental impacts associated with the Starliner launch from CCAFS and landing and recovery at WSMR. The decision to be made is either: (1) Approve a FONSI 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 WSMR beginning in 2018. 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 to clear the necessary terrain, as required, and support Starliner mission landing and recovery requirements at WSMR. The OFT is scheduled for the January, 2019 timeframe with the CFT scheduled for the May, 2019 timeframe. 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 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 perform launch and landing and recovery operations of the Starliner and its flight crew. These operations would take place in the following phases:

- A. Clearing of the necessary terrain by demolition of abandoned buildings and burial or relocation of power lines per internal WSMR procedures and processes.
- B. Integration and launch of the Starliner from CCAFS.
- C. Staging of the landing recovery personnel and equipment at WSMR
- 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 WSMR as a landing location for the Starliner, C&D above would also be performed approximately 6 months before the scheduled OFT. Completion of A would be needed before the OFT mission in January, 2019.

For a commercial (i.e., non-NASA) mission, Boeing would be required to apply to the FAA for a reentry license. Therefore, the FAA action of issuing ULA a launch license for Atlas V, and issuing Boeing a reentry license for Starliner reentries and landings at the WSMR sites, 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. All ordnance and hypergolic propellants will be loaded in the C3PF. 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.

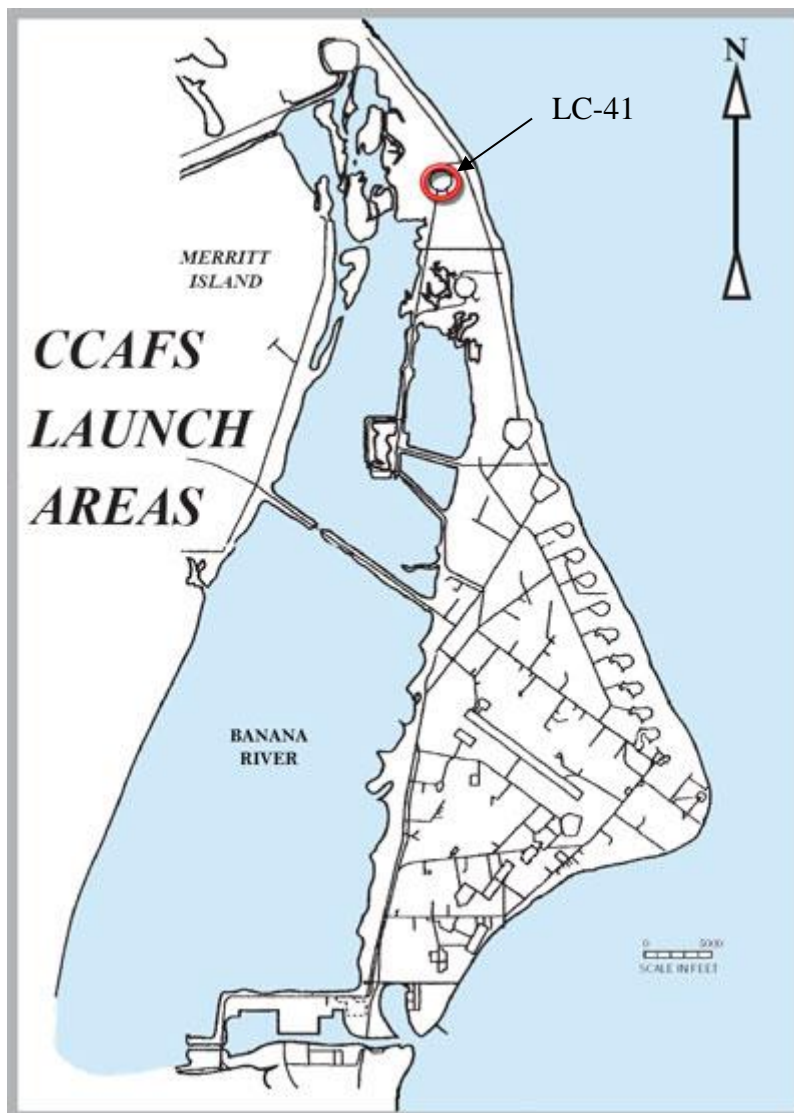


Figure 2-1: Launch Complex 41 Location

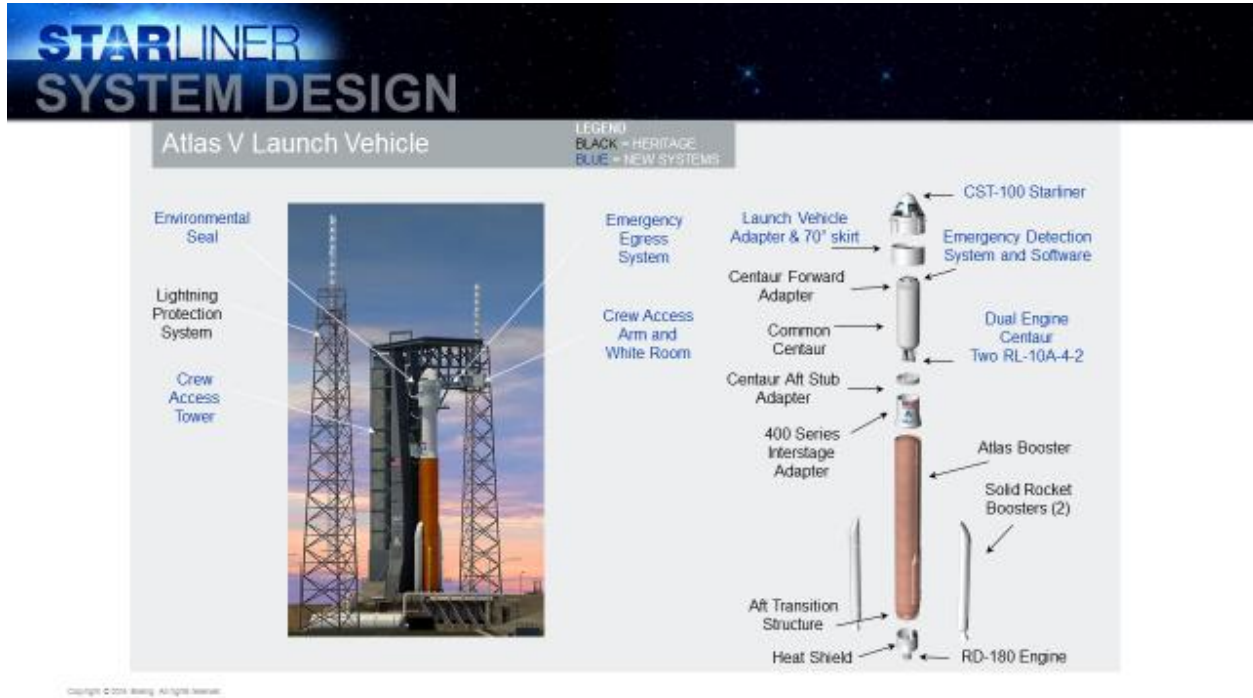


Figure 2-2: Starliner and Atlas Launch Configuration

2.4 Landing Locations

2.4.1 WSMR-649 Landing Area

The WSMR-649 landing site is centered at latitude 33.640 degrees North and longitude 106.610 West. (Figure 2-3).



Figure 2-3: Map of WSMR-649 Landing Area

2.4.2 WSSH Landing Area

The WSSH landing site is centered at latitude 32.95 degrees North and longitude 106.45 west. (Figure 2-4).

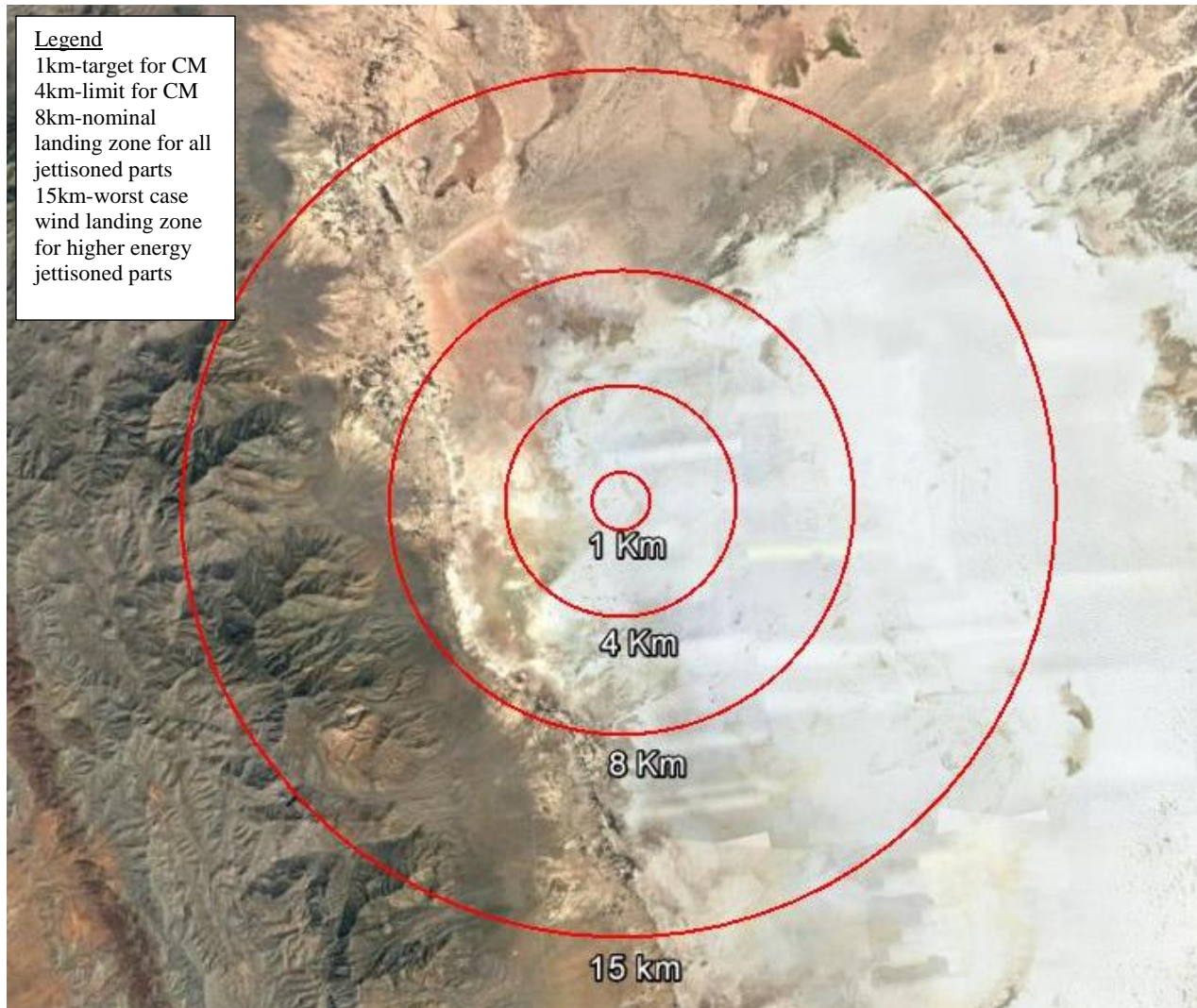


Figure 2-4: Map of WSSH Landing Area

2.4.3 Targeted Landing Points

The targeted CM landing is within a 1 km radius circle around the above center points. To allow margin based on the potential for changing winds, a 4 km radius circle will be cleared to allow a safe landing of the CM. All jettisoned pieces should nominally land within 8 km of this center point however, under worst case wind conditions, some of the smaller jettisoned parts could land up to 15 km from this center point. (See figures 2-3 and 2-4)

2.4.4 Operational Controls for 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 stay within the landing zone.

2.5 Preparing of Landing Zone

The Starliner requires a clear, relatively flat, circular landing zone 4 km in radius. There are currently a small number of abandoned buildings, test equipment, and power lines within the 4 km landing zones at both the WSMR-649 and WSSH sites. WSMR plans to demolish these buildings and will bury or relocate the power lines currently traversing across the landing sites to provide a clear landing zone at each site. No clearing of vegetation is required. This work will be approved and conducted per WSMR internal processes and regulations.

No new facilities will be constructed as part of this proposed action. All necessary support will be transported to the landing site on the day of landing and removed following completion of recovery operations.

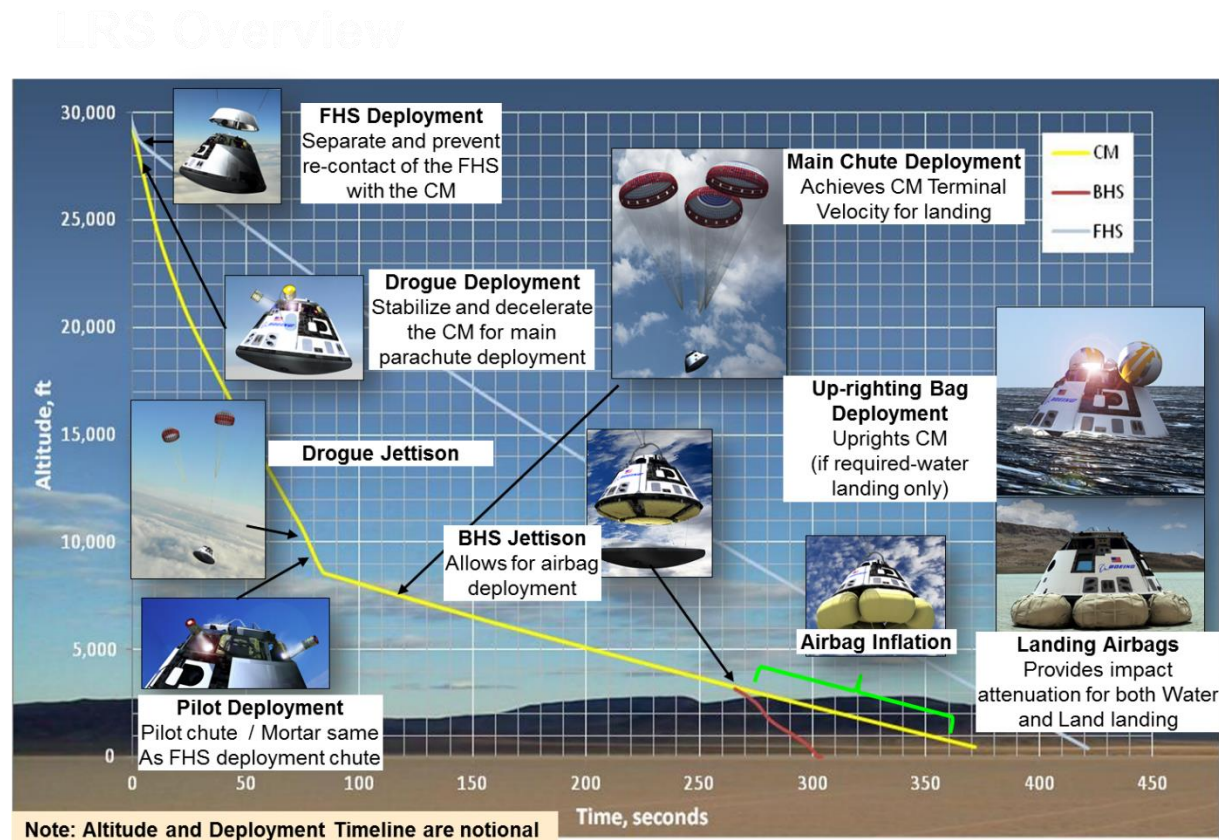
2.6 Starliner Description

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 crew members 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 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 ft. in diameter, less than 2 feet tall, and less than 350 pounds) would jettison at approximately 30,000 feet altitude and parachute to the ground under two pilot chutes each less than 10 feet in diameter and weighing less than 15 pounds. The CM drogue parachutes (2 chutes each less than 25 feet in diameter and weighing less than 75 pounds) would jettison at approximately 8000 feet altitude just before deployment of the main parachutes and continue to the ground. Three additional pilot chutes, identical to the FHS chutes, pull out the main chutes before releasing and continuing to the ground. Seven mortar lids (thin plates less than 18 inches in diameter) and 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 ft. in diameter, less than 4 feet tall and weighing less than 1700 pounds) would jettison at approximately 4400 feet altitude and would free fall until ground impact. The three main landing parachutes (less than 110 feet in diameter) would jettison at CM landing. All jettisoned pieces would land nominally land within an 8 km radius circle however, should the spacecraft land in a maximum wind condition scenario the higher energy (greater than 15 joules at landing) parts could drift up to 15 km from the center point. Some mortar lids having less than 15 joules at impact, and therefore below the risk threshold of injury to personnel or damage to structures (RCC 321-17), could land up to 18 km from the center point for these high wind cases. All items would be located and recovered, if possible. It may not be possible to find and recover all of the mortar lids and sabots due to their small size and the large area of the landing zone for these parts. The jettisoned items do not pose a significant threat to any area of environmental concern. Appropriate methods of recovery will be practiced for all jettisoned items to ensure minimum environmental impacts. The CM contains hazardous material in the form of residual hydrazine, unused explosive devices, ammonia, and heat transfer material.

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. Only the CM and crew are recovered after an emergency water landing. All jettisoned parts of the spacecraft will sink.



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Figure 2-5: Starliner Landing Sequence

2.7 Landing Recovery Forces Description

The landing and recovery convoy would consist of both Boeing and WSMR vehicles and equipment. The Boeing vehicles and equipment would arrive at WSMR one week prior to the planned landing date and would park 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 landing recovery personnel, equipment, and portable buildings to the landing site. WSMR would provide a crane for Starliner recovery, fire and rescue, and emergency medical vehicles and personnel.

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 landing zone 3 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 and perform 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.

Temporary shelters 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 landing and recovery convoy.

Figure 2-6 shows 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 CM, and other support vehicles.

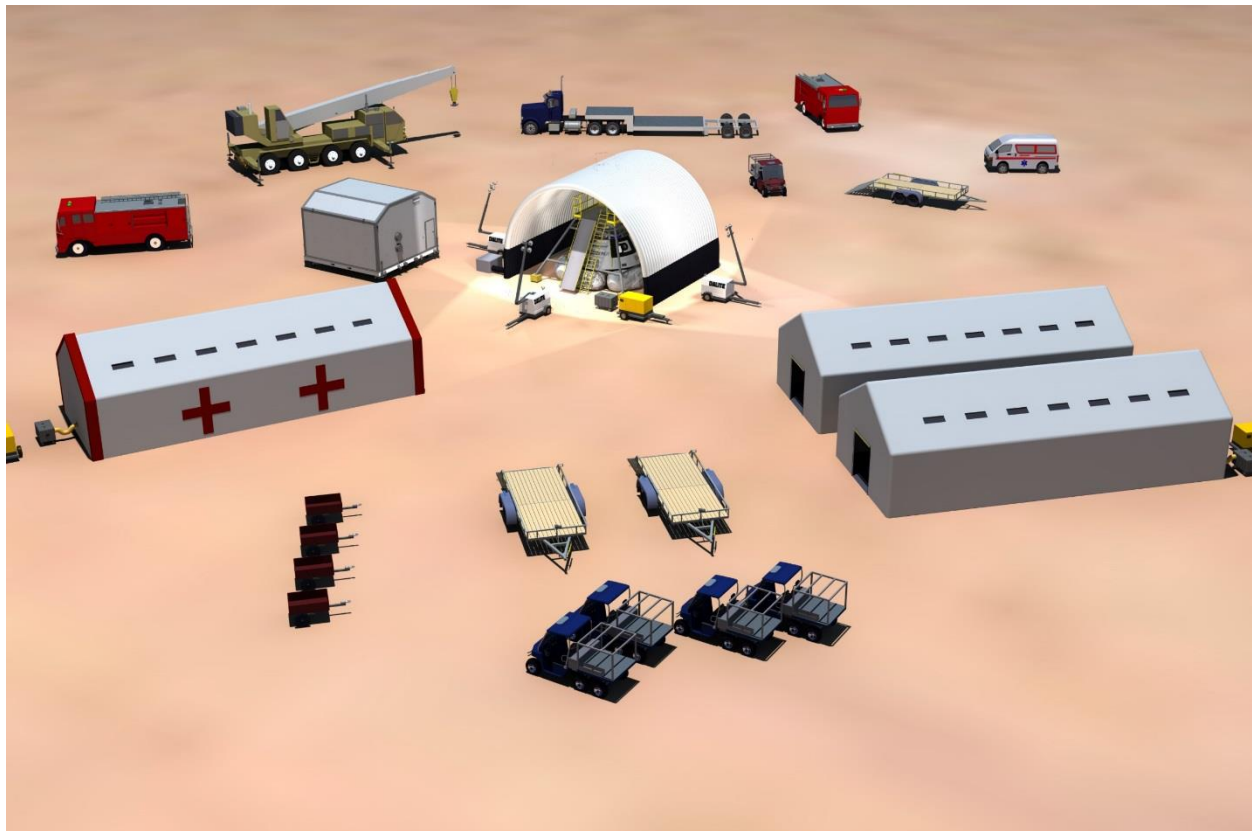


Figure 2-6: Landing Site Post Landing Configuration (notional)

2.8 No Action Alternative

Under the No Action Alternative, there would be no proposed action activities at CCAFS or WSMR 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 launch and reentry licenses 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 for allowing 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 an injured astronaut.
4. Access for recovery – not 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 landing the CM, for a large portion of the year.
6. Geographic location for a 51.6 degree inclination mission, allowing for the SM disposal in the Pacific, to ensure the SM pieces that survive re-entry to not impact on land, and between the latitude trajectory limits of the ISS.

This assessment resulted in selection of WSMR-649 and WSSH as two of the five areas (along with Dugway, Willcox and Edwards) for designation as landing sites due to the suitability of the landing sites and the availability of the supporting capabilities needed. WSMR-649 and WSSH also have favorable weather throughout the year. As both these sites are located in the same geographic area and are on the same military range, both are included in this EA. Landing and recovery activities at Willcox, Edwards, and Dugway are being assessed in separate EAs.

The following sites were assessed but not selected. Each 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 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 in addition to the one selected but not selected due to site size and 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 concerns about impacting a pristine desert environment

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

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 WSMR) describe 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 WSMR landing sites. 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 of this EA is the area within the boundaries of WSMR with the following exceptions:

For Department of Transportation Act, Section 4 (f), Biological Resources, Noise and Noise-Compatible Land Use, and Airspace, the region of influence also includes the area within the sonic boom 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 areas of New Mexico’s Doña Ana and Otero Counties.

Table 3-1: Table summary of Environmental Analyses for the WSMR Landing Sites

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>WSMR: Combustion emissions from generators and vehicles and dust would be generated by the landing and 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 and 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>WSMR: A small area of vegetation (if present) would be disturbed by the Starliner landing and recovery operations. Jettisoned</p>	Insignificant Impact

	<p>hardware would be collected as efficiently as possible to minimize the impact to vegetation and wildlife. Wildlife could be affected by Starliner landing and recovery activities and noise. Wildlife populations would not be significantly impacted because the activity would affect only a limited portion of the total available habitat and is very short term in nature. Threatened, endangered, or sensitive species are unlikely to occur at the landing sites. 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 affects. There would be no significant impacts to vegetation or wildlife.</p>	
Climate (3.3)	<p>CCAFS: The Starliner integration and launch activities would have no impact on the climate.</p> <p>WSMR: The demolition and landing recovery operations are very short term in nature. The demolition activities are a one-time event while the landing recovery activities happen infrequently. The proposed action would not be a major source of GHG emissions. The climate at WSMR 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>WSMR: Direct impacts from landing and recovery operations are not anticipated to extend outside the boundaries of WSMR to the surrounding communities with the following exceptions:</p> <ul style="list-style-type: none"> -The sonic boom which will be short term in nature and, while possibly noticeable (the maximum overpressure is 0.5 psf. which equates to less than a clap of thunder), would not cause any impacts. -The potential for jettisoned items to land in the northern section of the White Sands National Monument should the Starliner be required to land under worst case wind conditions. This would require closure of the Monument for a short period. WSMR Flight Safety would coordinate with the Monument should this be required per standard WSMR procedures. -The potential for jettisoned items to land in the Trinity National Historic Landmark. However, the landmark is only open to the public on two weekends per year. Starliner landings will not be planned at WSMR-649 for those two weekends. -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. <p>The Proposed Action would not result in a use of Section 4(f) resources.</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>WSMR: The removal of abandoned buildings and burial of power lines would help return the landing zone to its natural state. White Sands National Monument (if required) and airspace closures during</p>	Insignificant Impact

	<p>landing would be coordinated with WSMR Flight Control and would be short term in nature and infrequent. All parts of the Starliner spacecraft would be removed and the landscape left in its original condition to the extent possible. It may not be possible to find all the jettisoned parts due to their small size and the size of the landing zone. These jettisoned items do not pose a significant threat to any area of environmental concern. Overall, the topography, soil, and soil quality would not be significantly affected. The landing recovery operations are typical of activities carried out at WSMR. No significant land use or airspace impacts are expected. The proposed action would not change the existing use of the land.</p>	
Physical Resources (3.6)	<p>CCAFS: The Starliner transportation, integration, and launch would have negligible impacts on physical resources.</p> <p>WSMR: The surface and ground water resources would not be impacted by the landing and recovery operations. The potential for soil contamination exists should a failure occur, but processes are in place to mitigate contamination and appropriately clean up any contamination that may occur. Overall, the topography, soil, and soil quality would not be significantly affected.</p>	Insignificant Impact
Cultural Resources (3.7)	<p>CCAFS: The Starliner would have no impacts on cultural resources during launch integration and processing.</p> <p>WSMR: Previous cultural surveys of the proposed landing sites were reviewed and additional surveys were conducted as part of the development of this EA. There are four sites within the WSMR-649 main 4 km landing zone that have been determined as eligible for the NHRP. Three of these are prehistoric and one is related to the Trinity National Historic Landmark. None are affected by the building demolition or power line removal/burial. The chances of the Starliner or a jettisoned part landing on any of these 4 sites is inherently low however, the landing recovery team will be trained to avoid these areas during recovery operations. Should any part of the spacecraft come to rest in one of these areas, WSMR archeologists would be notified for guidance on how to proceed. There are also four sites at WSSH that have been recommended for the NRHP. These consist of three runways and a control tower used for the Space Shuttle Program. Of these, the runways are within the Starliner landing zone but the landing recovery operations would not have any long term effect on these surfaces. 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 State Historic Preservation consultation resulted in a concurrence with the WSMR recommendation of “no historic properties affected”. Overall the cultural resources would not be significantly impacted.</p>	Insignificant Impact
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>	Insignificant Impact

	<p>WSMR: Noise generated during landing and recovery operations would be consistent with that generated by other activities at WSMR, with the exception of the sonic boom (maximum overpressure 0.5 psf), which would be very short term in nature and not cause any impacts. Any loud noise or vibration generated by the demolition and LRT vehicles and activities during the demolition and recovery operations would be infrequent, very short in duration, and not be expected to affect the local people or wildlife. The proposed landing and recovery operations would have no significant impact on conditions that currently exist.</p>	
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>WSMR: 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>WSMR: For landing and recovery operations, direct impacts are not anticipated to extend outside the boundaries of WSMR to the surrounding communities, with the exception of the sonic boom which, while potentially noticeable to the population within the footprint, will be short term in duration and 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>WSMR: Portable lighting would only be used when landing recovery operations take place after sunset and then only for the six hour 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 to both the landscape and local wildlife would be insignificant.</p>	Insignificant 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>WSMR: 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	<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. Personnel would be trained prior to launch integration operations and comply with applicable Air Force</p>	Insignificant Impact

<p>Pollution Prevention (3.13)</p>	<p>procedures and protocols. No significant impact relative to the use of hazardous materials or disposal of waste is anticipated. WSMR: Hazardous materials would be present on the Starliner and in the ground cooling units that are part of the landing recovery convoy. Solid waste would be generated during both the demolition and landing recovery activities. Hazardous waste would only be generated if a failure occurs on the Starliner spacecraft. Biohazard waste could be generated during the astronaut post-landing medical evaluation. This would be removed by the medical team for disposal. Personnel would be trained prior to 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>	
<p>Human Health and Safety (3.14)</p>	<p>CCAFS: Personnel would be trained prior to launch integration and operations and comply with applicable Air Force procedures and protocols. No significant impact on human health and safety is expected. WSMR: Personnel would be trained prior to landing and recovery operations and comply with applicable Army procedures and protocols. Protective gear would be used at landing until the Starliner is determined to be safe for recovery operations. No significant impact on human health and safety is expected.</p>	<p>Insignificant Impact</p>

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 Starliner activities taking place at KSC prior to transportation to the launch site are:

- The buildup and testing of the Starliner spacecraft.
- Installation of ordnance, loading of hypergolic propellants, and non-time critical cargo.
- Loading into the transportation container for transportation to the CCAFS. ULA will perform the loading and transportation.

The route used to transport the Starliner to the VIF is shown in Figure 4-1. A combination of KSC and CCAFS security will secure the route prior to transportation.

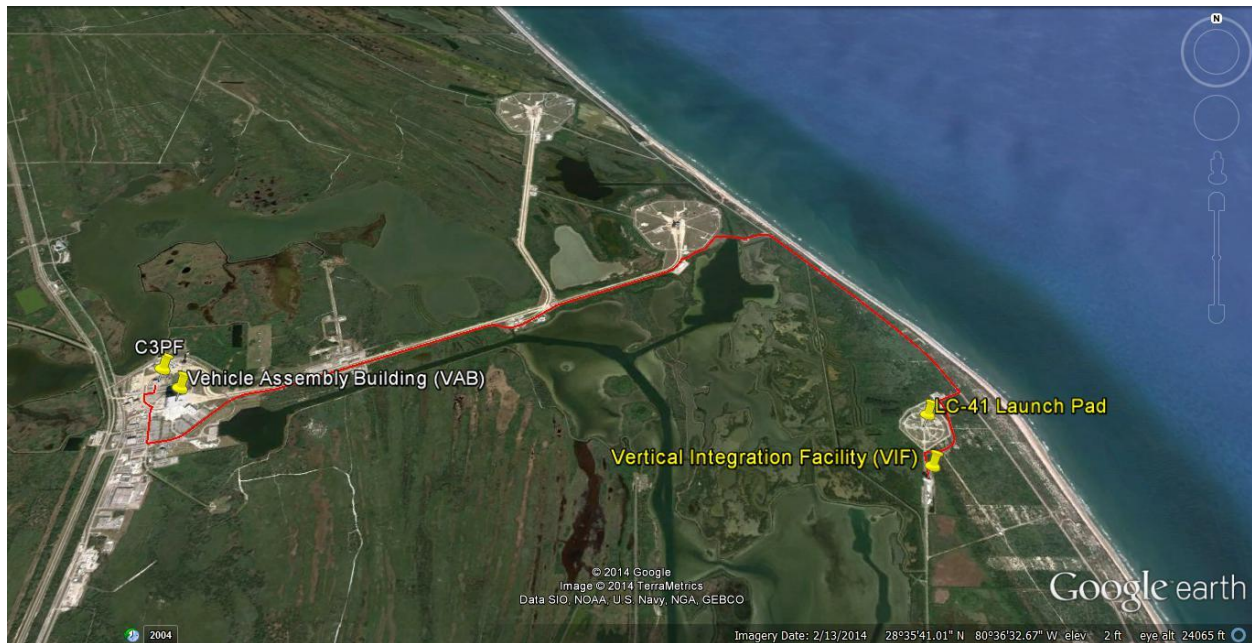


Figure 4-1: Starliner Transportation Route from the Boeing C3PF to the CCAFS

For this action the Starliner activities taking place at the CCAFS are:

- Transportation of the Starliner to the Vertical Integration Facility (VIF).
- Lifting the Starliner onto the top of the Atlas V.
- Connection of all physical interfaces and umbilicals between the Starliner and the Atlas V.
- Integration and testing of the Starliner interfaces to the Atlas V rocket and the ground support facilities.
- Transporting the integrated Starliner/Atlas V to the launch pad.

- Loading of late cargo items and the crewmembers.
- Launch.

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 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 will 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.

4.2.1 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.

4.2.2 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.

4.2.3 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.

4.2.4 Department of Transportation Act, Section 4(f)

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

4.2.5 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.

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

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

4.2.7 Cultural Resources (Architectural, Archeological, and Area of Tribal Interest)

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

4.2.8 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.

4.2.9 Socioeconomics

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

4.2.10 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.

4.2.11 Visual Effects

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

4.2.12 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.

4.2.13 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.

4.2.14 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.

4.2.15 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.

4.2.16 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 WSMR Affected Environments and Environmental Impacts

The *Final Environmental Impact Statement for Development and Implementation of Range-Wide Mission and Major Capabilities at White Sands Missile Range, New Mexico* (U.S. Army, 2009) contains details on the on-going activities that take place at WSMR. This EIS and the *Integrated Natural and Cultural Resources Management Plan (INCRMP) and Environmental Assessment* (U.S. Army, 2015) contain a general discussion of the affected environments present. Both were utilized in the preparation of this EA. The *Final Environmental Assessment Joint Urban Test Capability White Sands Missile Range, New Mexico*, U.S. Army, 2013 and the *Commercial Crew Transportation System (CCTS) Pad Abort Test, U.S. Army White Sands Missile Range Environmental Assessment*, DCC1-00755-01, Revision A, the Boeing Company, 2014 were also utilized in the preparation of this EA.

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). WSMR is located in counties considered to be in attainment of NAAQS except potentially for particulate matter less than 10 microns in size (PM10). In December 2000, the New Mexico Air Quality Bureau submitted a Natural Events Action Plan (NEAP) for Doña Ana County for PM10. EPA would excuse those PM10 exceedances caused by uncontrollable natural events, if adequate dust control plans are in place. For Doña Ana County, getting these exceedances excused would keep the area from being designated as nonattainment for PM10 (EPA 2011, New Mexico Environmental Department (NMED) 2016) High levels of particulate matter from natural sources, such as dust storms, may occur temporarily during periods of high winds. The State of New Mexico, in accordance with federal clean air standards, has adopted a set of air quality control regulations that apply to stationary sources of air pollution, such as diesel generators. They do not apply to mobile sources, such as trucks, aircraft, or missiles.

WSMR has a Title V air permit (Permit # P085R2) and must comply with applicable federal, state, and local regulations. WSMR must also comply with State or Federal Implementation plans, if any, with adequate supporting analysis. Air quality at WSMR is affected by daily weather conditions, such as individual and common collective sources of air pollutants. Most emissions are primarily from vehicle exhaust and dust generated on dirt and gravel roads. The proposed action would produce temporary man-made airborne pollution from vehicles traversing dirt and gravel roads and vehicle engine and portable generator emissions during landing and recovery activities. WSMR has signed a memorandum of agreement with the New Mexico Environment Department regarding the Natural Events Action Plan. This plan outlines WSMR's actions and responsibilities to implement dust control measures in an effort to reduce anthropomorphic dust.

Refer to Section 3.4 of the WSMR EIS for a general discussion of air quality (U.S. Army, 2009).

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 clearance of the landing sites, by demolishing unused buildings and burying power lines, and two landing tests followed by regularly scheduled missions anticipated to take place 1-2 times/per year (spread out over the 5 landing sites), all of short duration.

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

Dust or soil particulate matter disturbance would occur at the landing site for the Starliner spacecraft, at the impact sites for the items jettisoned before landing, and from the recovery vehicles. However, only small quantities of dust would be generated during these short events. 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.

The proposed action would require the use of portable generators to supply appropriate power at the demolition and landing sites. For demolition the construction contractor would be responsible for providing any permitting necessary. For Starliner landings, WSMR would provide generators from existing units if available. These generators are included in the WSMR Title V Air Permit, and would be operated in accordance with the applicable regulations and operating restrictions. If WSMR generators are unavailable, Boeing would supply units and the air permit would be modified as needed.

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.) Standard Operating Procedures (SOPs) would be developed, including having personnel in personal protection equipment approach the spacecraft with sampling equipment 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 sampling 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) (2 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 WSMR 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 fuel leak from a vehicle or generator, WSMR SOPs would be utilized to contain and clean up the spill, thereby minimizing impacts to air quality.

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

Based in the size of the LRT convoy that will be involved in the activities, emissions are estimated at a few tens to a few hundred pounds per year, depending on the pollutant. This is well 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 WSMR. Therefore, the No Action Alternative would not result in air quality impacts at the WSMR landing sites or the surrounding area.

5.1.4 Mitigation Measures

Normal dust-suppression methods would be employed as necessary. Vehicles and generators would be inspected to ensure proper working order and compliance with applicable permitting requirements, safety. The site safety plan would be designed to minimize environmental impacts and health hazards in the unlikely event of an accidental fuel or hazardous material leak. Hazardous materials-related response plans and standard safety operating plans would be developed before beginning the proposed action.

5.2 Biological Resources

5.2.1 Affected Environment

A literature search was performed to compile existing data relating to surveys that have been previously conducted at or near the proposed landing sites. Additionally, the U.S. Fish and Wildlife Service (USFWS) website was consulted to complete an Information for Planning and Conservation (IPaC) search which provided a current list of potential threatened and endangered species (TES) that may occur at the proposed landing sites. Natural resource surveys were then conducted at each of the proposed landing sites. For each site ten sampling points were selected (green circles on figures 5-1 and 5-2), each consisting of a 425 ft. (129 m) radius area, that were surveyed by walking throughout the area and recording vegetation and faunal species. Note the maps also show old land condition trend analysis points (shown as LCTA). These were not utilized as part of the survey results.

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).

The migratory bird nesting season for WSMR is between March 1 and August 31.

A general discussion on biological resources found on WSMR is available in Section 3.7 of the WSMR EIS and the WSMR Integrated Natural and Cultural Resources Management Plan and Environmental Assessment (U.S. Army, 2009; US Army, 2015).

The report generated as a result of the 2016 survey is found in Appendix E of this document.

WSMR-649 Landing Site

Four vegetation communities have been described at the WSMR-649 landing site: desert plains grassland, lowland basin grassland, sandsage shrub land, and vegetated gypsum outcrop (Muldavin et al. 2000). Desert plains grasslands are characterized as occurring on rolling sandy plains with black grama/soaptree yucca communities (Muldavin et al. 2000). Lowland basin grasslands are characterized by alkali sacaton dominated types and occur on alluvial flats in basin bottoms (Muldavin et al. 2000). Sandsage shrub lands are dominated by sand sagebrush on the sandy plains of the northern Jornada Del Muerto basin (Muldavin et al. 2000). This community is intermixed with desert plains and lowland basin grasslands. The vegetated gypsum outcrop community is restricted to gypsum outcrops within basin bottoms and on foothills throughout WSMR (Muldavin et al. 2000). Basin bottoms are characterized by Gyp dropseed/hairy coldenia and Fourwing saltbush/Gyp dropseed communities (Muldavin et al. 2000). Figure 5-1 shows the demarcations between these communities and the 10 sample sites for the biological survey conducted. At the WSMR-649 site, locations outside the 4km CM landing zone were surveyed to take into account vegetation that could be impacted by the larger landing zone.

The USFWS IPaC produced a total of 15 potential TES that exist in Socorro County. After analyzing information from the literature search, consultation with resource experts, and assessing existing habitat conditions, seven species were deemed appropriate for consideration within the landing zone (Table 5-1).

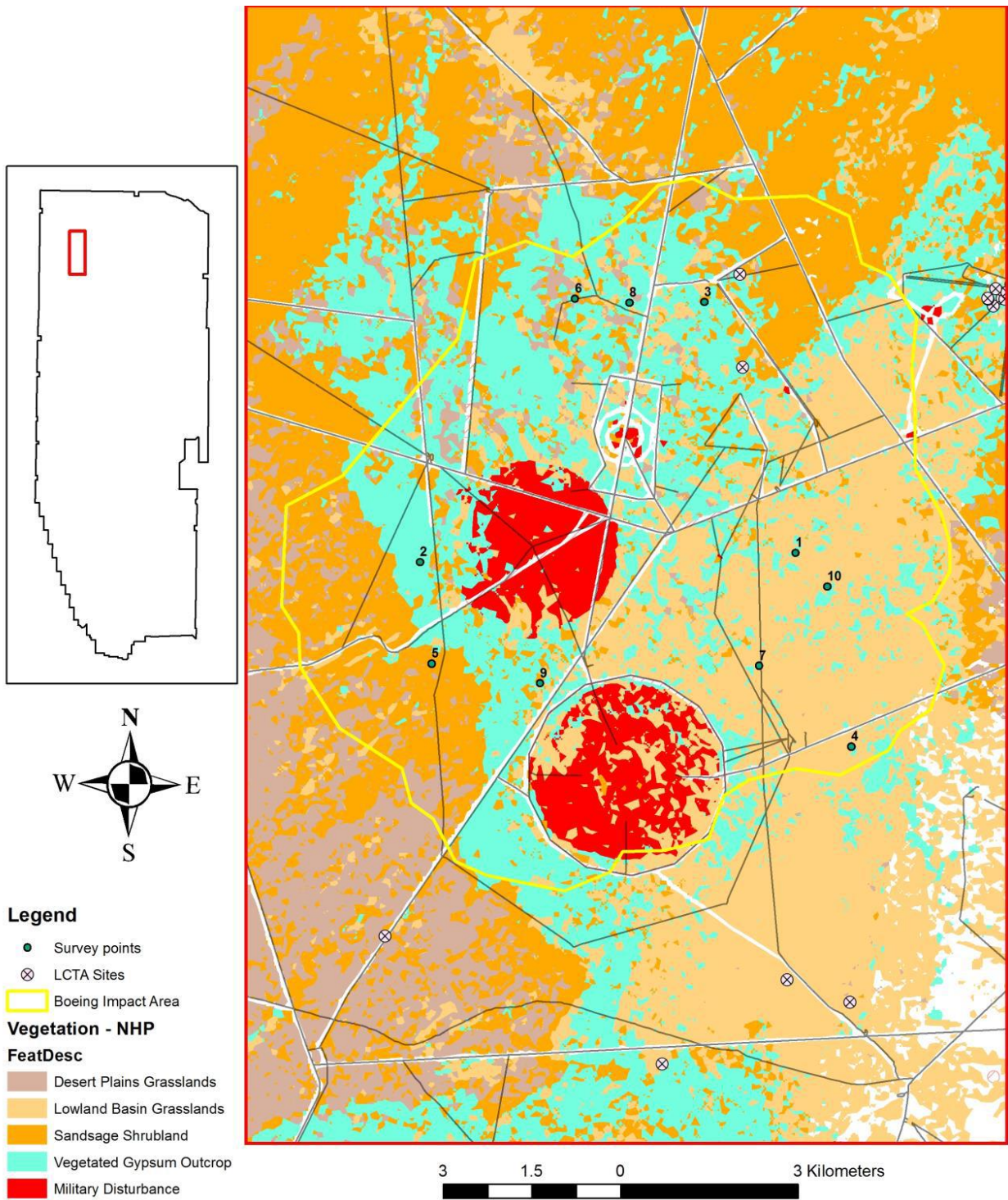


Figure 5-1: WSMR 649 Vegetation Communities and Survey Locations

Species	Status	County where species occurs	Range/Habitat Requirements	Potential Occurrence at 649 WIT	Note on Effects Determination
Least Tern (<i>Sterna antillarum</i>)	Endangered	Socorro	River systems	Unlikely to occur	No Effect
Aplomado falcon (<i>Falco femoralis septentrionalis</i>)	Endangered, Experimental populations, Non-essential	Socorro	Desert grassland associations	Unlikely to occur	No effect
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Threatened	Socorro	Riparian systems	Unlikely to occur	No effect
Piping Plover (<i>Charadrius melodus</i>)	Threatened	Socorro	Sandy upper beaches and shorelines	Unlikely to occur	No effect
Southwestern Willow flycatcher (<i>Empidonax traillii extimus</i>)	Endangered	Socorro	Riparian habitats	Unlikely to occur	No effect
Pecos sunflower (<i>Helianthus paradoxus</i>)	Threatened	Socorro	Permanent wetlands	Does not occur	No effect
New Mexico meadow jumping mouse (<i>Zapus hudsonius</i>)	Endangered	Socorro	Riparian habitats	Does not occur	No effect

Information obtained from USFWS; Muldavin et al. 2000; WSMR 2015; Burkett 1997; and Tazik et al 1992.

Table 5-1: Species Federally Listed as Threatened and Endangered, Recorded or Potentially occurring at 649 WIT North Landing Site

All five bird species considered for this site have the potential to fly through the area, particularly during spring and fall migration. Desert plains grassland habitat with yucca association is known to provide habitat for the Northern Aplomado falcon. No suitable habitat exists at the 649 site for the other three species of birds considered. No wetland or riparian habitat suitable for the Pecos sunflower or the meadow jumping mouse exist within the North landing zone. A single observation of an aplomado falcon was recorded in the Stallion basin near Gallegos Site in 2005 (Burkett 2005). Other observations of aplomado falcons in the Stallion basin were the result of the reintroduction program, which is no longer being conducted. The Peregrine Fund (2014) has determined that this region of the Chihuahuan Desert is not currently suitable for the aplomado falcon due to prolonged drought. This analysis supports the conclusion that no threatened or endangered species are at potential risk from proposed landing and recovery operations of Boeing spacecraft at the North landing site.

Surveys at the WSMR-649 landing site revealed several habitat types. Survey sites 1, 3, 4, 7, and 10 were in the lowland basin grassland vegetation type and were dominated by fourwing saltbush and alkali sacaton. Survey plot 8 was characterized by a burrograss flat. Survey plot 6 is a soaptree yucca/alkali sacaton grassland. Survey plot 2 was dominated by fourwing saltbush with scattered soaptree yucca.

Survey plot 5 is a black grama/soaptree yucca grassland. Survey plot 9 is a fourwing saltbush shrub land. Bare ground appeared to comprise the majority of the surface area (60-70 percent) within survey plots number 7, 9, and 10. Thirty-seven species of vegetation were identified within the survey areas. Twenty-seven faunal species were detected during the surveys.

A complete list of species identified at WSMR 649 can be found in Appendix E: Natural Resources Survey Report.

WSSH Landing Site

Muldavin et al. (2000) classified the vegetation at the WSSH landing site as pickleweed shrub land. These communities are characterized as open-canopied shrub lands of pickleweed with understories that are poor in diversity and cover (Muldavin et al. 2000). These communities are an excellent indicator of highly alkaline soils (Muldavin et al. 2000). Species diversity appears to be naturally low in this community, with only a limited set of salt-tolerant species able to occupy these areas (Burkett 1997, WSMR 2015, Muldavin et al. 2000, Tazik et al. 1992). Faunal surveys conducted in this habitat type have resulted in detection of very few faunal and floral species (Burkett 1997, Tazik et al. 1992). Figure 5-2 shows the 10 sample sites for the biological survey conducted. At the WSSH site, only locations within the 4km landing zone were surveyed as this was representative of the vegetation that could be impacted by the larger landing zone.

For analysis of the WSSH landing site the USFWS IPaC produced a total of four potential TES that exist in Doña Ana County. Species federally listed as endangered, threatened, candidate, or proposed, and nonessential experimental populations that may occur within the landing sites were examined to determine potential for occurrence and effect from proposed actions (Table 5-2).

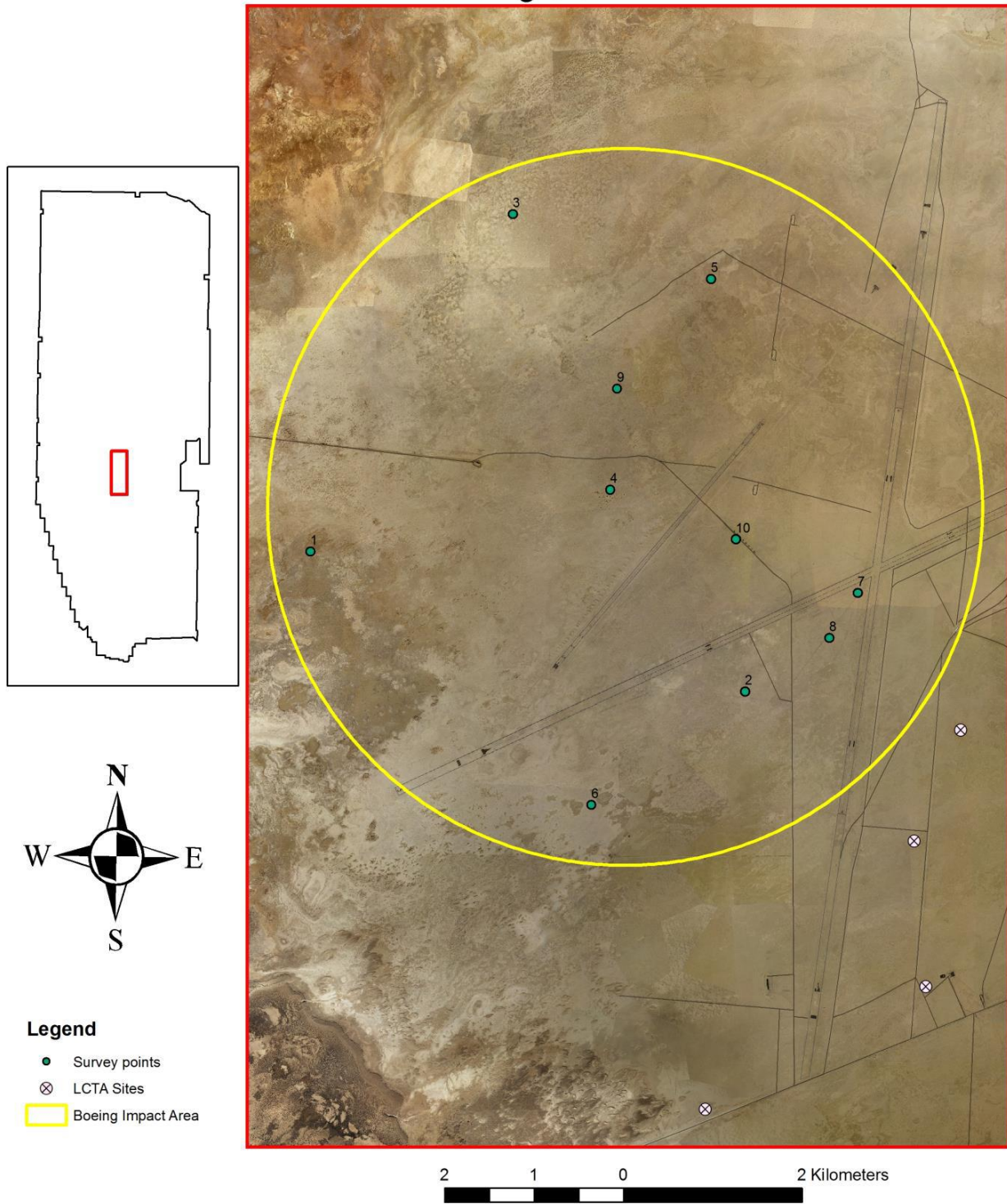


Figure 5-2: WSSH Vegetation Survey Locations

Species	Status	County where species occurs	Range/Habitat Requirements	Potential Occurrence at WSSH	Note on Effects Determination
Least Tern (<i>Sterna antillarum</i>)	Endangered	Doña Ana	River systems	Unlikely to occur	No Effect
Aplomado falcon (<i>Falco femoralis septentrionalis</i>)	Endangered, Experimental populations, Non-essential	Doña Ana	Desert grassland associations	Unlikely to occur	No effect
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Threatened	Doña Ana	Riparian systems	Unlikely to occur	No effect
Sneed's pincushion cactus (<i>Escobaria sneedii</i> var. <i>sneedii</i>)	Endangered	Doña Ana	Found in cracks of limestone formations in broken terrain and steep slopes usually in Chihuahuan desert scrub.	Does not occur	No effect

Information obtained from USFWS; Muldavin et al. 2000; WSMR 2015; Burkett 1997; and Tazik et al 1992.

Table 5-2: Species Federally Listed as Threatened and Endangered, Recorded and Potentially Occurring in White Sands Space Harbor South Landing Site

All three bird species considered for this site have the potential to fly through the area, particularly during spring and fall migration. Least terns are known to use broad open sandy habitats but always in association with river and lake habitats where they forage for fish. No suitable habitats exist for any of these three bird species or the Sneed's Pincushion cactus at the South WSSH landing site.

Surveys at the WSSH landing site revealed very low species diversity and large areas of bare ground (exceeding 95 percent) in each survey area. Only two species of vegetation were identified within the survey areas: pickleweed (*Allenrolfea occidentalis*) and non-native saltcedar (*Tamarix ramosissima*). Very few faunal species were detected during the surveys. Saltcedar trees at this site are suffering from the effects of saltcedar leaf beetles and several were observed on the trees while conducting surveys. Saltcedar response to beetle presence varies greatly at different sites and situations; for example, the USDA reports mortality levels approaching 90 percent in Utah after 9 years (USDA 2016). Numerous studies of the beetles' effect on saltcedar are currently being conducted across the western U.S., but studies have not been conducted on widely separated saltcedar in extremely low density, such as are found at the WSSH landing site. It is thus likely, but not certain, that these beetles will eventually (within three to five years) kill all the saltcedar at this site.

A complete list of species identified at the WSSH landing site can be found in Appendix E: Natural Resources Survey Report.

Sonic Boom Footprint

Table 5-3 shows the federally listed species and whether there is critical habitat within the footprint of the sonic boom as shown in the USFWS IPaC system. Fish and plants were not included as they will not be affected by the boom.

Species	Status	Critical Habitat in Sonic Boom Footprint
Mammals		
Gray Wolf (<i>Canis lupus</i>)	Endangered	No
Canadian Lynx (<i>Lynx canadensis</i>)	Threatened	No
Jaguar (<i>Panthera onca</i>)	Endangered	No
Lesser Long-nosed Bat (<i>Leptonycteris curasoae yerbabuenae</i>)	Endangered	No
Mexican Long-nosed Bat (<i>Leptonycteris nivalis</i>)	Endangered	No
New Mexico Meadow Jumping Mouse (<i>Zapus hudsonius luteus</i>)	Endangered	Yes
Penasco Least Chipmunk (<i>Tamias minimus atristriatus</i>)	Candidate	No
Birds		
Least Tern (<i>Sterna antillarum</i>)	Endangered	No
Mexican Spotted Owl (<i>Strix occidentalis lucida</i>)	Threatened	Yes
Northern Aplomado Falcon (<i>Falco femoralis septentrionalis</i>)	Endangered	No
Piping Plover (<i>Charadrius melodus</i>)	Threatened	No
Southwestern Willow Flycatcher (<i>Empidonax traillii extimus</i>)	Endangered	Yes
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	Threatened	Yes
Red Knot (<i>Calidris canutus rufa</i>)	Threatened	No
Reptiles		
Narrow-headed Gartersnake (<i>Thamnophis rufipunctatus</i>)	Threatened	No
New Mexican Ridge-nosed Rattlesnake (<i>Crotalus willardi obscurus</i>)	Threatened	No

Northern Mexican Gartersnake (<i>Thamnophis eques megalops</i>)	Threatened	No
Amphibians		
Chiricahua Leopard Frog (<i>Rana chiricahuensis</i>)	Threatened	No

Table 5-3: Federally Listed Species Within Sonic Boom Footprint

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.

Flora

Disturbance and/or removal of vegetation would occur in areas around the buildings during demolition and along the path of the power lines during burial. The loss of vegetation will not be significant because these vegetation communities are well represented and extensively distributed within WSMR and elsewhere throughout the region. Vehicular traffic will be limited to that needed to gain access to the work sites to prevent unnecessary vegetation disturbance.

Some vegetation, if present, would be disturbed at the Starliner landing site and during the recovery of jettisoned pieces, but only a small area would be affected. In all proposed recovery activities, ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Off-road traffic would be restricted in accordance with WSMR regulations to minimize disturbance to vegetation.

There is a small possibility of a wild land fire due to the latent heat of the spacecraft following reentry. This would be more likely at the WSMR-649 site due to the amount of vegetation present versus the WSSH site, but is still extremely unlikely due to the large amount of bare ground. However, should one occur, WSMR has appropriate equipment and existing processes to control and extinguish fires. Re-vegetation and best management practices to minimize erosion would be included in the recovery plan if a fire were to occur. The only debris generated is from the pieces of the spacecraft that jettison during landing and any trash generated as part of the landing and recovery operations. All jettisoned pieces, if found, and trash would be collected as efficiently as possible to minimize the impact to surrounding vegetation and wildlife. It may not be possible to find all of the jettisoned pieces due to their small size and the size of the overall landing zone. The jettisoned items do not pose a significant threat to any area of environmental concern.

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

Fauna

Fauna could be affected by construction activities, vehicle landing, and recovery activities. Noise from sources, such as vehicles, heavy machinery, and general human activities, related to construction and recovery activities would lead to species-specific faunal reactions. Factors influencing faunal responses may be time and length of the noise, seasonality, time of day, stress and physiological effects, life history,

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

Small mammals, ground-nesting birds, reptiles, and amphibians could be injured or killed by vehicles during demolition and power line burial. To minimize project-related mortality of wildlife, vehicles will keep to existing roadways whenever possible. Construction personnel will be instructed not to collect, harm or harass any wildlife species.

Fauna could be affected by the Starliner landing and recovery activities. The probability of directly hitting fauna with the spacecraft or jettisoned pieces is inherently low. Small mammals, ground-nesting birds, reptiles, and amphibians could be injured or killed by vehicles during landing and recovery operations. Any active bird nests found during landing recovery operations will be marked for avoidance and reported to WSMR biologists, as will any injured or dead birds. To minimize project-related mortality of wildlife, vehicles would keep to existing roadways whenever possible. Landing and recovery personnel would be instructed not to collect, harm or harass any wildlife species. For night operations that require portable lighting, WSMR portable lighting guidelines would be followed to ensure they don't attract migrating birds.

While individual mortality may occur to non-protected wildlife species, regional populations of species would not be affected. Construction and landing activities would affect only a limited portion of the total available habitat within WSMR.

Habitat associations with the WSMR-649 landing site are varied and support a broad diversity of animal life. Analysis of past surveys and information gathered during the 2016 survey efforts at this site revealed no federally or state listed species inhabiting or likely to inhabit the site. Habitat associations with the WSSH landing site are extremely biologically unproductive and large expanses of the area are completely barren. 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.

No long term negative effects to biological resources are anticipated from the proposed action at either landing site. There would be no impact to TES species as none are likely to occur in either landing zone and the sonic boom would take place at most two times per year. Therefore the proposed action will not have any significant impacts to biological resources.

5.2.3 No Action Alternative

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

5.2.4 Mitigation Measures

Appropriate methods of recovery will be practiced for all jettisoned items. Ground vehicles would use existing roads when available, and follow a single in-and-out path when traveling off-road. Off-road traffic would be restricted to minimize disturbance to the vegetation. If any species listed in Table 35-1 and 5-2 are found following the completion of this EA, WSMR Directorate of Public Works - Environmental 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

Located in the northern portion of the Chihuahuan Desert, WSMR has an arid to semi-arid climate with abundant sunshine, relatively low humidity, modest rainfall, and relatively mild winters typical of low latitude arid areas. Rainfall through the year is light and insufficient for any growth except desert vegetation. The average annual rainfall at WSMR is around 25 cm (10 in); however, it varies across the range with highest amounts on or near the mountains. Temperatures at WSMR are generally warm in the summer and mild during the winter. Temperatures are often near 32 to 38°C (90 to 100° F) for long periods in the summer. Mild daytime temperatures characterize winter, rising to 12.8 to 15.6° C (55 to 60° F) on average. The lowest temperatures occur in December and January, and nighttime temperatures often drop below freezing (WSMR EIS 2009).

At WSMR, the prevailing wind direction is from the southwest with spring being the windy season. Average wind speed is approximately 10 kph (6mph), but wind gusts of more than 48 kph (30 mph) are common. Winds are strongest from late February through early May. Westerly winds during this time occasionally cause severe dust storms. These storms are a result of sparse vegetation and dry loose soil. Dust storms occur most frequently in March and April and more rarely in other months (Eschrich 1992).

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 of the Starliner would not generate greenhouse gas emissions). No propulsion jet firings take place below approximately 30,000 feet altitude. There would be exhaust from construction and recovery vehicles and portable generators, as well as some dust caused by the movement of the vehicles during the demolition/power line burial and landing recovery operations. Project emissions would not alter the global climate or climate at WSMR. 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 WSMR. Therefore, the No Action Alternative would not result in climate impacts at the WSMR landing sites 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. The proposed action will take place entirely within WSMR, with the exception of the sonic boom footprint. These areas contain the following potential Section 4(f) properties (see Appendix D for the sonic boom footprints):

- The White Sands National Monument (WSNM) is directly south of the WSSH landing site. It is accessed by U.S. Route 70, which is the closest public road to the WSSH landing site and traverses the southern portion of WSMR.
- The San Andres National Wildlife Refuge is west of the WSSH landing site but is entirely within WSMR and has no public access.
- The Trinity National Historic Landmark is east of the WSMR-649 landing site but is entirely within WSMR and has no public access except during two weekends per year when it is open to the public.
- The Bosque del Apache National Wildlife Area is outside the WSMR boundary northwest of the WSMR-649 landing site but is under the footprint of the highest overpressure area of the sonic boom.
- The sonic boom footprint, depending on re-entry trajectory, could also be heard in parts of McKinley, Cibola, Valencia, Catron, Sorocco, Lincoln, Grant, Sierra, Otero, Hidalgo, Luna, and Dona Ana Counties. Potential Section 4(f) properties within the footprints include public sites in the Cibola and the Gila National Forests, the El Malpais National Conservation Area, the Sevilleta and the Bosque Del Apache National Wildlife Refuges, the Organ Mountains-Desert Peaks National Monument, and several state parks. The boom footprint also covers several historic districts and many properties listed on the NRHP. The potential Section 4(f) properties closest to the landing site, and therefore more likely to hear the sonic boom, are the Elephant Butte Historic District, Dam, and Irrigation District; the Tingly, Carrie, Hospital and the Hot Springs Bathhouse and Commercial Historic Districts in Truth or Consequences; the La Mesilla, the Alameda-Depot, and the Mesquite Street Original Townsite Historic Districts and other properties in Las Cruces; and other properties to the northwest and southwest of WSMR.

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 Section 4(f) property. For Starliner landings WSMR Flight Safety, based on the specific mission parameters, would determine the need for public road and WSNM closures during landing and recovery operations. If needed, road closures would occur according to the existing agreements with the WSNM and New Mexico DOT, would take place a maximum of two times per year, and would be short term in nature. Any impacts on public access to the WSNM would be minimal and not impair the monument.

The sonic boom generated prior to landing would be short term in duration and, while noticeable, would not cause any impacts or damage due to the small magnitude of the overpressure (a maximum of 0.5 pounds per square foot (psf), somewhat less than a clap of thunder).

Starliner landings would not be planned for the weekends the Trinity Landmark is open to the public (first weekend of April and October). The Proposed Action would not result in a constructive use of any of the potential Section 4(f) properties listed above. Thus, there would be no 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 WSMR. Therefore, the No Action Alternative would not result in Section 4(f) impacts at the WSMR landing sites or the surrounding area.

5.4.4 Mitigation Measures

Public road and WSNM closures during landing and recovery operations would only take place when determined to be necessary by WSMR Flight Safety based on the specific mission parameters.

5.5 Land Use and Airspace

5.5.1 Affected Environment

WSMR was established on July 9, 1945, as White Sands Proving Ground to conduct research in rocket warfare. The DoD facility is closed to the public and is surrounded by land that is primarily managed by other federal agencies and the state government. The proposed action is comparable with other types of activities carried out at WSMR, and is compatible with the overall mission of WSMR. Refer to Section 3.2 of the WSMR EIS for a general discussion of land use (U.S. Army, 2009).

Public access to the northern portion of WSMR, including the proposed WSMR-649 landing site, is restricted. However, hunting regularly occurs in this region. Hunting is allowed on WSMR on a non-interference basis during weekends, holidays, and Range non-duty days. Hunting is seasonal and for those species listed in the current New Mexico Department of Game and Fish (NMDGF) proclamation. All hunting activities on WSMR are done in compliance with NMDGF regulations, State and Federal laws, Army regulations, and Range policies and regulations (WSMR 2015). The WSMR-649 landing site is located within Stallion Hunting Area and Recreational Hunting Area 4 (U.S. Army, 1999).

Public access to the White Sands National Monument is normally available daily although is closed periodically for WSMR testing.

At WSMR, the Cox Range Control Center (CRCC) is delegated management and control (e.g. air traffic control and scheduling) of the airspace in the area described for the proposed action. WSMR's airspace complex includes several restricted areas that individually have unique specifications (e.g. area, altitude, and operation times). Refer to Section 3.3 of the WSMR EIS for a general discussion of airspace (U.S. Army, 2009).

5.5.2 Environmental Consequences

The building demolition and power line burial activities would have a short term impact on the land caused by vehicle traffic to and from the sites and the trenching needed to bury the power lines. However, it provides the long term benefit of returning the land back to its original state within the landing zones.

The proposed overflight and landing are typical of activities carried out at WSMR. Hunting access to the WSMR-649 landing site would be prohibited on the day of landing through the completion of landing and recovery activities. Should the Starliner need to land under a maximum wind scenario, with those winds coming from the north, there is a possibility some of the jettisoned items could impact on the northern section of the White Sands National Monument. Should the wind readings on landing day indicate this could happen, WSMR Flight Safety will coordinate with the WSNM to close the monument during landing and recovery operations per standard WSMR processes. This is also similar to the way these areas are currently managed during DoD activities.

The spacecraft and all jettisoned hardware would be collected and removed from the landing site if found. Some of the smaller jettisoned items may be difficult to find due to the size of the landing zone. The jettisoned items do not pose a significant threat to any area of environmental concern. Appropriate methods of recovery will be practiced for all jettisoned items. Hazardous materials and hazardous wastes would be recovered immediately, transported, stored, and disposed of in accordance with WSMR regulations and the Resource Conservation and Recovery Act (RCRA) permit. Nonhazardous waste would be handled as solid waste or non-regulated waste. There would be no long term affect or change to the land from the proposed action.

Waste disposal for both demolition and LRT activities is addressed in section 3.13 of this EA.

Impacts on airspace and scheduling from the proposed action would be scheduled through WSMR Range Operations. The proposed action would involve over flight of the range from the west to each of the WSMR landing sites. At 60,000 ft. attitude the Starliner will be on a nearly vertical subsonic trajectory within 20 km of the center of the landing zone. As a result it will already be over WSMR controlled airspace and minimal airspace would require clearing. This activity is within the scope of normal actions currently planned within WSMR-controlled airspace. All airspace re-entry operations would comply with the necessary notification requirements, including issuance of Notices to Airmen (NOTAM) and Local Notices to Mariners (LNMs), 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.

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

5.5.3 No Action Alternative

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

5.5.4 Mitigation Measures

Close scheduling and coordination from WSMR Range Operations would minimize any airspace or scheduling conflicts with other testing or training operations being conducted at WSMR.

5.6 Physical Resources

5.6.1 Affected Environment

The proposed action would not affect wetlands², floodplains, or wild and scenic rivers, as none of these are located within the area affected by the proposed action. Therefore, the above water resources are not considered further. This section focuses on surface water, groundwater, water quality and soils. Water quality is protected under the Clean Water Act 1972 (Federal Water Pollution Control Act), Safe Drinking Water Act 1974, and New Mexico Water Quality Regulations (20 New Mexico Administrative Code 6.2). As all of the proposed action takes place above or on the surface, the underlying geology is also not affected.

Water

The WSMR-649 landing site is located in the Jornada del Muerto Basin. The WSSH landing site is located in the Tularosa Valley Basin. Both are closed basins and lack effective external surface drainage to the Rio Grande. Thick alluvial basin deposits comprise most of the aquifers in the region. Groundwater quality varies throughout the region, but is generally of low quality and high in sulfates (Roybal, 1991). Groundwater wells that exist in the area are historic water sources for livestock. A few of these wells are wildlife water units. No wells are within the landing and recovery areas .

Rainfall can infiltrate rapidly to the subsurface (Weir, 1965). Heavy rainstorms can create short-duration overland flows, and ponding can result in formation of shallow playa lakes. There are no perennial streams in either landing area.

There are two main basin-fill aquifers which underlie WSMR. They are the Rio Grande aquifer and the Tularosa Basin aquifer. The main sources of groundwater for WSMR are wells which tap into regional aquifers located within the basin-fill aquifers.

Table 5-4 summarizes the water resources at the landing sites.

Landing Area	Hydrologic Basin	Avg. Precipitation (in. /yr.)	Approx. Depth to Groundwater (ft.)
WSMR649	Jornada del Muerto	11	100

² A search of the USFWS National Wetlands Inventory website indicated that a single wetland occurs within the WSMR-649 landing site. However, local resource experts consulted as part of the 2016 survey agreed that no wetlands occur at this site. Site visitation confirmed that no wetland exists. No riparian obligate or facultative vegetative species or permanent surface water exists in or around the WSMR-649 landing site. A search of the USFWS website shows no wetland areas within the WSSH landing site. Site investigation confirmed that no wetlands exist at this site (Ama Terra, 2016).

WSSH	Tularosa	8	10
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Table 5-4: WSMR Water Resource Summary

There are no potable water locations within either landing area.

Soils

Figure 5-3 shows the soil types in and around the WSMR 649 4 km radius landing site. The majority of the site consists of Yesum gypsiferous sandy loam with areas of NASA yesum complex and Whitlock-Pajarito-Nations complex on the south to west sides of the landing zone. The yesum soils are classified as course-gypseous while the Whitlock is course-loamy. Slopes range from 0-9 percent. These soils are classified as having a slight erosion hazard caused by activities that disturb the soil and are moderately susceptible to site degradation due to wind erosion and soil rutting. The area has no flooding concerns and very limited ponding. (USDA 2016a)

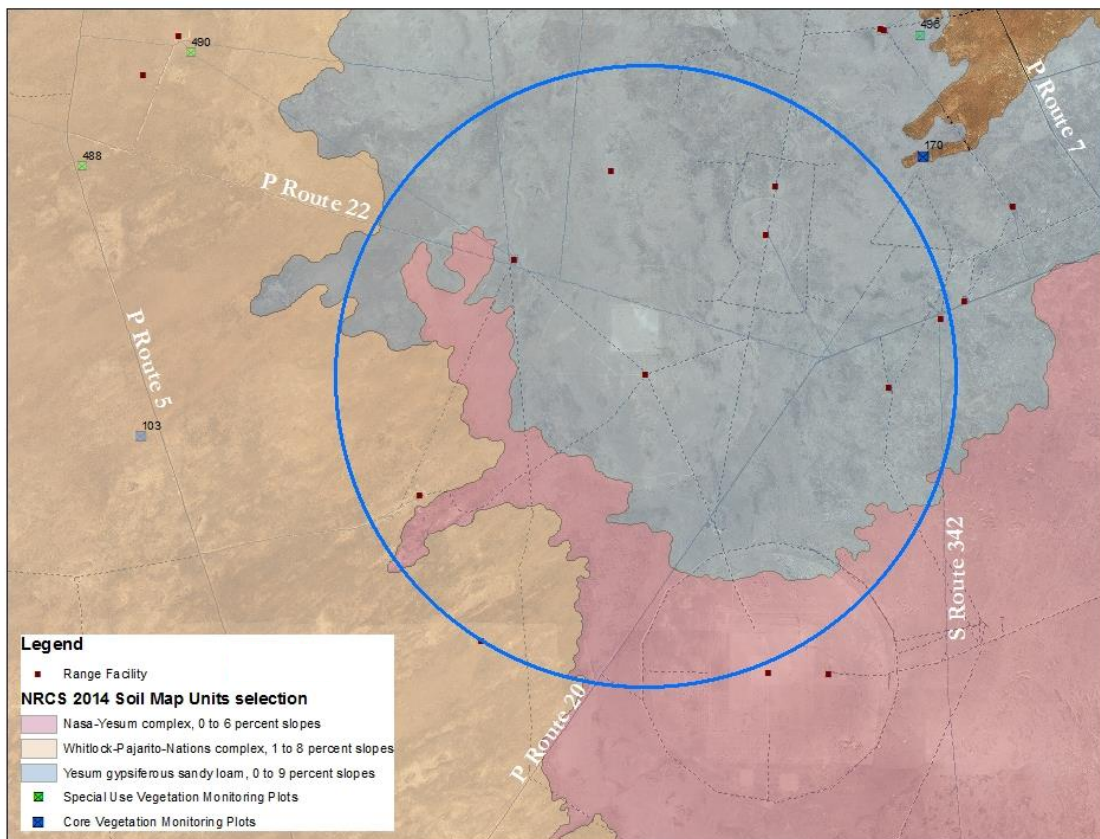


Figure 5-3: Soils at WSMR-649

Figure 5-4 shows the soil types in and around the WSSH 4 km radius landing zone. The vast majority of the site consists of Llano-Ratscat complex with an area of Typic Petrogypsids-Oxyaquic torriorthents complex on the west side and an area of Salago-Llano complex on the northwest side. All three are classified as course-gypseous. Slopes range from 0-8 percent with the majority of the landing zone being in

a nearly level dry lake bed. These soils are classified as having a slight erosion hazard caused by activities that disturb the soil and are moderately susceptible to site degradation due to wind erosion and soil rutting. The area can have ponding after intense rain that, depending on the level and location of the ponding, this could make the site no-go for landing until it dries out sufficiently. (USDA 2016a)

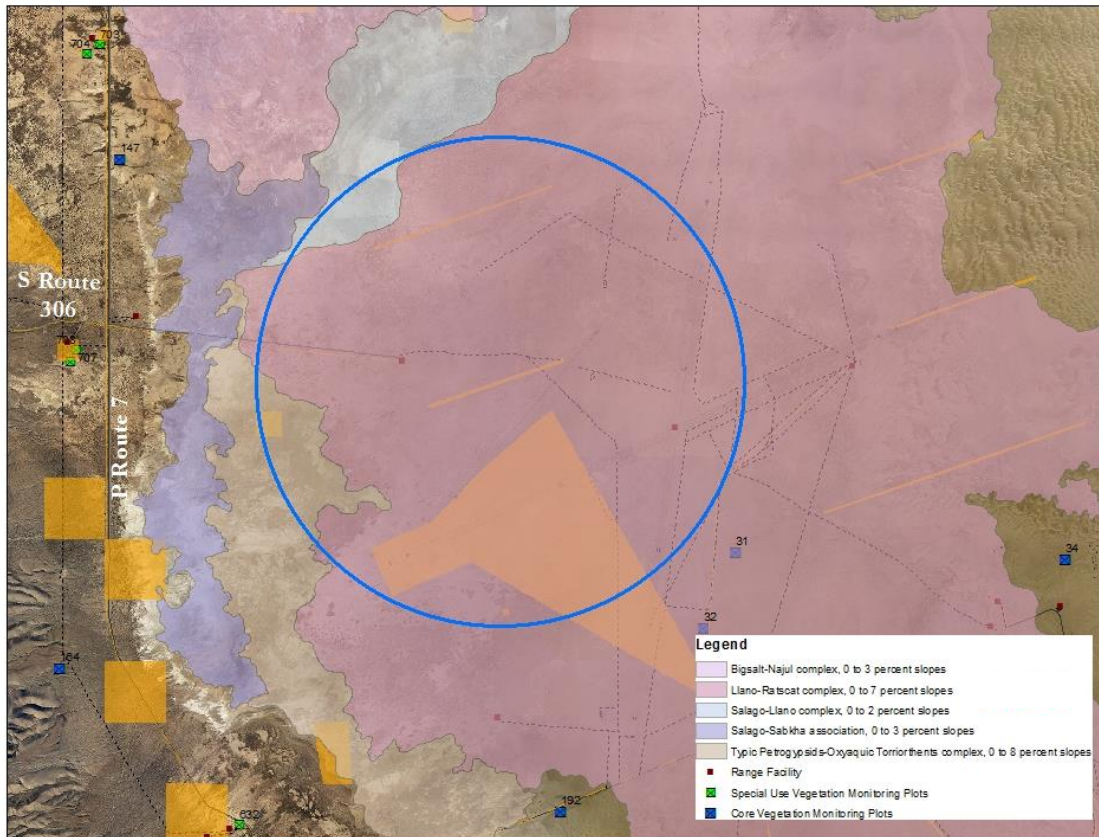


Figure 5-4: Soils at WSSH

A general discussion of the physical resources found on WSMR is available in Section 3.8 of the WSMR EIS (U.S. Army, 2009).

5.6.2 Environmental Consequences

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

Water

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 (FAA Order 1050.1F). 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).

No permanent water bodies (e.g. stream, creeks) occur within the landing areas. Therefore, surface water would not be affected by any of the proposed operations. Minor amounts of water could temporarily accumulate in low laying areas, especially during the summer rainy season. The building demolition and power line burial activities would only take place when the area is dry enough to allow access to the construction sites. The power lines burial will not be deep enough to affect the water table. Should standing water be expected for the planned Starliner landing, an alternate landing site would be selected. Given the lack of water resources, it is unlikely that the proposed action would impact water resources.

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

Soils

Equipment used for construction and landing recovery activities would be inspected in accordance with established site procedures for petroleum, oil, and lubricant (POL) leaks and, if necessary, appropriate containment would be placed underneath equipment when not in use. In the unlikely event of an accidental POL spill, contaminated soil would be cleaned using established site procedures. Likewise, should an unlikely failure occur in the Starliner or GCUs, any contaminants would be cleaned up utilizing applicable WSMR regulations. As a result, groundwater would not be contaminated such that water quality standards would be exceeded, and no aquifers used for public water supply would be affected.

In all proposed activities, ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Building demolition crews would be able to access the sites via existing roads so the only soil disturbance would be around the buildings themselves. Power line re-routing/burial and landing recovery activities would require vehicles to travel off road. Off-road traffic would be restricted in accordance with WSMR regulations to minimize disturbance to the soil. All of the construction and the vast majority of the landing recovery activities would take place within the 4km radius landing zone so the soils in those areas were assessed in detail. The soils in the larger 15 km landing zone were not assessed in detail since the only disturbance in that area would be from ATVs with trailers traversing the land to recover any jettisoned items that landed outside the 4km landing zone.

Overall, the proposed action would not significantly affect the water resources or soils at either landing site.

5.6.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in water resource or soil impacts at the WSMR landing sites 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.

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

5.7.1 Affected Environment

Archaeological evidence demonstrates that humans have lived in southern New Mexico for more than 12,000 years. On the basis of changes over time in artifacts and sites, coupled with absolute chronometric

techniques such as radiocarbon, archaeologists have classified this broad span of time into various periods and sub periods (Table 5-5).

Cultural Period	Associated Dates
Paleoindian	ca. 10,000–6000 BC
Clovis	ca. 10,000–9000 BC
Folsom	9000–8000 BC
Plano/Cody	8000–6000 BC
Archaic	6000 BC–AD 200
Early	6000/4000–3000 BC
<i>Gardner Springs</i>	6000–4000 BC
Middle	4000/3000–2500 BC
<i>Keystone</i>	4000–2500 BC
Late	2500 BC–AD 200
<i>Fresnel</i>	2500–900 BC
<i>Hueco</i>	900 BC–AD 250
Formative	AD 200–1450
Mesilla	AD 200–1000
<i>Early Formative</i>	AD 200/400–1000
Doña Ana	AD 1000–1200
<i>Transitional Formative</i>	AD 1000 – 1200/1300
El Paso	AD 1200–1450
<i>Late Formative</i>	AD 1200/1300–1450
Precontact	AD 1450–1581
Protohistoric	AD 1581–1659
Historic	AD 1659–present

5-5: Cultural Periods for Southern New Mexico and Associated Dates

A general discussion of the cultural resources found on WSMR is available in Section 3.5 of the WSMR EIS (U.S. Army, 2009).

WSMR-649 Landing Site

Investigations:

Within the WSMR-649 landing zone, numerous cultural resource inventories have been conducted and abundant data are available about the cultural resources that are present. Of the 12,421 acres within the 4-km radius landing zone, approximately 5,650 acres are recorded as having been previously inventoried. This acreage includes 5,226 acres that are documented with the New Mexico Cultural Resources Information System (NMCRIIS) and an additional 424 acres that are recorded as being surveyed by WSMR but not by NMCRIIS. Based on a recommendation from the WSMR environmental office, an additional 874 acres were surveyed in support of the development of this EA. Of the 776 acres within the 1-km radius central target zone, 100 percent have been previously inventoried. The total survey area, including the newly surveyed 874 acres, is shown in Figure 5-5.

These inventories have included at least 13 separate investigations (Table 5-6). All of the inventories have been conducted in compliance with National Historic Preservation Act (NHPA) requirements and in support of various military missions at WSMR. The inventories range from three surveys that were each less than 100 acres in size to one survey that was larger than 5,000 acres in size.

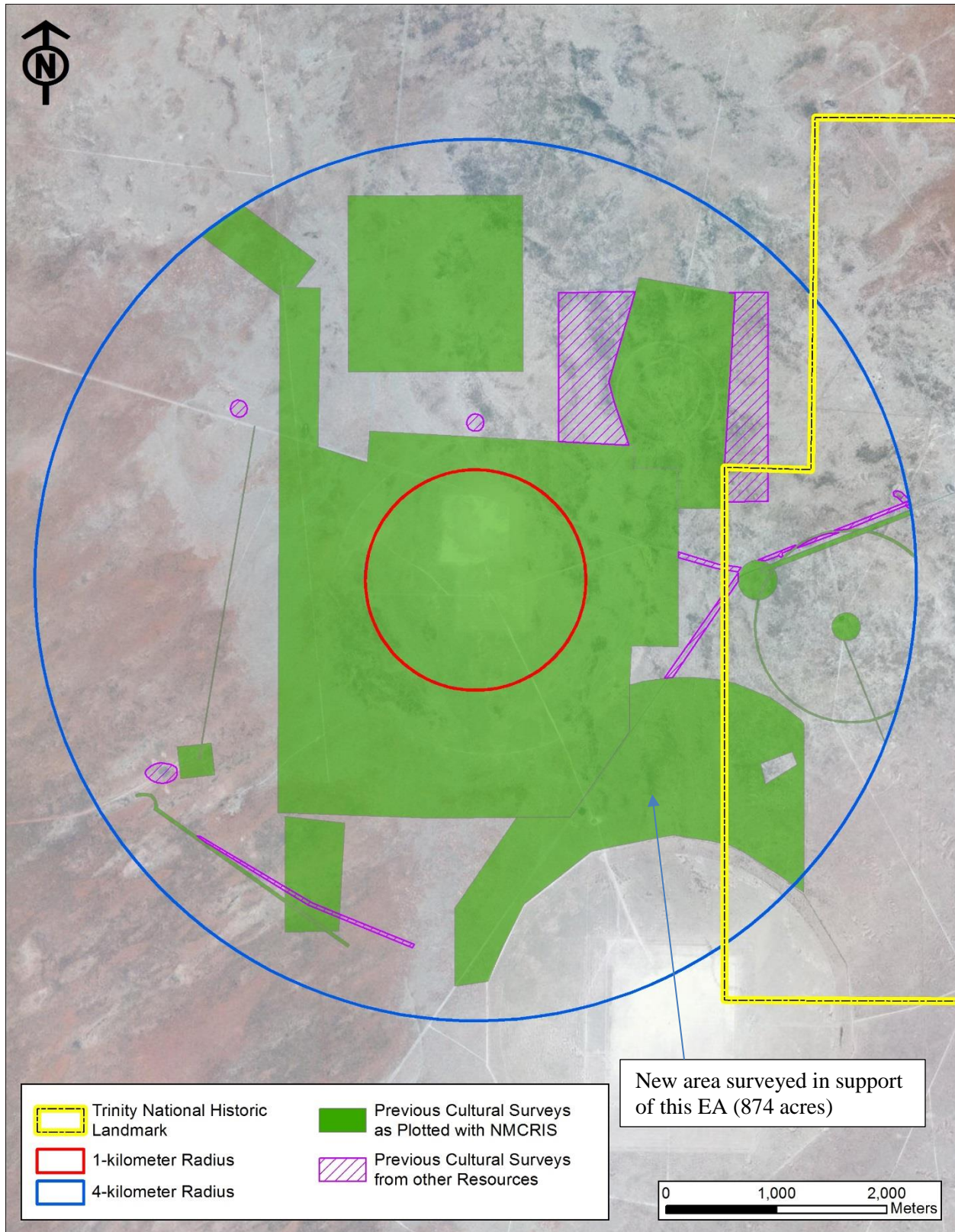


Figure 5-6: Previous Cultural Resource Survey within the WSMR-649 Location

Project Type, Size ¹	Report Date	Author(s)	Reference
Survey, 2,069 Acres	1982	Beck, C.	Archaeological Survey of Six Proposed Construction Areas on the White Sands Missile Range; Stallion Fence Project, MLRS Uprange Launch (Miracle) Site; East Boundary Fence Project; Simulated Runway Target Site; UH-1B Drone Helicopter Operation site; Mars Site Parking Lot
Survey, 71 Acres	1986	Clifton, D	Survey of Three Areas on White Sands Missile Range
Survey, 2,950 Acres	1987	Clifton, D.	2950 Acres in Northern Jornada del Muerto for White Sands Missile Range
Survey, 287 Acres	1987	Clifton, D. et al	Fiber Optics Communication Network Project: Survey and Testing for White Sands Missile Range
Survey, 67 Acres	1987	Kirkpatrick, D.	Appendix D7 Communications R/W's & 1 Access for White Sands Missile Range
Survey, 92 Acres	1990	Allen, L	92 Acres Naval Aerial Weapons Testing for White Sands Missile Range
Survey, 730 Acres	1996	Browning, C. K. Faunce, M. Ernst, V. Gibbs, M. Sale and R. Giese	The Air Force Special Weapons Complex Cultural Resources Survey, White Sands Missile Range, Socorro County
Survey, 469 Acres	1996	Mendez, S., J. Hart, M. Kemrer, and D. Webb	Trinity at 50 Technical Report No. 2 Archaeological Survey and Reconnaissance of the Trinity Site Communication Lines, White Sands
Survey, 730 Acre	1997	Reider, M. and M. Lawson	Trinity at Fifty: Trinity Site National Historic Landmark, White Sands Missile Range, Socorro County
Survey 5,270 Acres	1997	Wessel, R., P. Eidenbach, L. Meyer, C. Comer, and B. Knight	From Playas to Highlands: Paleoindian Adaptations to the Region of the Tularosa (2 volumes)
Survey, 640 Acres	2002	Yduarte, M. A. Scott, and R. Klein	A Pedestrian Survey of 640 Acres Near the AFSWC Target on White Sands Missile Range, Socorro County
Survey, 1,456 Acres	2002	Shields, H.	Archaeological Survey of 52 UXO Sign Locations at Coma Site, White Sands Missile Range, Socorro County
Survey, 874 acre	2016	Sale, M. and A. Silberberg	Landing on the Lake: Archaeological Survey of 874 Acres within the WSMR-649 Landing Site, White Sands Missile Range
15,705 acres			

Note 1. Including portions outside the WSSH Landing Area

Table 5-6: Archaeological Investigations within the WSMR-649 Landing Site

Recorded Cultural Resources:

The surveys conducted within the WSMR 649 location have recorded at least 28 cultural resources. These include four sites dating to the historic period and 24 which date to the prehistoric period.

The 24 prehistoric sites are characterized by scatters of lithic manufacturing debris, lithic tools, ground stone, with occasional fire cracked rock (FCR) and/or hearths. The majority of the prehistoric sites (18) have no specific temporal indicators, but six sites have temporally diagnostic artifacts which indicate occupations from the Paleoindian Period (1), Middle to Late Archaic (4) and Late Archaic to Early Formative (1). None of the prehistoric sites contain ceramic artifacts or other indicators of the Transitional Formative or Late Formative Periods. Of the 16 prehistoric sites with National Register of Historic Places (NRHP) eligibility determinations, two are eligible for the NRHP, five are ineligible and nine are of unknown or uncertain eligibility. Of the eight most recently recorded sites (2016) for which NRHP eligibility has not yet been determined, seven are recommended as not eligible for the NRHP and one is recommended eligible for the NRHP.

The four historic period sites consist of three locations of ranching related activities and one location related to the Trinity National Historic Landmark (NHL). The three ranching locations include wells, corrals, the remains of a barn, and scatters of glass, and metal artifacts. These ranching sites date to the early twentieth century. One of these has been recommended not eligible for the NRHP and the other two have been insufficiently recorded. The fourth historic period site is a Trinity-related instrumentation location and was recommended eligible for the NRHP in 1997 as a contributing element within the Trinity NHL.

The Trinity NHL is located east of the WSMR-649 landing zone. This is the location of the world's first nuclear detonation on July 16, 1945, as part of the Manhattan Project. The immediate test site as well as 51,500 acres of the surrounding landscape was declared a National Historic Landmark district on December 21, 1965, and was listed on the NRHP on October 15, 1966. Approximately 1,595 acres of the Trinity NHL overlap with the 4-km radius landing zone(see Figure 5-5).

Unrecorded Sites:

Extrapolation from the 28 known sites within the surveyed portion (5,650 acres) to the unsurveyed portion (6,771 acres) suggests that an additional 30 to 40 unrecorded archaeological sites may exist. These probably consist mostly of prehistoric sites, but a small number may be historic period ranching sites as well. Additional sites related to the Trinity NHL are unlikely. Of the 24 known prehistoric sites, three are eligible (or are recommended eligible) for the NRHP. This suggests that at least some of the sites that are currently unrecorded within the unsurveyed portion of the WSMR 649 landing zone may be eligible for the NRHP.

The WSSH Landing Site

Previous Investigations:

In contrast to the WSMR-649 landing zone, relatively few cultural resource investigations have been conducted within the WSSH location and sparse data are available about the prehistoric cultural resources at this location. Of the 12,421 acres within the 4-km radius landing zone, approximately 6,620 acres are recorded as have been previously inventoried. This acreage includes about 2,000 acres of archaeological survey and 4,620 acres of survey associated with the Space Shuttle program. Of the 776 acres within the 1-km radius central target zone, 212 acres have been previously inventoried. Based on the area being almost completely barren and unlikely to contain cultural resources, the WSMR environmental office recommended there was no need to perform any new surveys of the WSSH landing site in support of this EA. The total survey area is shown in Figure 5-6.

These investigations have included four archaeological surveys and one historic resources inventory (Table 5-7), all of which were conducted in compliance with NHPA requirements and in support of various military and/or NASA missions. All of the archaeological surveys were less than 300 acres in size. At least two of these, totaling about 413 acres, are contemporary with modern survey tactics and

methodologies; the date of a third survey is unknown and the fourth was in 1977. The historic resources survey was conducted in 2011-2012 in compliance with the transfer of NASA properties to WSMR following the termination of the Space Shuttle program.

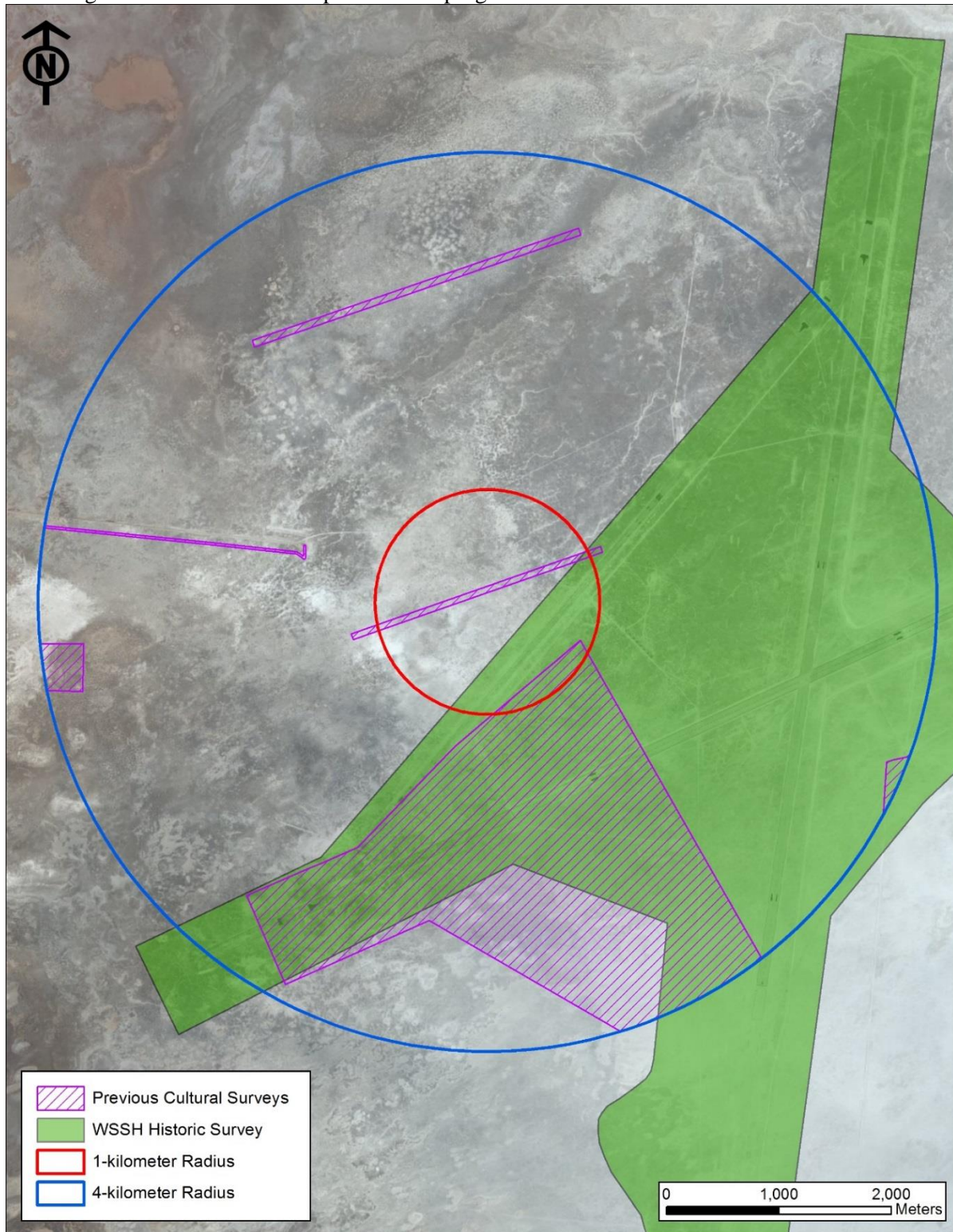


Figure 5-6: Previous Cultural Resource Surveys within the WSSH Location

Project Type, Size ¹	Report Date	Author(s)	Reference
Archaeological Survey, 117.4 Acres	Unknown (after 2013)	Church, T.	Historic Properties Inventory Report in Support of Lance Missile Flight Tests-MEADS
Archaeological Survey, 235 Acres	Unknown	Unknown	(no data in WSMR/NMCRIS)
Archaeological Survey, 42.8 Acres	1977	Unknown	Fixed Camera Locations
Archaeological Survey, 296 Acres	2013	Burt, C. and E. Kirsch	United States Air Force Light Experiment 2015 at White Sands Space Harbor
Historic Resources Survey, 7,820 acres	2012	Reed, M B., and R.D. Jones	NASA White Sands Space Harbor

Note 1. Including portions outside the WSSH Landing Area

Table 5-7: Previous Archaeological Investigations within the WSSH landing site

Recorded Cultural Resources:

Archaeological surveys conducted within the WSSH location have recorded the locations of only two cultural resources, both of which are Cold War-era bunkers. Both sites are insufficiently documented and neither is associated with an NRHP eligibility assessment or determination.

In addition, the 2011-2012 inventory of Space Shuttle related properties (Reed and Jones 2012) documented 72 individual properties. Of these, four properties were recommended eligible for NRHP listing both individually and as contributing resources to a proposed historic district. These four properties, consisting of three runways and the Control Tower, are recommended eligible under Criterion A (significant events) and under Criterion Consideration G (exceptional significance for properties less than 50 years of age) for their association with the Space Shuttle Program. The remaining 68 resources are recommended not eligible for the NRHP, although 19 of these are recommended as contributing to the proposed district even though they are not recommended individually eligible for the NRHP. The proposed historic district contains a total of 28 resources including 23 contributing resources (the four individually eligible properties and the 19 not individually eligible properties) plus five non-contributing resources.

Unrecorded Sites:

No additional properties related to the Space Shuttle program exist at WSSH. Extrapolation from the surveyed areas within the 4-km radius WSSH landing zone suggests that few, if any, unrecorded archaeological sites may exist within the unsurveyed portion of the WSSH landing zone.

Due to its size (several thousand sq. mi. for all footprints) and the small amplitude of the sonic boom generated by the Starliner during re-entry (max 0.5 psf, somewhat less than a clap of thunder), no review was done for all cultural resources within the sonic boom footprints show in Appendix D. The impact to NRHP properties is included in section 3.4 Department of Transportation Act, Section 4(f) of this EA.

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 in the NRHP.
3. Cause substantial unauthorized artifact collection by personnel.
4. Adversely affect known Traditional Cultural Properties on WSMR. 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.

There are no known culturally sensitive areas impacted by the buildings demolition or the power lines burial/re-routing. Construction crews will be instructed prior to beginning their activities to avoid cultural areas and to not disturb prehistoric or historic artifacts if found. If needed, an archaeologist will be on-site to monitor for potential inadvertent discovery of cultural resources. Should a previously unknown cultural site be found, ground disturbing activities will cease and WSMR archaeologists will be notified immediately to determine how to proceed.

The LRT will also be instructed prior to landing to avoid cultural areas and to not disturb prehistoric or historic artifacts. Due to the small number of eligible cultural sites within the landing zone, and the small number of landings expected to take place at any given site, the probability of the Starliner or any of the jettisoned pieces impacting a culturally eligible site is inherently low. However, should the Starliner come to rest on or near a cultural site, it will be marked for avoidance, WSMR archaeologists would be notified immediately, and only the minimum disturbances necessary to get the crew and critical cargo out of the spacecraft would take place. Further ground disturbing activity would cease until the WSMR archaeologists determine how to proceed. Should any of the jettisoned parts land on or near a cultural site, it will be marked for avoidance, WSMR archaeologists would be notified immediately, and ground disturbing activity would cease until the archaeologists determine how to proceed.

WSMR environmental personnel determined tribal consultation was not required for this project. A recommendation of "no historic properties affected" was provide to the State Historic Preservation Officer (SHPO), who concurred with this recommendation.. A copy of SHPO correspondence will be included in Appendix F of this EA for public review.

5.7.3 No Action Alternative

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

5.7.4 Mitigation Measures

In the event that a previously unknown resource is located, all activity would cease and WSMR archeologists would be notified. In the event that any project activities are required outside the proposed areas in this EA, these activities would be coordinated with site archeologists and additional archeological surveys would be conducted if necessary.

Landing and recovery efforts would be monitored. Should a falling piece of the spacecraft impact a site a damage assessment would be required. WSMR-ES-C managers may also require NRHP testing if a site with undetermined NRHP status is damaged.

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 5-7 compares the relative noise of common sounds.

Both landing areas are located in a generally quiet part of WSMR. Both are isolated from urban centers, highways, and commercial air traffic. Noises generated in the region may include weapon systems testing and occasional aircraft over flights. The proposed action would generate similar types of noise that commonly occur on WSMR with the exception of the sonic boom. The sonic boom would extend past the boundaries of WSMR and potentially be noticeable in several towns along Interstate 25. Socorro is the largest town under the footprint for a descending node trajectory. Truth or Consequences is the largest town under the footprint for an ascending node trajectory.

Refer to Section 3.10 of the WSMR EIS for a general discussion of noise and noise-related issues (U.S. Army, 2009).

5.8.2 Environmental Consequences

A significant impact would occur if the proposed action would increase noise by day-night average sound level (DNL)³ 1.5 decibels (dB) or more for a noise sensitive area⁴ that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe (FAA Order 1050.1F).

The heavy equipment and vehicles used for demolition activities would generate noise and vibration. Per figure 5-7, this noise could be as high as 90db in the areas of the demolition work but would probably not be noticeable outside the WSMR boundaries. 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. Landing recovery vehicle traffic, portable generators, and recovery operations would also generate noise and vibrations. In addition, the Starliner spacecraft would generate a sonic boom during atmospheric reentry to the WSMR landing site. Sonic booms are measured in pounds per square foot (psf) of overpressure. This is the amount of the increase over the normal atmospheric pressure which surrounds us (2,116 psf/14.7 psi). At one psf overpressure, no damage to structures would be expected. Overpressures of 1 to 2 psf are produced by supersonic aircraft flying at normal operating altitudes. (NASA Armstrong). Booms in the 0.2 to 0.3 psf range could be heard by someone who is expecting it and listening for it, but usually would not be noticed. Booms of 0.5 psf are more likely to be noticed, and booms of 1.0 psf are certain to be noticed. 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 psf boom breaking a typical residential window is somewhat less than one in a million (Hershey, 1974). Rare minor damage may occur with 2 to 5 psf overpressure. As overpressure increases, the likelihood of structural damage and stronger public reaction also increases. Tests, however, have shown that structures in good condition have been undamaged by overpressures of up to 11 psf. Sonic booms produced by aircraft flying supersonic at altitudes of less than 100 feet, creating between 20 and 144 psf overpressure, have been experienced by humans without injury. (Armstrong 2014).

³ 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.

⁴ 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.

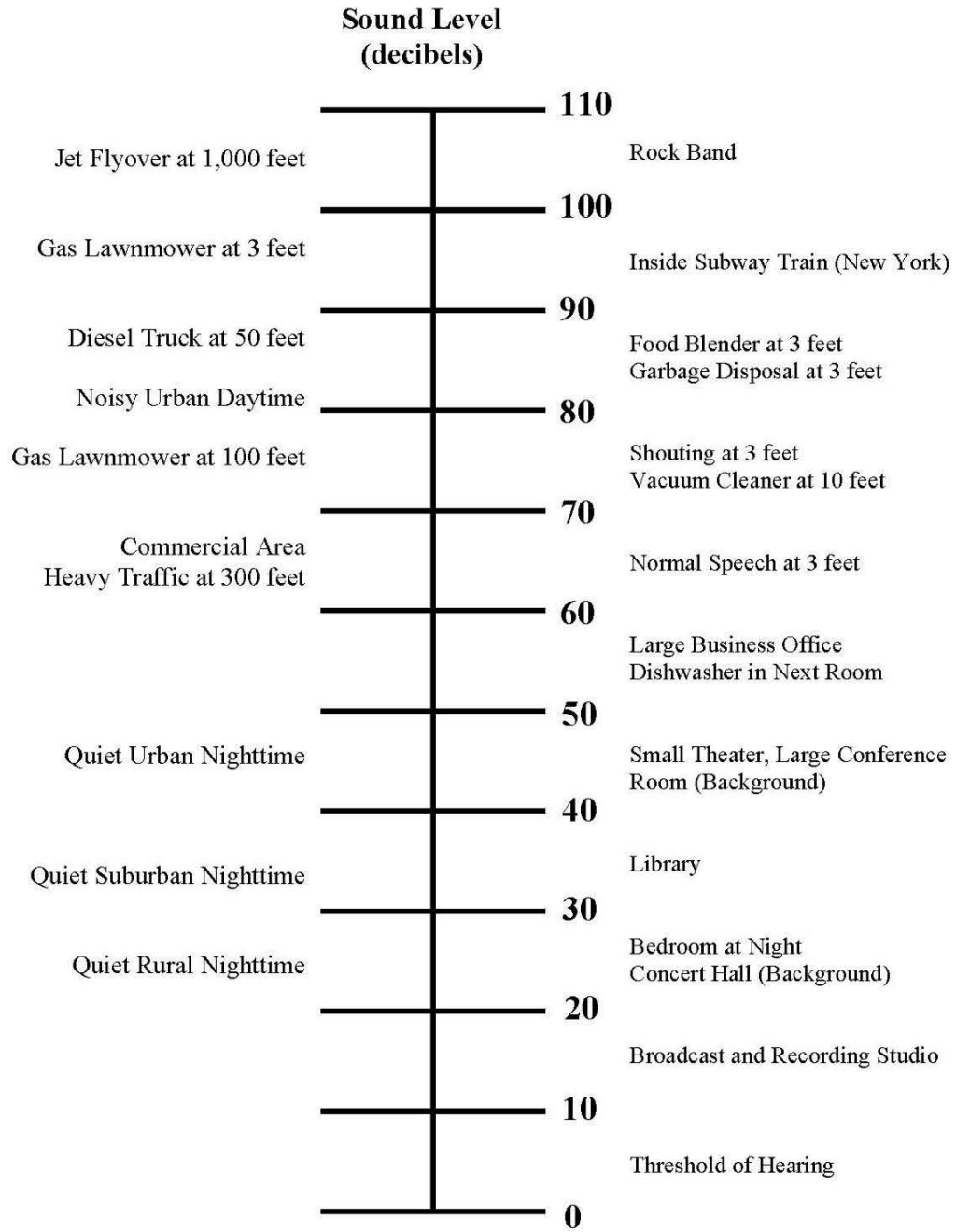
Appendix D contains details of the dispersion of the sonic boom. As shown, the maximum sonic boom overpressure caused by the Starliner spacecraft is 0.5 psf and will take place at most 2 times per year. This equates to a CDNL of 24 dB, well below the FAA threshold of 65 dB. Therefore the sonic boom does not create any long-term high levels of noise.

Any loud noise or vibration generated during these activities would be one time and/or very short in duration, and are not be expected to significantly affect the local people or wildlife.

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

Common Outdoor Sound Levels **Common Indoor Sound Levels**



impacts.

Figure 5-7: Relative Noise Comparisons

5.8.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in noise or existing land use impacts at the WSMR landing sites 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 either WSMR landing site 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 cities of Las Cruces (approximately 32 km (20 mi) away) and Alamogordo (Approximately 64 km (40 mi) away) are the nearest in proximity to the two landing sites.

Refer to Section 3.14 of the WSMR EIS for a general discussion of socioeconomic resources (U.S. Army, 2009).

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. Personnel working in support of the proposed activities would include military, civil servants, and contractors. Proposed activities would provide a very small economic benefit for cities close to WSMR such as Las Cruces, El Paso and Alamogordo. This is due to the contracted work needed for the building demolition and power line burial, the approximately 24 members of the LRT who will travel to and spend a week in the area for the landing, the approximately 30 NASA officials who will spend two days in the area around the landing date, and the small number of Boeing personnel who will travel to WSMR periodically to perform routine maintenance of the LRT convoy vehicles based at the FITF. 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 or employment levels in the area. Therefore the proposed action will not significantly impact socio-economic activity.

5.9.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in socioeconomic impacts at the WSMR landing sites or the surrounding area.

5.9.4 Mitigation Measures

Under the proposed action, no mitigation is necessary, as the direct and indirect impacts on the local economy would be slightly positive.

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 60 percent Hispanic of any race with a combined average of 10 percent minority population for “other” minority groups. The population in poverty within the region of influence averages 26 percent. The general population of minority and low-income population in the state of New Mexico average 48 percent Hispanic of any race, 17 percent population of “other” minority groups, and 20 percent in poverty (USCB 2015). The proposed landing sites are remote and not near towns or schools. There are no playgrounds or schools in or adjacent to either landing site. Refer to Section 3.15 for a general discussion of environmental justice (U.S. Army, 2009).

5.10.2 Environmental Consequences

The proposed action would have direct insignificant impact on WSMR air quality, noise, soils and other environments as identified above. Direct impacts are not anticipated to extend outside the boundaries of WSMR to the surrounding communities, with the exception of the sonic boom, which is very short term in nature, low in magnitude, and would occur up to two times per year. 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 the proposed action 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.

No children would be allowed around or within the landing sites 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 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 WSMR. Therefore, the No Action Alternative would not result in minority, low-income, or child population impacts at the WSMR landing sites 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

WSMR has considerable aesthetic and visual resources within its boundaries and merging into surrounding areas. Scenic desert landscapes with rugged topography are typical. However, most of the WSMR landscape is not readily viewable by the general public due to access restrictions. There are no Federal statutory or regulatory requirements for classifying and assessing light emissions and visual impacts. For the majority of the year, light emissions at the landing sites are minimal, primarily because this area is devoid of any permanent buildings and people except when being used for testing activities. There is no permanent lighting or other high-powered light sources used on a daily basis.

5.11.2 Environmental Consequences

The building demolition and power line burial 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 several buildings and power lines would no longer be present and the land would be back in its original state.

The proposed action would have a slight impact on light emissions at the landing sites for those instances where the Starliner spacecraft is scheduled to land 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. WSMR portable lighting guidelines would be followed to ensure they don't attract migrating birds. 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. 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 to either the landscape or the local wildlife.

5.11.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in visual impacts at the WSMR landing sites 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 portable 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 at WSMR were examined to determine infrastructure constraints.

Structures and Utilities:

The WSMR-649 landing site is situated in an relatively undeveloped area of WSMR. However, there are existing abandoned buildings and test equipment that will require demolition and existing power lines that will require removal/burial in order to have a clear 4 km landing zone. The WSSH site is also undeveloped except for the existence of runways on the salt flats.. Refer to Section 3.12 of the WSMR EIS for a general discussion of facilities and infrastructure (U.S. Army, 2009).

Public services, including civil and military police, fire protection, and emergency medical treatment services, are operated and /or supervised by the U.S. Army at WSMR. Most of the personnel providing these services are based at the Main Post. The landing and recovery convoy would park at the Flight Integration Test Facility for approximately a week before the landing.

Transportation and Roads:

An extensive road network connects most areas within WSMR. The existing paved and unpaved roads would be utilized to get as close to the construction sites and the landing site as possible, then vehicles will follow a single in-and-out path when traveling off-road. Vehicular traffic and parking is expected to increase during the building demolition and power line burial activities. As the LRT convoy is stationed at WSMR, the only increase in traffic for the week before landing will involve the LRT traveling to and from the FITF to prepare the convoy for landing and recovery operations. WSMR guidelines would dictate the transportation and handling of waste and hazardous materials to and from the landing site.

Refer to Section 3.13 of the WSMR EIS for a general discussion of transportation (U.S. Army, 2009).

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 proposed action, which occurs entirely within WSMR boundaries, would not significantly impact public infrastructure or increase the burden on infrastructure. Infrastructure and power requirements for the activities leading up to landing would not exceed WSMR's existing infrastructure resources.

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 landing and recovery convoy. Water and septic system use 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 at WSMR. Cellular phones or radios would see increased use during landing recovery operations, but the increased use of these would not significantly impact communication resources.

Increased vehicle traffic to the construction sites and the landing sites 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 transportation of waste or hazardous materials would

comply with WSMR procedures and applicable regulations. Only approved or existing routes would be used.

WSMR Flight Safety would determine the need for public road closures during landing and recovery operations based on the specific mission parameters. If needed, road closures would occur according to the existing agreements with New Mexico Department of Transportation.

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

5.12.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in infrastructure, transportation, or communications impacts at the WSMR landing sites or the surrounding area.

5.12.4 Mitigation Measures

Close scheduling and coordination would minimize transportation blockages. Practices would be consistent with WSMR procedures and applicable regulations.

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 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.

The WSMR Environmental Compliance Handbook addresses the mandatory requirements governing the management of hazardous material and hazardous waste. This handbook provides guidelines for safe handling and environmentally acceptable management of hazardous material and hazardous waste from its initial use to its ultimate disposition. WSMR Regulation 200-1, Environmental Protection and Enhancement, provides guidelines for the handling and management of hazardous waste and facilitates compliance with all Federal, State, and local laws regulating generation, handling, treatment, storage, and disposal of hazardous wastes. WSMR has developed an Environmental Disaster Plan as part of the WSMR Disaster Control Plan to prevent and/or control (i.e., minimize the impact) accidental discharges of oil and hazardous substances and includes all actions taken before, during, and after the spill event to reduce the probability of damage, minimize its effects and initiate recovery.

Refer to Section 3.11 of the WSMR EIS for a general discussion of hazardous materials and wastes (U.S. Army, 2009).

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

5.13.2 Environmental Consequences

The demolition of buildings would generate building waste. This would be handled and disposed of by the demolition contractor in accordance with applicable federal, state, and WSMR regulations as documented in the WSMR EIS, Section 3.11.

The Starliner landing and recovery activities 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 potentially 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 initiative. Boeing would contract with the Army to provide this service for landings at WSMR.

Following the 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 live ordnance.

Following a nominal landing, the only live ordnance devices would be in the NASA Docking System (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 devices are Class 1 Division 1.4 per the Department of Transportation CFR 49, Part 173.50 (see definitions below). SureSep Expanding Tube Assemblies (XTAs), used to separate the Starliner from the launch vehicle during ascent, are division 1.1 and the drogue parachute mortars, fired as part of the parachute deploy sequence during landing, are division 1.2. All these division 1.1 and 1.2 ordnance would be expended prior to landing. The NDS ordnance is initiated via NASA standard detonators (NASA standard initiator + detonating booster assembly). The remainder of the ordnance devices, with the exception of the AVCC's, are initiated via smart initiators. The AVCC has a built-in initiator. All ordnance devices receive command signals from ordnance controllers within the Starliner Command and Data Handling system. All ordnance is developed per MIL-HDBK-83578, Criteria for Explosive Systems and Devices used on Space Vehicles.

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

“Division 1.1 consists of explosives that have a mass explosion hazard. A mass explosion is one which affects almost the entire load instantaneously.

Division 1.2 consists of explosives that have a projection hazard but not a mass explosion hazard.

Division 1.4 consists of explosives that present a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.”

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 collected, transported, stored, and disposed of in accordance with WSMR Regulation 200-1, *Hazardous Waste/Material Management*, and WSMR's RCRA permit. Nonhazardous waste would be handled as solid waste or non-regulated waste. 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 WSMR Installation Spill Contingency Plan would be followed. Health and safety risks would be minimized by following established WSMR procedures.

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. Entry to the landing site would be restricted to approved hazardous materials response personnel until the area is determined to be safe. Fluids released after landing would be handled in accordance with the WSMR Installation Spill Contingency Plan.

The GCUs (2 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.

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 WSMR as 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 WSMR. Therefore, the No Action Alternative would not result in any hazardous or solid waste impacts at the WSMR landing sites or the surrounding area.

5.13.4 Mitigation Measures

The 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 WSMR regulations and RCRA permit. Nonhazardous waste would be handled as solid waste or non-regulated waste and disposed of accordingly. Vehicles, generators, and the GCUs would be routinely inspected to ensure proper operation and no leaking of POLs or hazardous material.

5.14 Human Health and Environment

5.14.1 Affected Environment

General health and safety protocols for WSMR personnel are addressed in various Federal, State, and Army and WSMR guidelines, rules and regulations. Other safety issues occurring during Starliner landing and recovery activities can potentially include radiation from the Starliner S-band antennas, encounters with unexploded ordnance (UXO), animal/vehicle collisions, biological hazards such as venomous snakes and spiders, heat-related illnesses and hantavirus pulmonary syndrome. Refer to Section 3.9 of the WSMR EIS for additional details on safety guidance and regulations (U.S. Army, 2009).

5.14.2 Environmental Consequences

The contractor performing the building demolition and power line burial would be required to meet all applicable safety regulations for its personnel involved in those activities.

During Starliner landings, WSMR Flight Safety would evacuate the appropriate area so ground crews are kept at a safe distance. All personnel would remain outside the projected landing zone until after the landing of the spacecraft and all jettisoned pieces. If needed based on the winds on landing day, WSMR Flight Safety would coordinate with the WSNM to close the monument should any jettisoned pieces be expected to land in the northern section of the park. 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 Propellant Handlers Ensemble or Breathing Air Packs), 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 WSMR safety procedures would be followed.

Personnel would be required to receive UXO training before being allowed entry onto WSMR, including instruction not to disturb potential UXO items. All potential UXO and unfamiliar objects would be reported to WSMR Range Operations.

There is some risk to personnel from venomous snakebites, but these typically occur only when the species is harassed or provoked. Demolition and recovery personnel would be instructed not to harass venomous snakes. Personnel would be trained prior to arrival at the WSMR on environmental hazards in the landing areas.

Public safety is also an issue with the proposed landing and recovery operations. 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 public viewers outside of WSMR are located outside of the safety buffer zone set by WSMR Flight Safety and would not be affected by the landing. All areas located on WSMR and inside of the WSMR landing zone would be cleared and all access to the area on the day of landing would be controlled by WSMR Flight Safety. NASA and WSMR Public Affairs and other WSMR officials would provide the necessary guidance and assist Public Affairs in providing landing information to the public.

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

5.14.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in human or safety impacts at the WSMR landing sites 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. Entry to the landing site would be restricted to approved hazardous materials response personnel until the area is determined to be safe.

Safe viewing sites would be provided during the landing. At a minimum, viewers would be placed outside the 15 km radius maximum landing zone. NASA and WSMR 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 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 which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. 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.

Past, present, and future activities at WSMR include providing critical testing for the nation's nuclear bomb program, development of testing/training facilities and infrastructure, expansion of current programs, addition of new training assets and new testing initiatives, and support to training and test groups from Holloman Air Force Base and Fort Bliss.

Refer to Section 34.19 of the WSMR EIS for a general discussion of cumulative impacts (U.S. Army, 2009).

The construction activities needed to demolish buildings and remove or bury power lines within the 4 km radius landing zones are a one-time event, take place in a relatively small section of WSMR, and are relatively short in duration.

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 WSMR coordinating and scheduling procedures would be utilized.

When taken in conjunction with other current, planned, and reasonably foreseeable activities at WSMR, the impacts from the proposed action would result in insignificant cumulative impacts to the existing environment at WSMR and the surrounding area.

The Starliner will only launch and land up to two times 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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8.0 Appendices

Appendix A – Abbreviations and Acronyms

AEGL	Acute Exposure Guideline Level
ALOHA	Areal Locations of Hazardous Atmospheres
AVCCC	Airbag Vent Cord Cable Cutters
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
CRCC	Cox Range Control Center
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
FAA	Federal Aviation Administration
FCR	Fire Cracked Rock
FHS	Forward Heat Shield
FITF	Flight Test Integration Facility
FONSI	Finding of No Significant Impact
GHG	Greenhouse Gases
HFC	Hydro-fluorocarbon
INCRMP	Integrated Natural and Cultural Resources Management Plan
IPaC	Information for Planning and Conservation
IPED	Institute for Professional and Executive Development

ISS	International Space Station
km	kilometers
KSC	Kennedy Space Center
LAS	Launch Abort System
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
NEAP	Natural Events Action Plan
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NHPA	National Historic Preservation Act
NMCRIS	New Mexico Cultural Resources Information System
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environmental Department
NOAA	National Oceanic and Atmospheric Administration
NPR	NASA Procedural Requirement
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
RoD	Record of Decision
SLS	Space Launch System
SM	Service Module
SOP	Standard Operating Procedure
TES	Threatened, Endangered, or Sensitive
U.S.C.	United States Code
USCB	United States Census Bureau
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance

WSMR	White Sands Missile Range
WSNM	White Sands National Monument
WSSH	White Sands Space Harbor

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
 - Hydrazine
 - Monomethyl Hydarzine
 - Dinitorgen Tetroxide
- Lithium Ion Battery
- Pyro materials
 - Detonating Booster Assembly/Electro-Explosive Initiator (EEI) Assembly
 - Explosive Bolt Assembly
 - Flexible Confined Detonating Cord Assembly
 - NASA Standard Initiator Assembly
 - Airbag Vent Cord Cable Cutters
- 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	National Institute for Occupational Safety and Health
		15 minute ceiling value	
Hydrofluoric acid	TWA	3 ppm	Occupational Safety and Health Administration - Table Z-2
		Z37.28-1969	
Hydrofluoric acid	TWA	0.5 ppm	American Conference of Governmental Industrial Hygienists
		Danger of cutaneous absorption Expressed as :Fluorine	
Hydrofluoric acid	C	2 ppm	American Conference of Governmental Industrial Hygienists
		Danger of cutaneous absorption Expressed as :Fluorine	
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



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

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

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

Safety Data Sheet

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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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

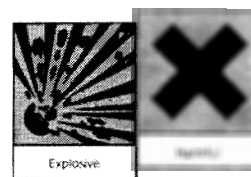
Emergency telephone number 0586-832 00, ERC +46-0(8)-33 70 43

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

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

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

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

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

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

6. ACCIDENTAL RELEASE MEASURES

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

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

7. HANDLING AND STORAGE

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

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

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

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

SAFETY DATA SHEET

CR 22686



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

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

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

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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Date Prepared : 07/26/2012
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 Date Revised : 07/05/2016
 Revision No : 3

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.

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

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.

Material Safety Data Sheet



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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-Ethanedio; 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.

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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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Halocarbon R-404A

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

Date of issue/Date of revision : 4/29/2015. Date of previous issue : 11/12/2014. Version : 0.02 7/11

Halocarbon R-404A

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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Halocarbon R-404A

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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Halocarbon R-404A

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.

Date of issue/Date of revision	: 4/29/2015.	Date of previous issue	: 11/12/2014.	Version	: 0.02	11/11
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Appendix C- Dispersion Modeling of Hydrazine H4N2 Using Areal Locations of Hazardous Atmospheres (ALOHA)

Introduction

The proposed action involves the use of hydrazine (H4N2). Hydrazine is a colorless flammable liquid with an ammonia-like odor. The purpose of this dispersion modeling analysis is to provide predictive estimates of the potential impact of various individual release scenarios of the hydrazine.

ALOHA is an atmospheric dispersion model available from the U.S. Environmental Protection Agency used to evaluate releases of hazardous chemical vapors and therefore was selected to model the hydrazine release scenarios. ALOHA generates estimates of the downwind dispersion of a chemical cloud based on the toxicological/physical characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release. With the use of the ALOHA air dispersion model, it shows that a release of hydrazine will disperse out from a source in a predictive manner.

Model Scenarios

Three cases were evaluated and modeled. These are based on the release of the worst-case propellant left in the Starliner spacecraft after an ISS mission, under three different weather conditions for each. These three cases provided results that enveloped all possible combinations of weather conditions. These are referred to as Test Case 1- 3 and are detailed below. In all cases, the model shows the leaking hydrazine could cause a flammability hazard within approximately 150 yards downwind of the spacecraft; however, the concentrations are not high enough to allow for a detonation. Results for both the WSMR-649 and WSSH landing sites were generated.

Hydrazine Release Cases

Nominal Propellant: Represents the nominal end of mission case based on the propellant loading for the two test missions and a typical mission to the ISS. The Starliner spacecraft would land with no more than 90 pounds of hydrazine remaining in its propellant tanks. All cases assume a leak in the propellant system that is not isolatable, causing a leak of the entire 90 pounds.

Test Case 1 - Daytime Landing, Low Cloud Cover and Wind speed

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

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

Test Case 3 - Anytime Landing, High Cloud Cover and Wind speed

Model Results

The ALOHA model output shows a toxic threat zone is an overhead view of the area where the ground-level pollutant concentration is predicted to exceed the Level of Concern (LOC) at some time after a release begins. That is, for any point within the threat zone, ALOHA predicts that the LOC will be exceeded at some time after the release begins—typically, this happens shortly after the cloud of pollutant gas reaches that point. Not all points within the threat zone will exceed the LOC for the same length of time. ALOHA displays the corresponding threat zones in red, orange, and yellow, and overlays them on a single threat zone picture as shown in Figures C-1 through C-7. By default, the red zone represents the worst hazard. (NOAA 2013)

AEGL

The Acute Exposure Guideline Level (AEGL) is a guideline intended to describe the risk to humans resulting from once-in-a-lifetime, or rare, exposure to airborne chemicals. Acute exposures are defined as single, non-repetitive exposures for not more than 8 hours. The development of the AEGLs is a collaborative effort of the public and private sectors worldwide. The National Advisory Committee for the Development of Acute Exposure Guideline Levels for Hazardous Substances (AEGL Committee) is involved in developing these guidelines to help both national and local authorities, as well as private companies, deal with emergencies involving spills, or other catastrophic exposures.

There three AEGL values are:

AEGL-1: Discomfort, non-disabling.

AEGL-2: Irreversible or other serious, long-lasting effects or impaired ability to escape.

AEGL-3: Life-threatening effects or death

(EPA 2013)(CDC NIOSH 2013)

Toxic Threat Zone

ALOHA® 5.4.6



Time: April 1, 2020 1200 hours MDT (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 : 760 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1128 yards --- (13 ppm = AEGL-2 [60 min])
Yellow: 3.5 miles --- (0.1 ppm = AEGL-1 [60 min])

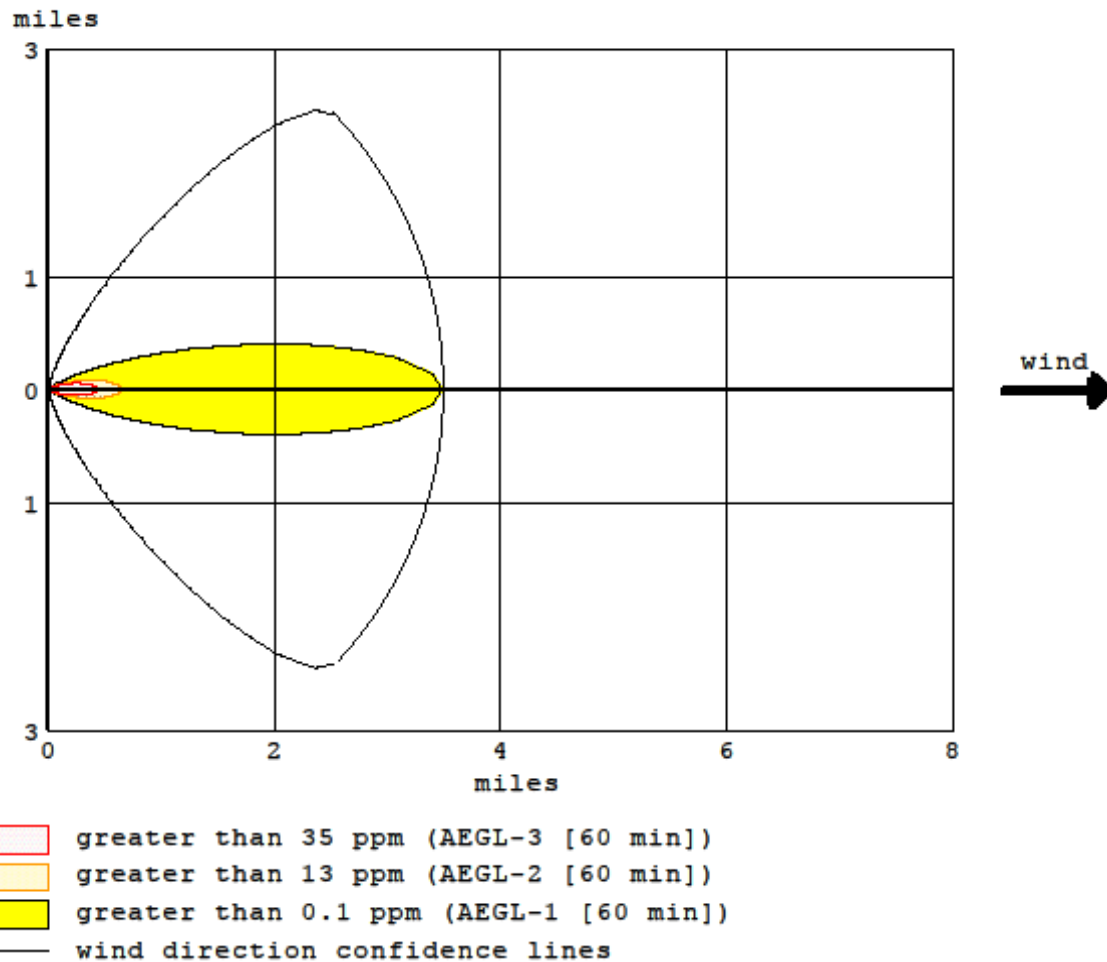


Figure C-1: WSMR-649 Test Case 1 - Daytime Landing, Low Cloud Cover and Wind Speed

Toxic Threat Zone

ALOHA® 5.4.6



Time: April 1, 2020 0000 hours MDT (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 : 1367 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1.1 miles --- (13 ppm = AEGL-2 [60 min])
Yellow: greater than 6 miles --- (0.1 ppm = AEGL-1 [60 min])

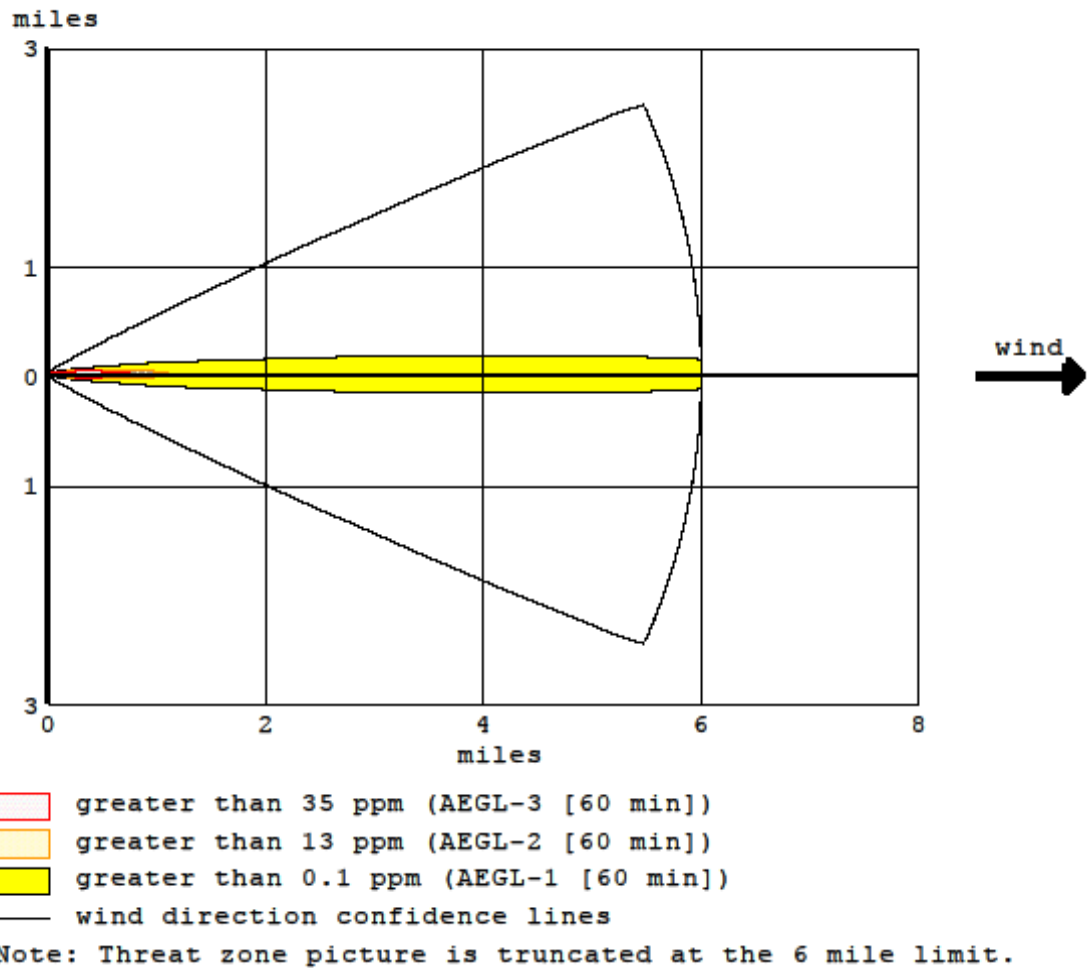


Figure C-2: WSMR-649 Test Case 2 - Nighttime Landing, Low Cloud Cover and Wind Speed

Toxic Threat Zone

ALOHA® 5.4.6



Time: April 1, 2020 1200 hours MDT (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 : 910 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1418 yards --- (13 ppm = AEGL-2 [60 min])
Yellow: 4.8 miles --- (0.1 ppm = AEGL-1 [60 min])

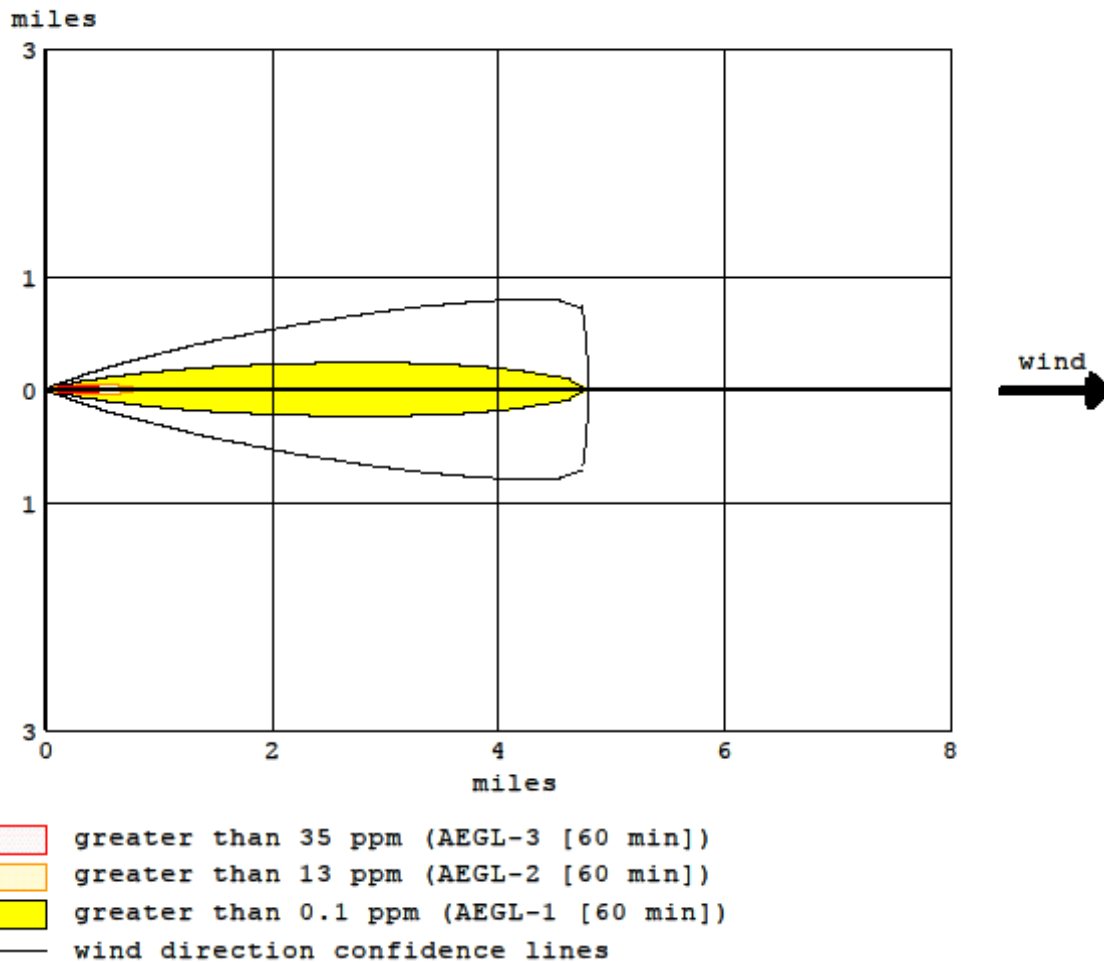


Figure C-3: WSMR-649 Test Case 3 - Anytime Landing, High Cloud Cover and Wind Speed

Toxic Threat Zone

ALOHA® 5.4.6



Time: April 1, 2020 1200 hours MDT (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 : 760 yards --- (35 ppm = AEGL-3 [60 min])
 Orange: 1129 yards --- (13 ppm = AEGL-2 [60 min])
 Yellow: 3.5 miles --- (0.1 ppm = AEGL-1 [60 min])

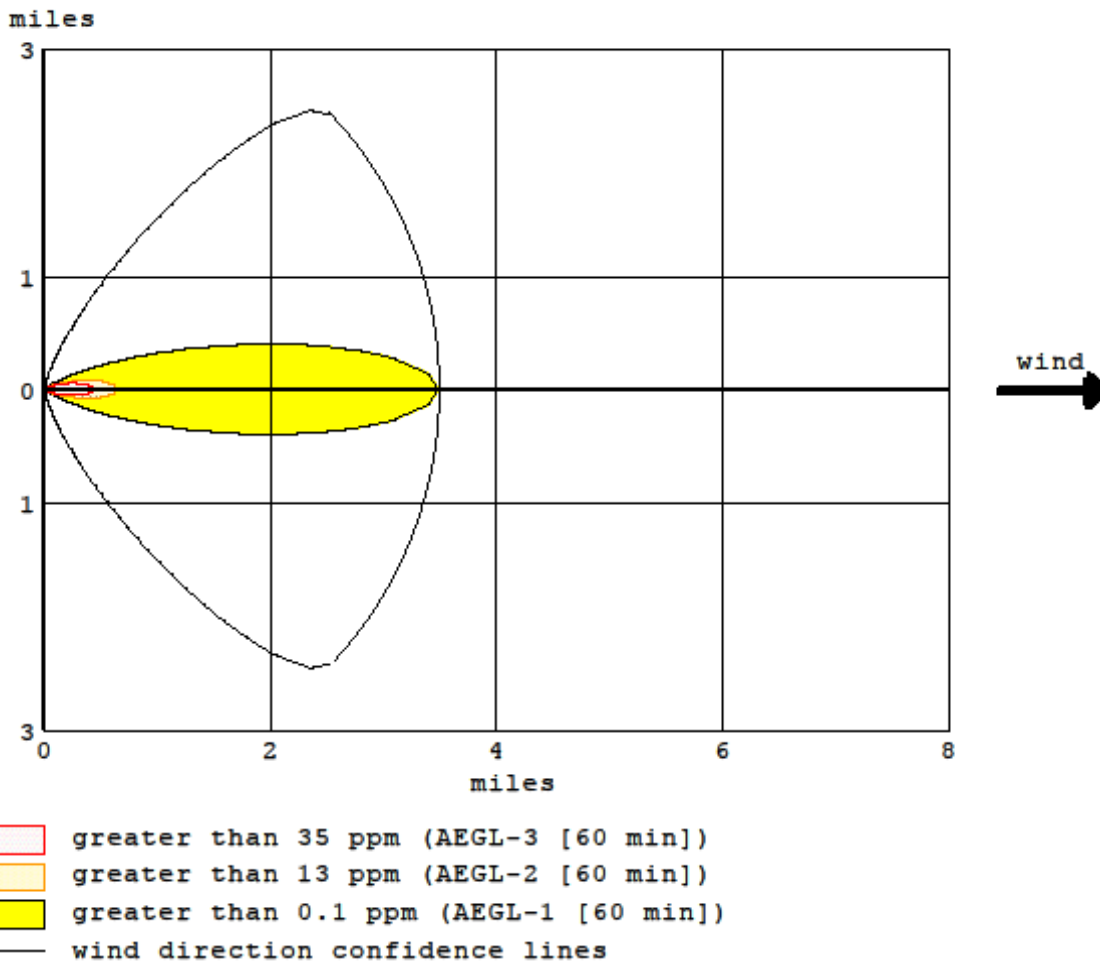



Figure C-4: WSSH Test Case 1 - Daytime Landing, Low Cloud Cover and Wind Speed

Toxic Threat Zone ALOHA® 5.4.6 

Time: April 1, 2020 0000 hours MDT (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 : 1370 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1.1 miles --- (13 ppm = AEGL-2 [60 min])
Yellow: greater than 6 miles --- (0.1 ppm = AEGL-1 [60 min])

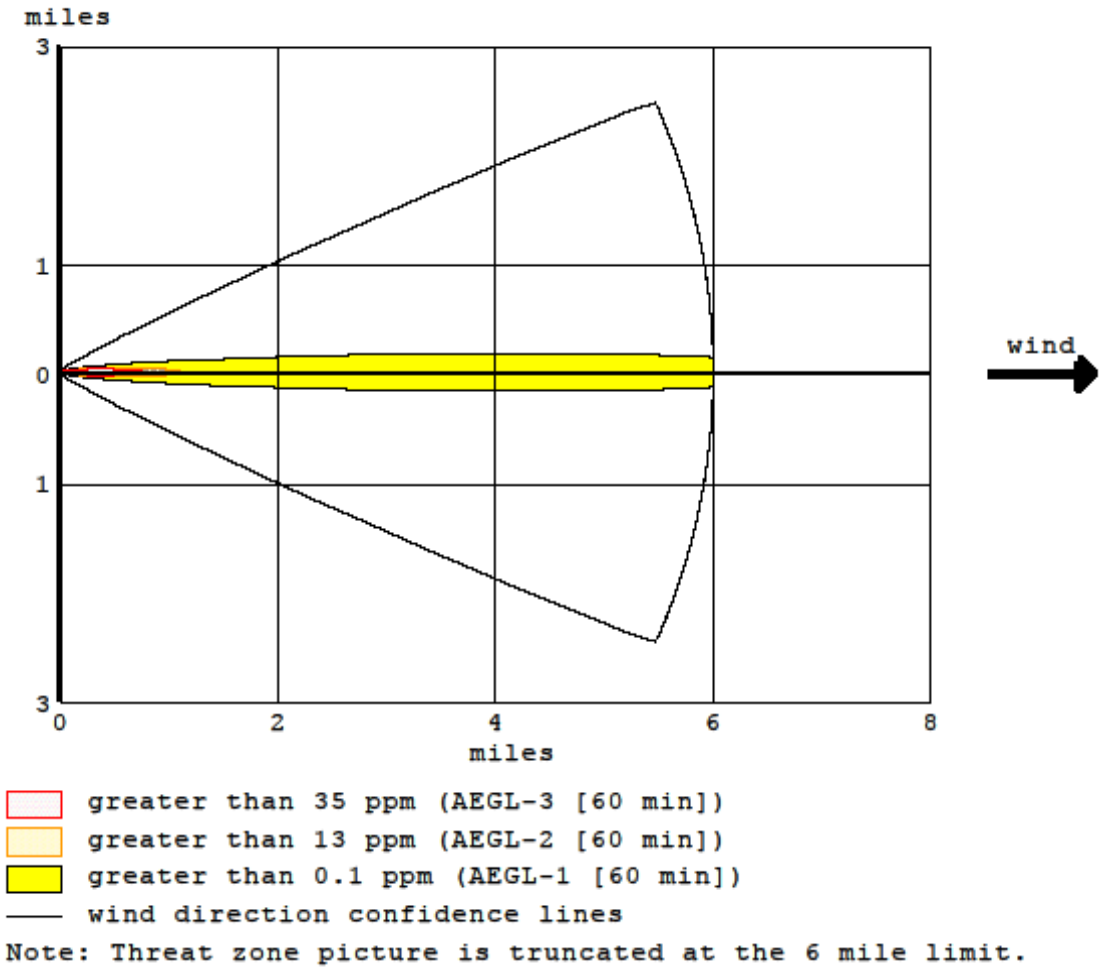



Figure C-5: WSSH Test Case 2 - Nighttime Landing, Low Cloud Cover and Wind Speed

Toxic Threat Zone ALOHA® 5.4.6 

Time: April 1, 2020 1200 hours MDT (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 : 911 yards --- (35 ppm = AEGL-3 [60 min])
Orange: 1419 yards --- (13 ppm = AEGL-2 [60 min])
Yellow: 4.8 miles --- (0.1 ppm = AEGL-1 [60 min])

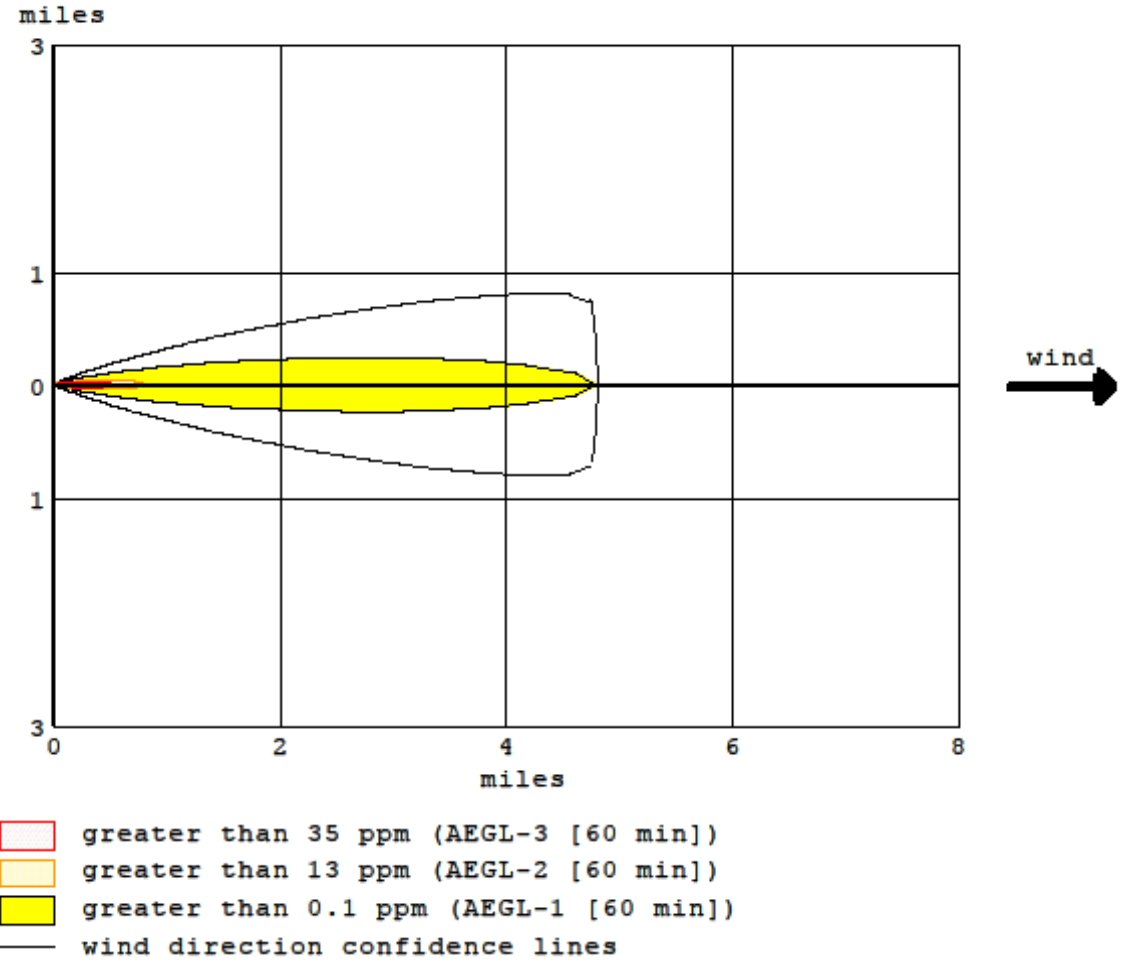


Figure C-6: WSSH Test Case 3 - Anytime Landing, High Cloud Cover and Wind Speed

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 descent to the landing site.

The Starliner could approach the landing site from two directions, one approach from the southwest (entry from a descending node of the Starliner orbit) and one from the northwest (entry from an ascending node of the Starliner orbit). The trajectory selected for a particular landing will be based on several factors, including selecting a de-orbit that allows for one or more backup opportunities, time of day, and weather.

Figure D-1 shows the descending node trajectory to WSMR-649. Figure D-2 shows the sonic boom footprint for this trajectory.

Figure D-3 shows the ascending node trajectory to WSMR-649. Figure D-4 shows the sonic boom footprint for this trajectory.

Figure D-5 shows the descending node trajectory to WSSH. Figure D-6 shows the sonic boom footprint for this trajectory.

Figure D-7 shows the ascending node trajectory to WSSH. Figure D-8 shows the sonic boom footprint for this trajectory.

The resulting sonic boom would have a CDNL= 24 dB (Annual CDNL)¹

The Mach 1 transition takes place at approximately 60,000 feet altitude above sea level. This transition is within 20 km of the center of the landing zone in all cases so takes place over WSMR.

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.

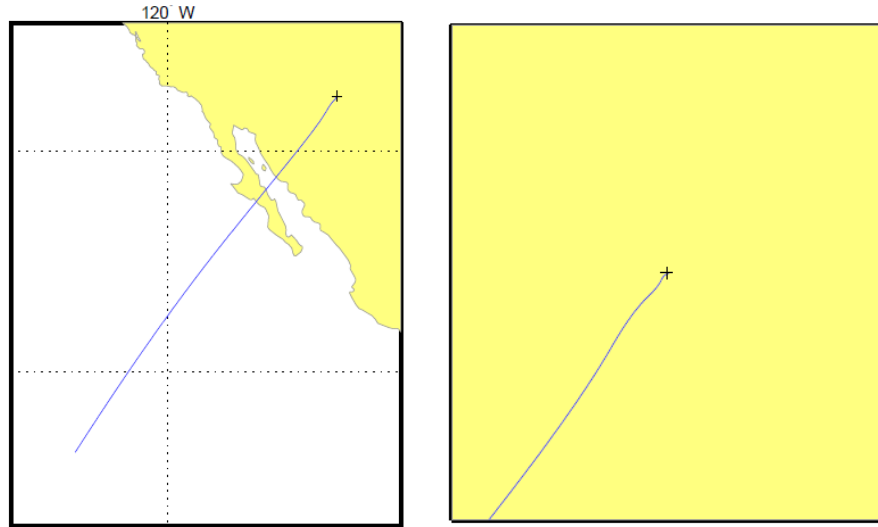


Figure D-1: WSMR-649 Descending Node Trajectory

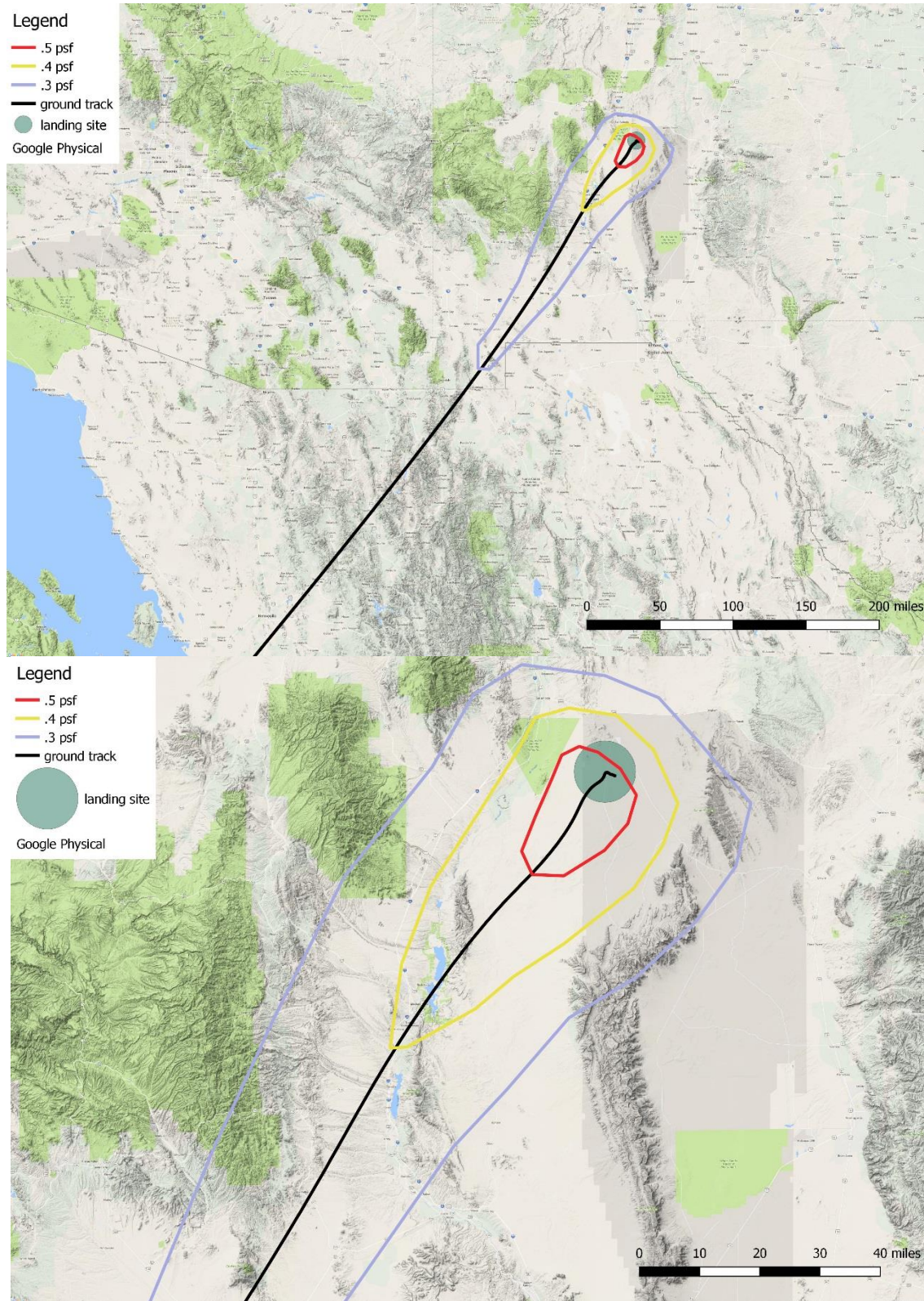


Figure D-2: WSMR-649 Descending Node Trajectory Sonic Boom Footprint

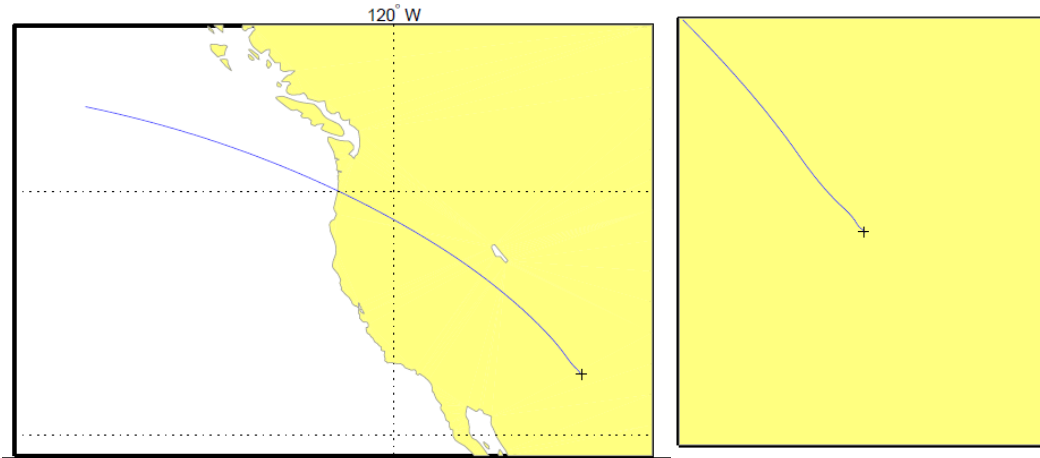


Figure D-3: WSMR-649 Ascending Node Trajectory

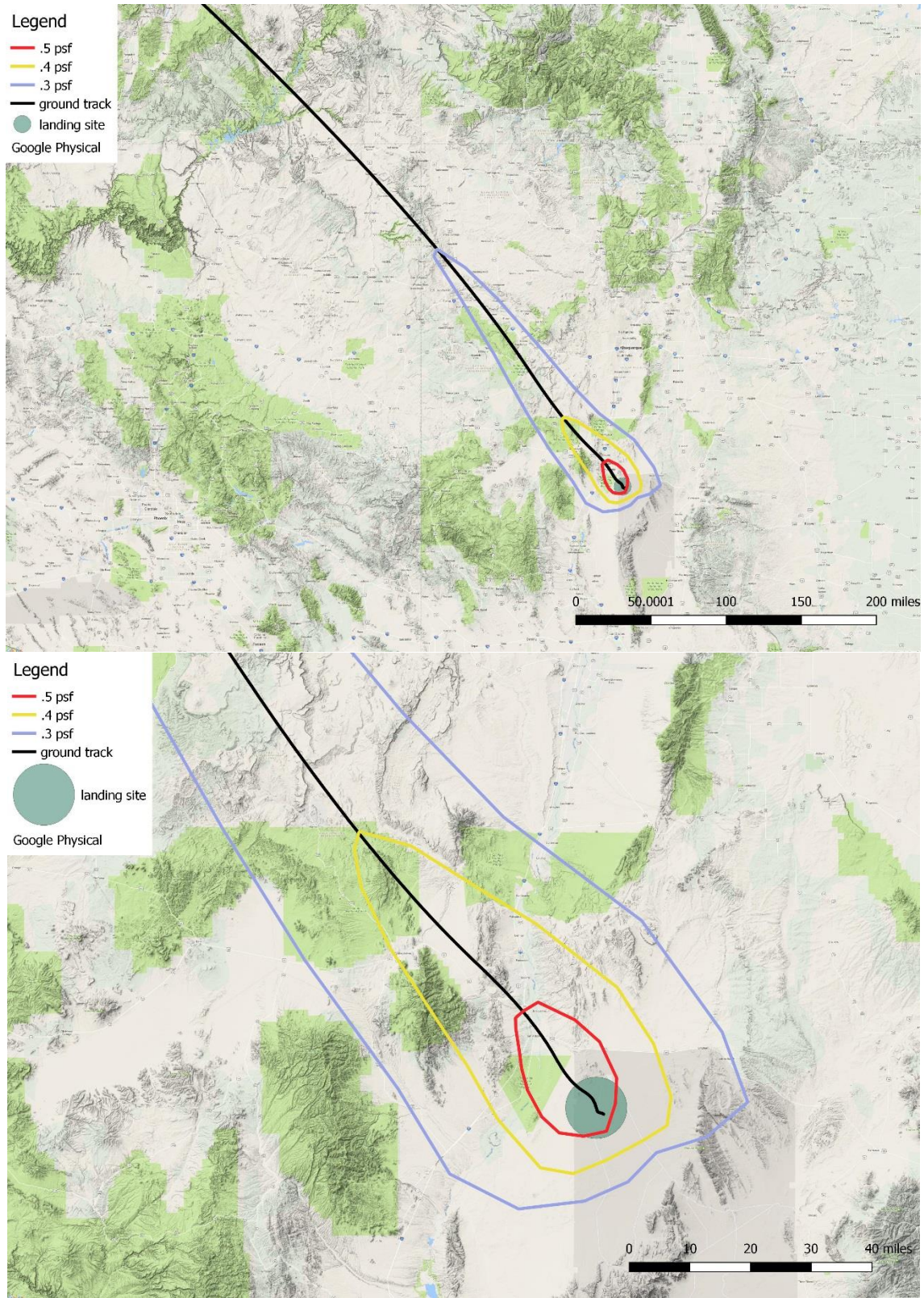


Figure D-4: WSMR-649 Ascending Node Trajectory Sonic Boom Footprint

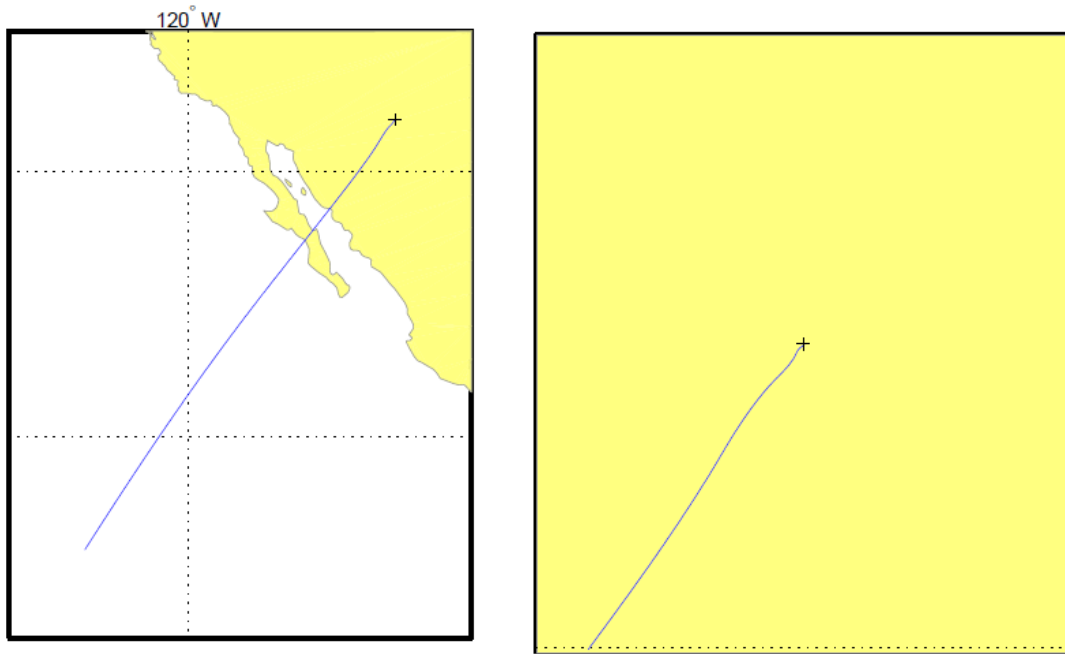


Figure D-5: WSSH Descending Node Trajectory

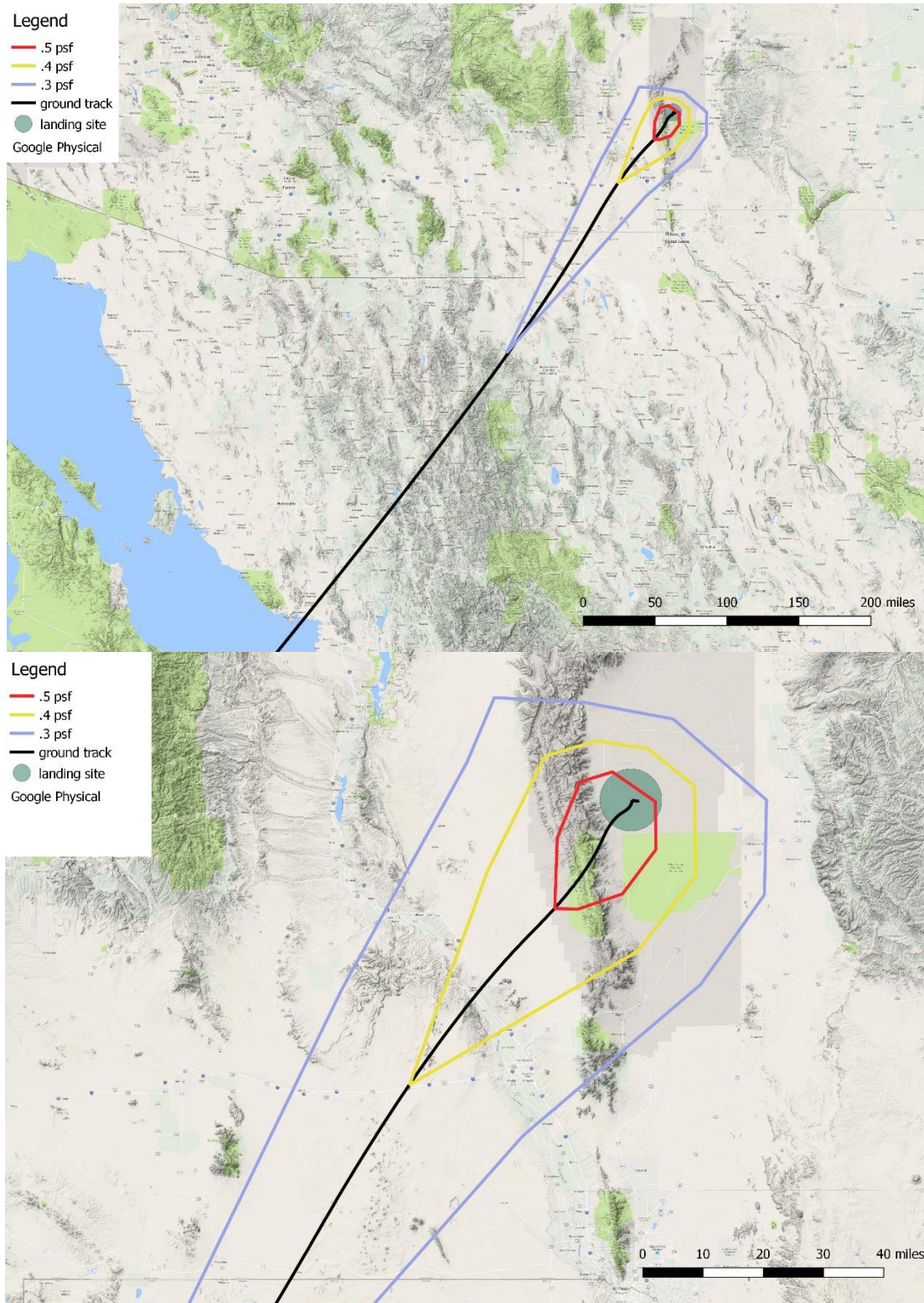


Figure D-6: WSSH Descending Node Trajectory Sonic Boom Footprint

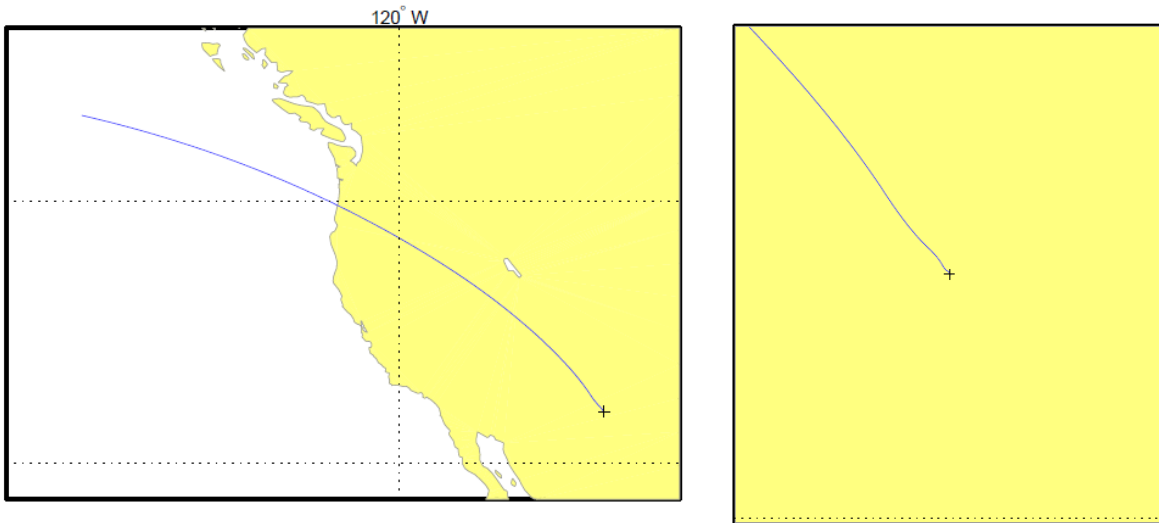


Figure D-7: WSSH Ascending Node Trajectory

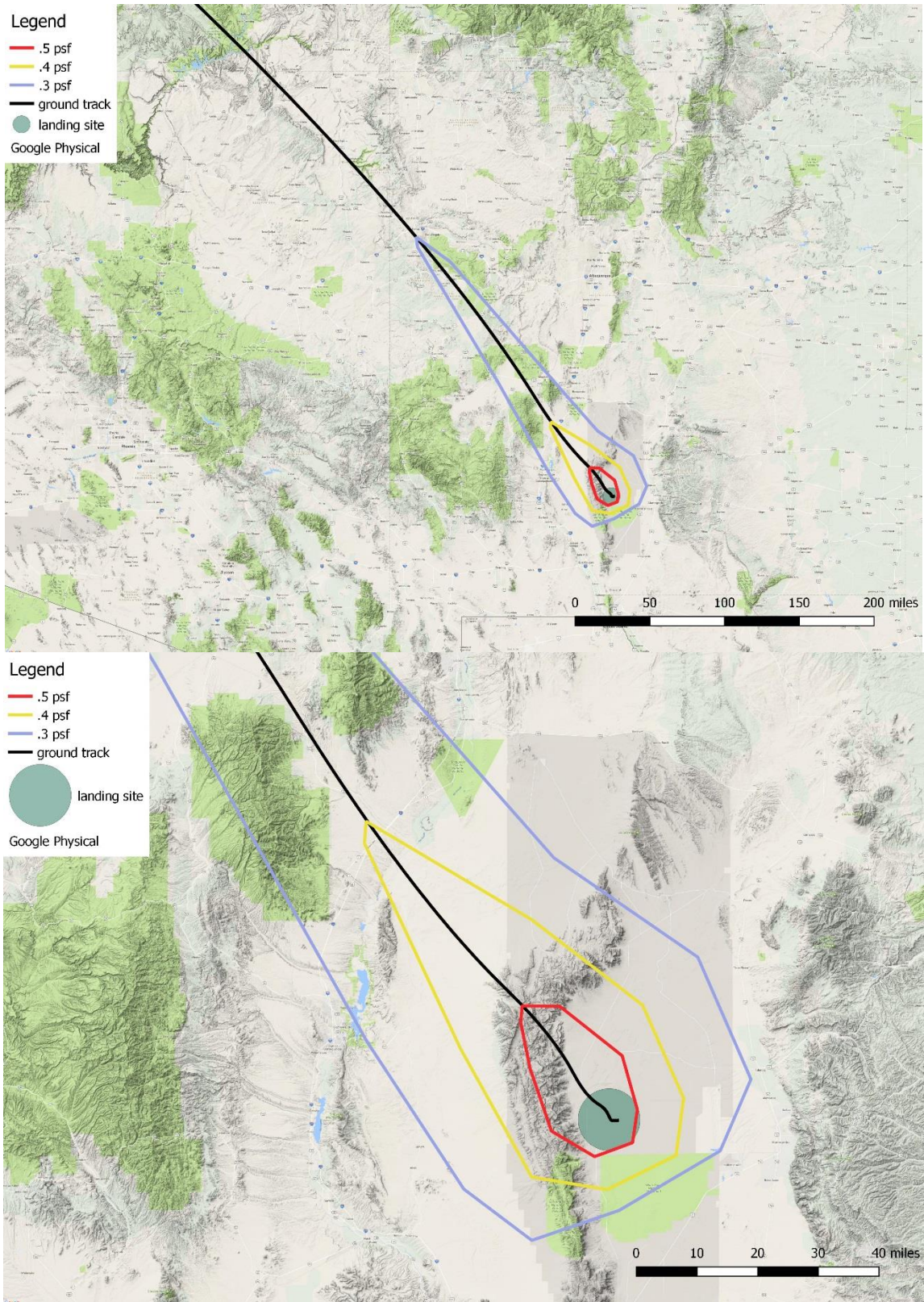


Figure D-8: WSSH Ascending Node Trajectory Sonic Boom Footprint

Appendix E – Natural Resource Survey Report

Below is the Natural Resources Survey Report

NATURAL RESOURCE SURVEYS
AT WHITE SANDS SPACE HARBOR AND 649 WIT
WHITE SANDS MISSILE RANGE, NEW MEXICO

Prepared for



**Special Aerospace
Services, LLC**

and



**White Sands Missile Range
New Mexico**

Prepared by:



and



**FINAL
Technical Report No 178**

November 22, 2016

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4009 Banister Lane, Suite 300
Austin, Texas 78704

AmaTerra Project No. 273-001

Cover photograph: Typical view of the 649 WIT Project Area.

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CHAPTER 1

INTRODUCTION

The White Sands Missile Range (WSMR) is the Department of Defense's (DoD) largest single land holding and covers 2.28 million acres (922,000 hectares) in south-central New Mexico (WSMR 2015). WSMR is located at the northern margin of the Chihuahuan Desert Ecoregion and encompasses two mountain ranges: the San Andres and Oscura Mountains. The installation is managed by the U.S. Department of Army and is operated to support DoD readiness programs, including research, development, testing and evaluation of weapons and space systems, and military training (WSMR 2015).

The Boeing Company (Boeing) and the National Aeronautics and Space Administration (NASA) have requested to use areas on WSMR for two potential Commercial Crew Transportation System Starliner spacecraft landing sites within WSMR. The spacecraft will parachute to earth and land at one of two potential sites on WSMR at the end of its mission to the International Space Station. One site is located within the central Tularosa Basin (South Site) and one is located in the Stallion Basin of northern WSMR (North Site). To meet the requirements of the National Environmental Policy Act (NEPA) and to obtain permission to perform the landing and recovery of the Starliner spacecraft, an Environmental Assessment (EA) is being completed by Special Aerospace Services (SAS). ECO Inc. was contracted through AmaTerra Environmental, Inc. (AmaTerra) to perform the natural resources surveys required for inclusion in the EA.

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CHAPTER 2

METHODS

2.1 Literature Search

A literature search was performed to compile existing data relating to surveys that have been previously conducted at or near the proposed landing sites. Additionally, the U.S. Fish and Wildlife Service (USFWS) website was consulted to complete an Information for Planning and Conservation (IPaC) search. The IPaC search is a useful tool for compiling a current list of potential threatened and endangered species that may occur at the proposed landing sites.

2.2 Surveys

Natural resource surveys were conducted at each of the proposed landing sites. For each site, ten random sampling points were selected. At the South Site located at the White Sands Space Harbor (WSSH), points were selected within a 4-km radius landing zone (**Appendix A**). At the North Site located near WSMR 649 Weapons Impact Target site (WIT), 10 points were randomly chosen within a larger polygon designated through consultation between WSMR and Boeing engineers (**Appendix B**). At each of the 10 points, a 425-ft (129-m) radius area was surveyed by walking throughout the area and recording vegetation and faunal species.

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CHAPTER 3 RESULTS

3.1 South White Sands Space Harbor Landing Site

Muldavin et al. (2000) classified the vegetation at the South WSSH landing site as pickleweed shrubland. These communities are characterized as open-canopied shrublands of pickleweed with understories that are poor in diversity and cover (Muldavin et al. 2000). These communities are an excellent indicator of highly alkaline soils (Muldavin et al. 2000). Species diversity appears to be naturally low in this community, with only a limited set of salt-tolerant species able to occupy these areas (Burkett 1997, WSMR 2015, Muldavin et al. 2000, Tazik et al. 1992). Faunal surveys conducted in this habitat type have resulted in detection of very few faunal and floral species (Burkett 1997, Tazik et al. 1992).

For analysis of the South WSSH landing site the USFWS IPaC produced a total of four potential Threatened and Endangered species that exist in Doña Ana County. Species federally listed as endangered, threatened, candidate, or proposed, and nonessential experimental populations that may occur within the landing sites were examined to determine potential for occurrence and effect from proposed actions (**Table 1**).

Table 1. Species Federally Listed as Threatened and Endangered, Recorded and Potentially Occurring in White Sands Space Harbor South Landing Site.

Species	Status	County where species occurs	Range/Habitat Requirements	Potential Occurrence at WSSH	Note on Effects Determination
Least Tern (<i>Sterna antillarum</i>)	Endangered	Doña Ana	River systems	Unlikely to occur	No Effect
Aplomado falcon (<i>Falco femoralis septentrionalis</i>)	Endangered, Experimental populations, Non-essential	Doña Ana	Desert grassland associations	Unlikely to occur	No effect
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Threatened	Doña Ana	Riparian systems	Unlikely to occur	No effect
Sneed's pincushion cactus (<i>Escobaria sneedii</i> var. <i>sneedii</i>)	Endangered	Doña Ana	Found in cracks of limestone formations in broken terrain and steep slopes usually in Chihuahuan desert scrub.	Does not occur	No effect

Information obtained from USFWS; Muldavin et al. 2000; WSMR 2015; Burkett 1997; and Tazik et al 1992.

All three bird species considered for this site have the potential to fly through the area, particularly during spring and fall migration. Least terns are known to use broad open sandy habitats but always in association with river and lake habitats where they forage for fish. No suitable habitats exist for any of these three bird species or the Sneed's Pincushion cactus at the South WSSH landing site.

Surveys at the WSSH landing site revealed very low species diversity and large areas of bare ground (exceeding 95 percent) in each survey area (**Figures 1 and 2**). Only two species of vegetation were identified within the survey areas: pickleweed (*Allenrolfea occidentalis*) and non-native saltcedar (*Tamarix ramosissima*). Very few faunal species were detected during the surveys (**Table 2**). Saltcedar trees at this site are suffering from the effects of saltcedar leaf beetles and several were observed on the trees while conducting surveys. Saltcedar response to beetle presence varies greatly at different sites and situations; for example, the USDA reports mortality levels approaching 90 percent in Utah after 9 years (USDA 2016). Numerous studies of the beetles' effect on saltcedar are currently being conducted across the western U.S., but studies have not been conducted on widely separated saltcedar in extremely low density, such as are found at the WSSH landing site. It is thus likely, but not certain, that these beetles will eventually (within three to five years) kill all the saltcedar at this site.

A search of the USFWS National Wetlands Inventory website shows no wetland areas within the WSSH landing site. Site investigation confirmed that no wetlands exist at this site.



Figure 1. WSSH Plot 4.



Figure 2. WSSH Plot 6.

Table 2. Species List for WSSH Survey Area.

White Sands Space Harbor Species list	
Flora Species – Composition	Faunal Species
<p>Tree – 10 percent Saltcedar (<i>Tamarisk ramosissima</i>)</p> <p>Shrub – 90 percent Pickleweed (<i>allenrolfea occidentalis</i>)</p>	<p>Oryx (<i>Oryx gazella</i>) Saltcedar Leaf Beetle (<i>Diorhabda spp.</i>) Twice-stabbed ladybird beetle (<i>Chilocorus stigma</i>) Dragonfly (<i>Odonata spp.</i>) Butterfly (<i>Lepidoptera spp.</i>) Grasshopper (<i>Orthoptera spp.</i>)</p>

3.2 649 WIT North Landing Site

Four vegetation communities have been described at the northern 649 WIT landing site: desert plains grassland, lowland basin grassland, sandsage shrubland, and vegetated gypsum outcrop (Muldavin et al. 2000). Desert plains grasslands are characterized as occurring on rolling sandy plains with black grama/soaptree yucca communities (Muldavin et al. 2000). Lowland basin grasslands are characterized by alkali sacaton dominated types and occur on alluvial flats in basin bottoms (Muldavin et al. 2000). Sandsage shrublands are dominated by sand sagebrush on the sandy plains of the northern Jornada Del Muerto basin (Muldavin et al. 2000). This community is intermixed with desert plains and lowland basin grasslands. The vegetated gypsum outcrop community is restricted to gypsum outcrops within basin bottoms and on foothills throughout WSMR (Muldavin et al. 2000). Basin bottoms are characterized by Gyp dropseed/hairy coldenia and Fourwing saltbush/Gyp dropseed communities (Muldavin et al. 2000).

The USFWS IPaC produced a total of 15 potential Threatened and Endangered species that exist in Socorro County. After analyzing information from the literature search, consultation with resource experts, and assessing existing habitat conditions, seven species were deemed appropriate for consideration (Table 3).

Table 3. Species Federally Listed as Threatened and Endangered, Recorded or Potentially occurring at 649 WIT North Landing Site.

Species	Status	County where species occurs	Range/Habitat Requirements	Potential Occurrence at 649 WIT	Note on Effects Determination
Least Tern (<i>Sterna antillarum</i>)	Endangered	Socorro	River systems	Unlikely to occur	No Effect
Aplomado falcon (<i>Falco femoralis septentrionalis</i>)	Endangered, Experimental populations, Non-essential	Socorro	Desert grassland associations	Unlikely to occur	No effect
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Threatened	Socorro	Riparian systems	Unlikely to occur	No effect
Piping Plover (<i>Charadrius melodus</i>)	Threatened	Socorro	Sandy upper beaches and shorelines	Unlikely to occur	No effect
Southwestern Willow flycatcher (<i>Empidonax traillii extimus</i>)	Endangered	Socorro	Riparian habitats	Unlikely to occur	No effect
Pecos sunflower (<i>Helianthus paradoxus</i>)	Threatened	Socorro	Permanent wetlands	Does not occur	No effect
New Mexico meadow jumping mouse (<i>Zapus hudsonius</i>)	Endangered	Socorro	Riparian habitats	Does not occur	No effect

Information obtained from USFWS; Muldavin et al. 2000; WSMR 2015; Burkett 1997; and Tazik et al 1992.

All four bird species considered for this site have the potential to fly through the area, particularly during spring and fall migration. Desert plains grassland habitat with yucca association is known to provide habitat for the Northern Aplomado falcon. No suitable habitat exists at the North site for the other three species of birds considered. No wetland or riparian habitat suitable for the Pecos sunflower or the meadow jumping mouse exist within the North landing zone. A single observation of an aplomado falcon was recorded in the Stallion basin near Gallegos Site in 2005 (Burkett 2005). Other observations of aplomado falcons in the Stallion basin were the result of the reintroduction program, which is no longer being conducted. The Peregrine Fund (2014) has determined that this region of the Chihuahuan Desert is not currently suitable for the aplomado falcon due to prolonged drought. This analysis supports the conclusion that no threatened or endangered species are at potential risk from proposed landing and recovery operations of Boeing spacecraft at the North landing site.

Surveys at the 649 WIT landing site revealed several habitat types. Survey sites 1, 3, 4, 7, and 10 were in the lowland basin grassland vegetation type and were dominated by fourwing saltbush and alkali sacaton (**Figures 3 and 4**). Survey plot 8 was characterized by a burrograss flat (**Figure 5**). Survey plot 6 is a soaptree yucca/alkali sacaton grassland (**Figure 6**). Survey plot 2 was dominated by fourwing saltbush with scattered soaptree yucca (**Figure 7**). Survey plot 5 is a black grama/soaptree yucca grassland (**Figure 8**). Survey plot 9 is a fourwing saltbush shrubland (**Figure 9**). Bare ground appeared to comprise the majority of the surface area (60-70 percent) within survey plots number 7, 9, and 10. Thirty-seven species of vegetation were identified within the survey areas. Twenty-seven faunal species were detected during the surveys (**Table 4**).

A search of the USFWS National Wetlands Inventory website indicates that a single wetland occurs within the 649 WIT landing site. The USFWS wetlands mapper describes this wetland as palustrine (inland wetland that lacks flowing water), with an unconsolidated bottom, and permanent surface water. Resource experts consulted regarding this site agreed that no wetlands occur at the 649 landing site. Site visitation confirmed what resource experts had predicted and no wetland exists. No riparian obligate or facultative vegetative species or permanent surface water exists in or around the 649 WIT landing site.



Figure 3. 649 WIT Plot 4.



Figure 4. 649 WIT Plot 3.



Figure 5. 649 WIT Plot 6.



Figure 6. 649 WIT Plot 8.



Figure 7. 649 WIT Plot 2.



Figure 8. 649 WIT Plot 5.



Figure 9. 649 WIT Plot 9.

Table 4. Species List for North 649 WIT Survey Area.

Flora Species - Composition	Faunal Species
Tree - < 1%	Mammals
Saltcedar (<i>Tamarisk ramosissima</i>)	Oryx (<i>Oryx gazella</i>)
	Spotted ground squirrel (<i>Xerospermophilus pilosoma</i>)
Shrub – 60%	Black-tailed jackrabbit (<i>Lepus californicus</i>)
Four wing saltbush (<i>Atriplex canescens</i>)	Desert cottontail rabbit (<i>Sylvilagus auduboni</i>)
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	Pronghorn antelope (<i>Antilocapra Americana</i>)
Soaptree yucca (<i>Yucca elata</i>)	Gopher (<i>Geomyidae spp.</i>)
Mormon tea (<i>Ephedra trifurca</i>)	Coyote (<i>Canis latrans</i>)
Torrey’s Mormon tea (<i>Ephedra torreyana</i>)	Badger (<i>Taxidea Taxus</i>)
Sand sagebrush (<i>Artemisia filifolia</i>)	
Honey mesquite (<i>Prosopis glandulosa</i>)	
Mesa dropseed (<i>Sporobolus flexuosus</i>)	
	Birds
Grass – 30%	Loggerhead shrike (<i>Lanius ludovicianus</i>)
Alkali sacaton (<i>Sporobolus airoides</i>)	Chihuahuan raven (<i>Corvus cryptoleucus</i>)
Burrograss (<i>Scleropogon brevifolius</i>)	Horned lark (<i>Eremophila alpestris</i>)
Fluffgrass (<i>Dasyochloa pulchella</i>)	Black-throated sparrow (<i>Amphispiza bilineata</i>)
Sixweeks grama (<i>Bouteloua barbata</i>)	Scott’s oriole (<i>Icterus parisorum</i>)
Sand dropseed (<i>Sporobolus cryptandrus</i>)	Great-horned owl (<i>Bubo virginianus</i>)
Ring muhly (<i>Muhlenbergia torreyi</i>)	Say’s phoebe (<i>Sayornis saya</i>)
Bush muhly (<i>Muhlenbergia porteri</i>)	
Indian ricegrass (<i>Oryzopsis hymenoides</i>)	Invertebrates
Black grama (<i>Bouteloua eriopoda</i>)	Orb weaver spider (<i>Araneidae spp.</i>)
Vine mesquite (<i>Panicum obtusum</i>)	Robber fly (<i>Asilidae spp.</i>)
Purple threeawn (<i>Aristida purpurea</i>)	Tarantula (<i>Theraphosidae spp.</i>)
Spike dropseed (<i>Sporobolus contractus</i>)	Harvester ant (<i>Pogonomyrmex spp.</i>)
Big bluestem (<i>Andropogon gerardii</i>)	Darkling beetle (<i>Tenebrionidae spp.</i>)
	Butterfly (<i>Lepidoptera spp.</i>)
Forb – 5%	Grasshopper (<i>Orthoptera spp.</i>)
Spear globemallow (<i>Sphaeralcea hastulata</i>)	Bumble bee (<i>Bombus spp.</i>)
Spectacle pod (<i>Dimorphocarpa wislizeni</i>)	Tarantula hawk (<i>Pepsis spp.</i>)
Cowpen daisy (<i>Verbesina encelioides</i>)	
Locoweed (<i>Astragalus spp.</i>)	Reptiles
Russian thistle (<i>Salsola tragus</i>)	Common side-blotched lizard (<i>Uta stansburiana</i>)
Cryptantha spp.	Texas horned lizard (<i>Phrynosoma cornutum</i>)
Silverleaf nightshade (<i>Solanum elaeagnifolium</i>)	Lesser earless lizard (<i>Holbrookia maculata</i>)
Mexican hat (<i>Ratibida columnifera</i>)	
Desert marigold (<i>Baileya multiradiata</i>)	
Hairy crinklemat (<i>Tiquilia hispidissima</i>)	

Cactus - 4%

Desert prickly pear (*Opuntia phaeacantha*)

Cane cholla (*Cylindropuntia imbricata*)

Club cholla (*Grusonia clavata*)

Desert Christmas cactus (*Cylindropuntia leptocaulis*)

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CHAPTER 4

CONCLUSION

Habitat associations with the South WSSH landing site are extremely biologically unproductive and large expanses of the area are completely barren. No negative effects to natural resources are anticipated from the proposed action at the South WSSH landing site. Field studies confirmed that there no wetland areas within the WSSH landing site; therefore, there will be no impacts to wetlands or other water resources.

Habitat associations with the North 649 landing site are varied and support a broad diversity of animal life. Analysis of past surveys and information gathered during current survey efforts at this site revealed no federally or state listed species inhabiting or likely to inhabit the site. No negative effects to natural resources are anticipated from the proposed action at the North 649 WIT site. As no riparian obligate wetland areas, facultative vegetative species, or permanent surface water exists in or around the 649 WIT landing site, there are no negative impacts expected to wetlands or other water resources.

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RESOURCE EXPERTS CONSULTED

Deborah Nethers – White Sands Missile Range Ecologist

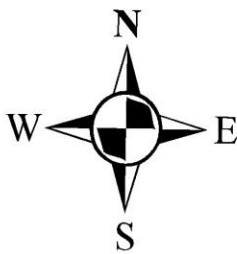
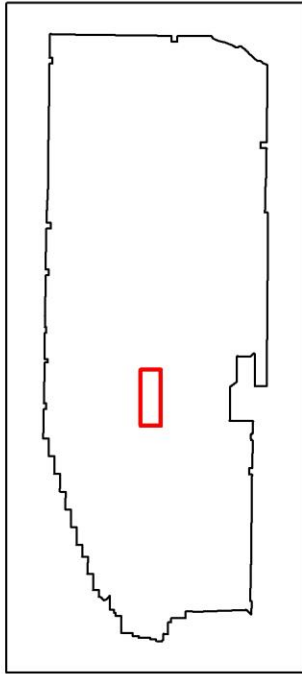
Dave Anderson – White Sands Missile Range Land Manager

Doug Burkett - Senior Ecologist ECO, Inc.

Matt Hartsough – Senior Ecologist / CEO ECO, Inc.

APPENDIX A
MAP OF WSSH LANDING SITE ON WSMR
2016

WSSH Landing Site



Legend

- Survey points
- ⊗ LCTA Sites
- Boeing Impact Area

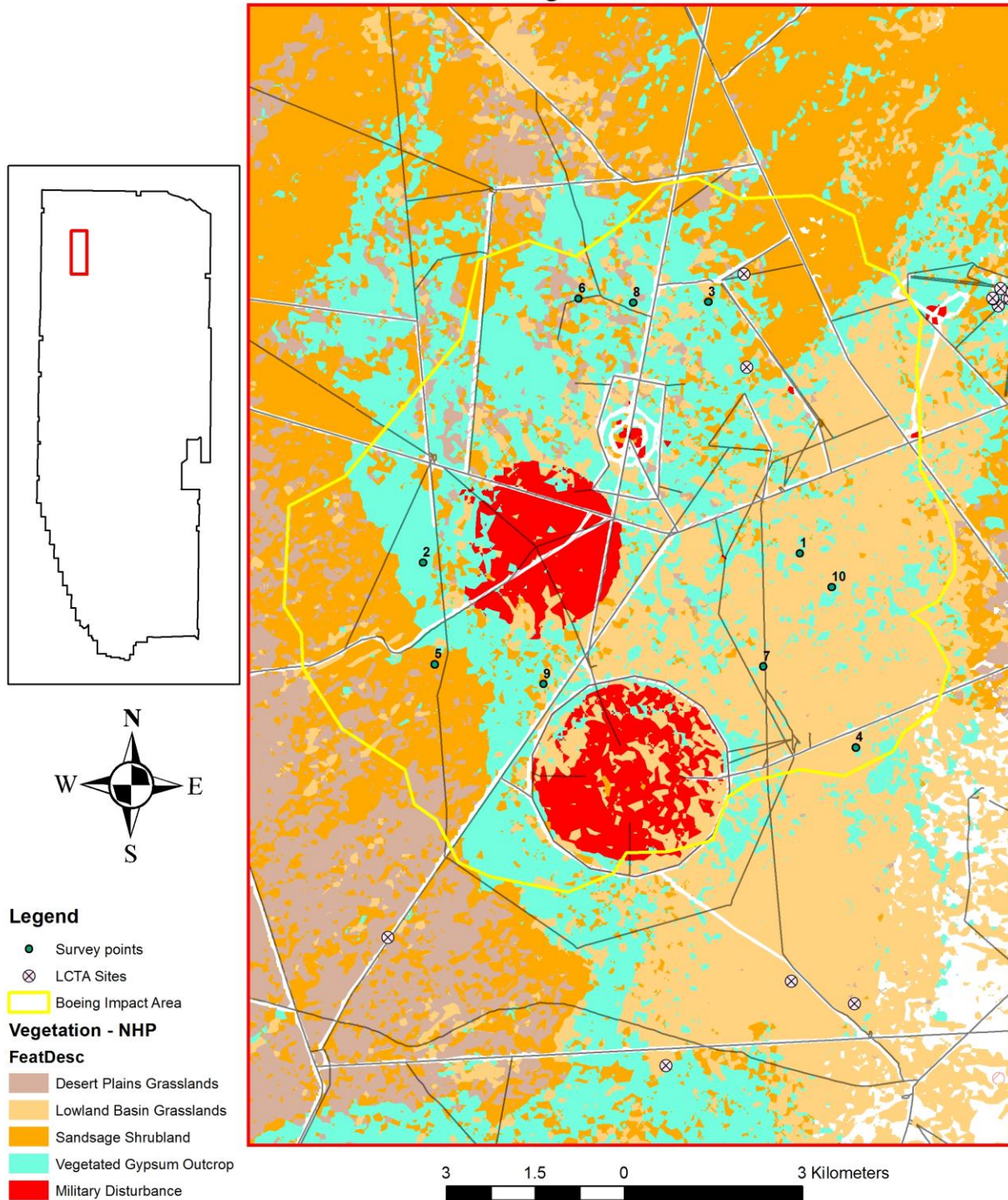


Sampling Point	Easting	Northing
1	360942	3646177
2	365807	3644616
3	363207	3649943
4	364301	3646868
5	365426	3649221
6	364089	3643351
7	367066	3645714
8	366750	3645212
9	364377	3647996
10	365704	3646315

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APPENDIX B
MAP OF 649 WIT LANDING SITE ON WSMR
2016

649 WIT Landing Site



Sampling Point	Easting	Northing
1	355303	3723146
2	348945	3722991
3	353756	3727384
4	356245	3719876
5	349146	3721277
6	351568	3727440
7	354682	3721238
8	352488	3727373
9	350982	3720940
10	355835	3722578

Appendix F - Consultation Results

Below are the consultation results.



DEPARTMENT OF THE ARMY
U.S. ARMY GARRISON WHITE SANDS MISSILE RANGE
100 HEADQUARTERS AVENUE
WHITE SANDS MISSILE RANGE, NEW MEXICO 88002-5000

August 7, 2017

106238

Dr. Jeff Pappas
State Historic Preservation Officer
State Historic Preservation Division
Bataan Memorial Building
407 Galisteo St., Suite 236
Santa Fe, New Mexico 87501

RECEIVED
AUG 14 2017 Bob
HISTORIC PRESERVATION DIVISION

Dear Dr. Pappas:

Enclosed please find one copy of the report entitled *Landing on the Lake: Archaeological Survey of 874 Acres Within the WSMR-649 Landing Site, White Sands Missile Range, New Mexico* by Mark Sale and Amy Silberberg of Amaterra Environmental, Inc. Also enclosed is one copy of the New Mexico Investigation Abstract Form (NMCRI 136608) and Laboratory of Anthropology forms for site LA 186365, LA 186366, LA 186367, LA 186368, LA 186369, LA 186370, LA 186371, and LA 186372. The project is an inventory of an area to be used as a buffer zone for the Commercial Crew Transportation System Starliner spacecraft (CCTS) landing site at the 649 Landing Site in the north-central part of White Sands Missile Range (WSMR). The 649 Landing Site is mostly within the 649 Weapons Impact Target (WIT) impact area with buffer zones to the north and east. The CCTS will approach from the southwest with touchdown in the center of 649 WIT. The Starliner will make a parachute landing within a circle with a radius of approximately 4 kilometers. This provides a relatively flat surface free of any buildings or above ground obstructions that could cause a hazard to the landing spacecraft. Several pieces jettisoned during the landing sequence would normally land up to 8 kilometers (km) from the center of this circle however, in the event that capsule returns to earth under a worst case wind scenario, it is possible that some jettisoned items would land up to 15 km from the center point. These items also use parachutes to assist landing. Recovery will be done with a truck-mounted crane. If the items miss the aim point (center of 649 WIT), archaeologists will accompany recovery crews for access.

The 649 WIT and buffer zone area is considered the Area of Potential Effect (APE). The 649 WIT was not surveyed due to concerns with unexploded ordnance. It is an active ordnance impact area with restricted access. Surface survey of the remainder of the APE was conducted at a 15 meter interval with all historic properties recorded within the APE utilizing a Global Positioning System (GPS) with sub-meter accuracy. Visibility was approximately 75% throughout the APE due to grasses and bushes. The archaeological survey discovered eight unrecorded prehistoric archaeological sites in the APE. In addition 183 isolated occurrences were observed. Of the eight sites recorded, one site, LA 186370, is recommended

eligible for the National Register of Historic Places (NRHP) under criterion d. There is requisite data potential and integrity left at the site. The remaining seven sites are recommended as not eligible for the NRHP. None of these sites has integrity and all seven have low data potential. None of the isolated occurrences has the requisite data potential and integrity for listing on the NRHP. Table 1 lists the NRHP eligibility for the sites.

LA Number	Eligibility
LA 186365	Not Eligible
LA 186366	Not Eligible
LA 186367	Not Eligible
LA 186368	Not Eligible
LA 186369	Not Eligible
LA 186370	Eligible
LA 186371	Not Eligible
LA 186372	Not Eligible

White Sands Missile Range determines that this project meets the criteria for "no historic properties affected" as per 36 CFR 800.4. We ask you for concurrence on the finding of "no historic properties affected" and the eligibility determination for the archaeological sites. If you should have any questions, please contact James Bowman, Directorate of Public Works, Environmental Division at (575) 678-7925 or (575) 678-2225.

Sincerely,



James Bowman
Cultural Resources Manager

Enclosures

Concur with recommendation of eligibility and/or effects as proposed.

John R. Ester Sept 12, 2017
for NM State Historic Preservation Officer

Appendix G - List of Preparers and Reviewers

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