**O&SHA EXAMPLE**

The following document (SEAL-SSD-014) is provided as an example of possible approach at developing and submitting an Operating and Support Hazards Analysis. Specific details on required content are included in AFSPCMAN 91-710, Volume 1, A3.2.4.3 and Volume 6, A2.2.2.6. The Range User has the flexibility to decide on document layout and format.

As described in Volume 6, Attachment 2, the O&SHA shall be performed for each procedure and the results summarized in the O&SHA deliverable. This analysis helps identify hazardous procedures, controls, verifications, etc. The O&SHA shall identify and evaluate the safety considerations associated with environments, personnel, procedures, and equipment involved throughout the operational phase of the program and shall meet the intent of O&SHA requirements in AFSPCMAN 91-710 Volume 1, Attachment 2.

If the Range User chooses to use this template as a deliverable format, it is recommended that the Volume 6, Attachment 2 be used as a checklist for populating the existing sections and subsections, or adding new sections or subsections to the document, as needed. This O&SHA example is by no means complete; therefore the Range User should use the Volume 6, Attachment 2 as the driver for document completion.

**<Company Name>**

DRAFT

**OPERATING & SUPPORT**

**HAZARDS ANALYSIS**

**FOR THE**

**<Title> PROGRAM**

Document Number: XXXXX

Revision X, 15 Sep 2021

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

This document is meant as an example only. Detailed requirements

are included AFPSPCMAN 91-710 Vol 6, Attachment 2

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

<Company Name>

102 Maybury Gardens

Isle of Avalon, FL 32145

Prepared by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

John Doe

<Company Name> System Safety Manager

Approved by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Adam Smith Date

<Company Name> Program Manager

**Document Change History:**

|  |  |  |  |
| --- | --- | --- | --- |
| Revision **Identification** | RevisionDate | **Pages Affected** | **Change Description** |
| Initial Release | 18 Sep 20 | N/A | N/A |
| A | 15 Sep 21 | Appendix A | Updated Personnel Listing |
|  |  |  |  |

##### PREFACE

This document establishes and defines the <Company Name> Operating and Support Hazard Analysis (O&SHA) and its elements as required by AFSPCMAN 91-710 [T] for the <Title> Program at Space Launch Delta 30 (SLD30).

<Company Name> Corporation, located at Isle of Avalon, Florida, has contracted with the USAF to launch <Title> launch vehicles from the Western Range. The <Title> launch vehicle consists of two stages. The first and second stage propellants are RP-1 and LOX.TABLE OF CONTENTS

#### GLOSSARY OF ACRONYMS AND DEFINITIONS

**1.0 INTRODUCTION**

**1.1** Purpose

**1.2** Scope

**1.3** Applicability

**1.4** Operating and Support Hazard Analysis Updates

**2.0 METHODOLOGY**

**2.1** Risk Assessment

**2.2** Hazard Risk Severity

**2.3** Hazard Risk Probability

**2.4** Hazard Risk Assessment Code Matrix

**2.5**  Primary Imitating Conditions, Events, or Circumstances

**2.8** Operational Hazards List

**3.0 PROCEDURE O&SHAs**

**3.1** Procedure Listing

**ATTACHMENT**

O&SHA Analysis Worksheet – LOX Storage Tank Fill

## GLOSSARY OF ACRONYMS AND DEFINITIONS

#### CFR Code of Federal Regulations

**GOP** Ground Operations Plan

#### GN2 Gaseous Nitrogen

#### Hazard Any real or potential condition that can cause injury, illness, or death to personnel; damage to or loss of a system, equipment or property; or damage to the environment.

**Hazardous** Those operations classified as hazardous according to the

**Operations** following criteria: (1) consideration of the potential or kinetic energy involved, (2) changes such as pressure, temperature, and oxygen content in ambient environmental conditions, (3) presence of hazardous materials. Hazardous operations (including storage, transport, and handling) include, but are not limited to, the following: material (launch vehicle, payload, and other critical loads) handling operations; operations with acoustic hazards; operations with ionizing and non-ionizing sources and systems; operations with hazardous materials; pressure system (greater than 150) psig operations; propellant system operations; ordnance operations; and electrical system operations.

**LN2** Liquid Nitrogen

**LO2/LOX** Liquid Oxygen

#### Life cycle All phases of the system’s life including design, research, development, test and evaluation, production, deployment (inventory), operations and support, and disposal

**Mishap** An unplanned event or series of events resulting in death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

**Mishap Risk** An expression of the impact and possibility of a mishap in terms of potential mishap severity and probability of occurrence.

**OSHA** Occupational Safety and Health Administration

**Residual Mishap** The remaining mishap risk that exists after all mitigation

**Risk** techniques have been implemented or exhausted, in accordance with the system safety design order or preference.

**Risk Assessment** Hazard Assessment Code: An alphanumeric rating of hazard risk based

**Code** **(RAC)** upon its anticipated frequency of occurrence and the resultant severity of exposure to such risk.

**Safety** To have freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

**Safety Critical** An operation, process, facility, system, or component that controls or monitors equipment, operations, systems, or components to ensure personnel, launch area, and public safety (for example, Flight Termination System integrity); these operations, processes, facilities, systems, or components may or may not be hazardous in and of themselves.

**SSPP** System Safety Program Plan

**Subsystem** A grouping of items satisfying a logical group of functions within a particular system.

**System** An integrated composite of people, products, and processes that provide a capability to satisfy a need or objective.

**System Safety** The application of engineering and management principles, criteria, and techniques to achieve acceptable mishap risk, within the constraints of operational effectiveness and suitability, time and cost, throughout all phases of the system life cycle.

**System Safety** An engineering discipline that employs specialized professional

**Engineering** knowledge and skills in applying scientific and engineering principles, criteria, and techniques to identify and eliminate hazards, in order to reduce the associated mishap risk.

**[T]** Tailored

# USSF United States Space Force1.0 INTRODUCTION

# 1.1 Purpose

The purpose of these O&SHAs is to evaluate activities for hazards and risks introduced into the system by operational and support procedures and to evaluate adequacy of operational and support procedures used to eliminate, control, or abate identified hazards or risks.

**1.2 Scope**

These O&SHAs identify and evaluate the safety considerations associated with environments, personnel, procedures, and equipment involved throughout the operational phase of the <Title> program and shall meet the intent of AFSPCMAN 91-710, Volume 1, A3.2.4.3 and Volume 6, A2.2.2.6.

# 1.3 Applicability

These O&SHAs are applicable to all hazardous procedures.

**1.4 Operating and Support Hazard Analysis Updates**

The applicable O&SHAs will be updated whenever there are any system design or operational changes to the <Title> Program. O&SHAs updates will follow the same approval protocol as the original documents.

# 2.0 METHODOLOGY

This analysis has been accomplished per the guidelines established in the applicable sections of AFSPCMAN 91-710 Range Safety Requirements as well as standard industry approach to systems engineering and analysis for human performance in a given work environment.

Once identified, each hazard is assessed in terms of its effect (i.e., its severity) should it be allowed to exist without the implementation of specific control measures.

Hazard elimination, control, or abatement measures/procedures are listed and/or described to ensure complete understanding of the risk management/risk reduction process employed in the subject procedure.

The data have been analyzed, evaluated, formatted, and documented in compliance with Space Force and Industry Standards, including AFSPCMAN 91-710 Range Safety Requirements and MIL-STD-882E System Safety Program Requirements, where applicable.

As per AFSPCMAN 91-710, Volume 1, A3.2.4.3 and Volume 6, A2.2.2.6, these O&SHAs analyses shall identify those activities that occur *under hazardous conditions.* While non-hazardous sequences will be routinely reviewed and assessed during the performance of O&SHAs, the specific results are not particularity noted herein. **Exception:** Were a risk of a hazard exposure is created as a direct or indirect result of some specific action (or inaction) during non-hazardous steps, the details of each hazard as well as control measures will be assed in the reports.

# 2.1. RISK ASSESSMENT

In each case where hazards are identified, a Hazard Risk Assessment Code (RAC) code has been assigned based on either the real or perceived degrees of hazard severity and occurrence probability. These codes have been developed using the severity and probability categories defined in MIL-STD-882 as reproduced in Table 2.2-1 and Table 2.3-1. The Risk Assessment Matrix defines and summarizes the risk acceptance criteria used for this analysis.

# 2.2. HAZARD RISK SEVERITY

MIL-STD-882 established system safety criteria guidelines to assist in the determination of hazard severity. The hazard severity categories are listed in **Table 2.2-1.** Hazard severity categories are defined to provide a qualitative measure of the most reasonable credible hazards resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, or system, subsystem, or component failure or malfunction.

The effect of failure modes will be evaluated and categorized into one of the following severity categories:

## Table 2.2-1 Hazard Severity Categories

|  |  |  |
| --- | --- | --- |
| **DESCRIPTION** | **CATEGORY** | **EFFECT CRITERIA** |
| Catastrophic | 1 | Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding $10M. |
| Critical | 2 | Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding $1M but less than $10M. |
| Marginal | 3 | Could result in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding $100K but less than $1M. |
| Negligible | 4 | Could result in one or more of the following: injury or occupational illness not resulting in a lost work day, minimal environmental impact, or monetary loss less than $100K. |

# 2.3. HAZARD RISK PROBABILITY

The hazard probability levels listed in **Table** **2.3-1** represent the relative likelihood of occurrence of a mishap caused by the existence of an uncorrected or uncontrolled hazard.

## Table 2.3-1 Probability Levels

|  |  |  |  |
| --- | --- | --- | --- |
| **Probability Levels** | | | |
| **Description** | **Level** | Specific Individual Item | **Fleet or Inventory** |
| Frequent | A | Likely to occur often in the life of an item. | Continuously experienced |
| Probable | B | Will occur several times in the life of an item. | Will occur frequently |
| Occasional | C | Likely to occur sometime in the life of an item. | Will occur several times |
| Remote | D | Unlikely, but possible to occur in the life of an item. | Unlikely, but can reasonably be expected to occur |
| Improbable | E | So unlikely, it can be assumed occurrence may not be experienced in the life of an item. | Unlikely to occur, but possible |
| Eliminated | F | Incapable of occurrence. This level is used when potential hazards are identified and later eliminated. | Incapable of occurrence. This level is used when potential hazards are identified and later eliminated. |

# 2.4 HAZARD RISK ASSESSMENT CODE MATRIX

The Hazard Risk Assessment Code (RAC) Matrix is shown in **Table 2.4-1.** This matrix categorizes total risk as a function of Severity and Probability.

## Table 2.4-1 Hazard Risk Assessment Code Matrix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Severity  Probability | **Catastrophic**  **(1)** | **Severe**  **(2)** | **Marginal**  **(3)** | **Negligible**  **(4)** |
| **Frequent**  **(A)** | **High** | **High** | **Serious** | **Medium** |
| **Probable**  **(B)** | **High** | **High** | **Serious** | **Medium** |
| **Occasional**  **(C)** | **High** | **Serious** | **Medium** | **Low** |
| **Remote**  **(D)** | **Serious** | **Medium** | **Medium** | **Low** |
| **Improbable**  **(E)** | **Medium** | **Medium** | **Medium** | **Low** |
| **Eliminated**  **(F)** | **Eliminated** | | | |

As stated in MIL-STD-882E, before exposing people, equipment, or the environment to known system-related hazards, the risks shall be accepted by the appropriate authority as defined in the <Title> Program SSPP and agreed to by Range Safety. The system configuration and associated documentation that supports the formal risk acceptance decision shall be provided to the Range Safety for retention through the life of the system, or Program. The definitions in Tables 2.2-1 and 2.3-1, and the RACs in Table 2.4-1 shall be used to define the risks at the time of the acceptance decision. The <Title> Program shall be part of this process throughout the life-cycle of the system and shall provide formal concurrence before all Serious and High risk acceptance decisions.

Risk Acceptance Levels Criteria:

Unacceptable: High and Serious risk must be eliminated by design, or hazard severity/probability reduced to acceptable levels by imposition of external controls.

Waiver/Deviation: Waiver or deviation required. Acceptable only with full concurrence from upper management and customer and tracked to assure the controls in place do not change.

Acceptable: Acceptable with no further hazard tracking required. Operations permissible.

# 2.5 PRIMARY INITIATING CONDITIONS, EVENTS, OR CIRCUMSTANCES

|  |  |
| --- | --- |
| **Equipment** | equipment design deficiency, equipment in operation failure, etc. |
| **Engineering Controls** | failure of an engineered safeguard |
| **Leak** | fracture, puncture, corrosion, seal/gasket failure, relief valve stuck open, etc. |
| **Control System** | run-away pressure regulator, etc. |
| **Utilities** | loss of electrical power, loss of GN2, loss of fire suppression, etc. |
| **Facility Siting** | proximity to other activity, equipment or facilities, etc. |
| **Reaction** | hypergol reaction, pyrophoric (TEATEB) reaction, catalytic decomposition or ignition, etc. |
| **Human Factors** | human error, accident, physical limitation, crane mishap, procedure run out of sequence, etc. |
| **Administrative** | failure of an administrative control, flawed procedure, etc. |
| **Radiation** | electromagnetic radiation exposure, ionizing radiation, etc. |
| **Environment** | perimeter fire, earthquake, weather, lighting, etc. |

[*Guidance: Table 2.5 and 2.6 are included as an examples of possible initiating events and operational hazards lists. SEL-SSD-011 – PHL & PHA Guidance and Template includes other examples. These specific tables used as examples have been previously included in active programs for the development of O&SHAs*.]

# 2.6 OPERATIONAL HAZARDS LIST

|  |  |
| --- | --- |
| Asphyxiant, Inert Gas (He, Ar, N2) | Ordnance (1.1, 1.3, 1.4) |
| Confined Space | Overhead Hazard/Falling Objects |
| Chemical Exposure | Oxidizing substances |
| Cryogenic Fluid, LOX | Compressed Gas |
| Cryogenic Fluid, LN2 | Pressurized Hydraulics |
| Cut, Laceration, abrasion, puncture | Pressurized vessels/lines [>150 psig] |
| Drop Hazard | Pyrophoric Fluid, TEA-TEB |
| Electrical, High Voltage (>120 volts) | Suspended Loads/Pinch Points |
| Electrical, Low Voltage (<120 volts) | Slip, Trip and Fall |
| Ergonomic (personnel safety) | Stored energy > XX ft-lbs |
| Hazardous Substances | Working at Elevation (>4 ft) |
| Hydrocarbon Fuel, RP-1 | Weather |
| Noise >85 Dba |  |

[*Guidance: Section 2.0 is partially reproduced from the organization’s SSPP and is used for PHAs, SSHAs, SHAs, and O&SHAs development. An alternative approach to developing deliverables for PHAs, SSHAs, SHAs, and O&SHAs is to produce a standalone document that encompasses Section 2.0 and is traceable to all developed PHAs, SSHAs, SHAs, and O&SHAs. This will limit the amount of duplicated text that needs to be attached to any individual PHAs, SSHAs, SHAs, and O&SHAs. Then the hazard analyses can be submitted as individual work sheets with individual tracking numbers. Reference* *SEAL-SSD-001.01, AFSPCMAN 91-710 Implementation Guide – Commentary.]*

*[Guidance: For this section, the Range User may opt to include FAA Hazard Category nomenclature:*

* *Public hazard*
* *Launch location hazard*
* *Employee hazard*
* *Non-credible hazard*

*Reference FAA 14CFR417 subpart, subsection 417.405*]

**3.0 PROCEDURE O&SHAS**

**3.1 PROCEDURE LISTING**

Procedures are listed below governing the safe operation, testing, maintenance and installation of components for the <Title> program.

## Table 3.1-1 <Title> program Procedures List

|  |  |  |
| --- | --- | --- |
| **PROCEDURE NUMBER** | **PROCEDURE TITLE** | **CLASSIFICATION** |
| TPD GL1 | LO2 Facility Initialization Checkout | Safety Critical |
| TPD GP1 | Pneumatic System Charging and Checkout | Hazardous |
| TPD GL2 | LO2 Facility Pneumatic Checkout | Hazardous |
| TPD GL3 | LO2 Storage Tank Fill | Hazardous |
| TPD TA1 | LO2 Test Article | Hazardous |
| TPD GL4 | LO2 Tank Drain | Hazardous |
| TPD GL5 | LO2 Facility Standby | Non-Hazardous |
| TPD E1 | Hurricane Preparation and Anomaly Recovery | Non-Hazardous |
|  |  |  |

[*Guidance: Though this example for an O&SHA deliverable shows what would be a complete procedure list, it is recommended that this list only be included in the GOP, which requires a listing of procedures. Within the GOP the procedure list will also show the associated O&SHAs*.]

|  |  |  |  |
| --- | --- | --- | --- |
| **Program** | **<Title>** | **Range Safety Approved** |  |
| **System or Procedure** | **TPD GL3 LOX Storage Tank Fill** | **Approved Date** |  |
| **Location** | **PAD - LOX Tank Complex** | **<Title> Program Approved** |  |
| **Hazard Classification / Overall Rating** | **Hazardous / Launch Location Hazard** | **Analyst** |  |

|  |  |
| --- | --- |
| **References:** | 1. AFSPCMAN 91-710 Range Safety under Requirements Manual, Space Force Command Range Safety Policies and Procedures 2. <Title> Program System Safety Program Plan (SSPP) (XX-XXX) 3. <Title> Program Launch Personnel Training and Certification Plan (XX-XXX) 4. Operations Safety Plan (XX-XXX) 5. LOX System P&ID Dwg (XX-XXX) |
| **Contributors / Reviewers:** |  |

This O&SHA was developed in accordance with the <Title> Program System Safety Program Plan (SSPP), XX-XXX.

Summary Hazard Designations:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Case #** | **Description** | **Hazard Severity** | **Likelihood** | **Overall Ranking** | **Hazard Classification & Criticality** |
| 1 | Pressurized LOX leakage occurs during LOX Storage Tank Fill operations | Marginal (3) | Improbable (E) | Medium | Launch Location Hazard |

Tasks:

1. Verify all personnel involved in LOX storage tank filling operation are properly trained and wearing the proper PPE.
2. Verify system status (valve positions, pressures, tank level)
3. Perform visual inspection for evidence of damage or external leakage
4. Position LOX Tanker for offload
5. In Fuel Offloading Area, position Containment Berms or approved Splash Guards at LOX connection points

Warning: THE FOLLOWING STEPS ARE HAZARDOUS DUE TO THE PRESSURIZATION OF LOX SYSTEM PIPING DURING LOX TANK FILLING. ALL PERSONNEL NOT INVOLVED IN TANK FILLING ARE TO ESTABLISH THE 50 FOOT HAZARD AREA CLEAR.

1. In LOX Offloading Area, remove cap from single point filling adapter
2. Connect LOX Tanker discharge hose to Filter skid, connect filter discharge hose to LOX Storage Tank Single Point Adapter.
3. Fill LOX Storage Tank until LOX Storage Tank Sight/Level Gage indicates maximum fluid level at 28,000 gallons

[*Guidance: Where necessary for clarification, include a task process flow chart along with the Task Summary*.]

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **WHAT IF:** | **HAZARD** | **CAUSE** | **HAZARD CONDITIONS**  **PRIMARY INITIATING CONDITIONS** | **Consequences Effect** | **INITIAL**  **RAC** | **SAFEGUARDS** | **FINAL**  **RAC** | **COMMENTS / RECOMMENDATIONS** |
| **OSHA-1** | Pressurized LOX leakage occurs during Storage Tank Fill operations | H1: Personnel injury  H2: Equipment Damage | C1: LOX Tank system is pressurized  C2: Pressurized line(s) rupture or fitting(s) leak  C3: Personnel error | Hazard Conditions  Cryogenic Fluid, LOX  Pressurized vessels/lines [>100 psig]  Primary Initiating Conditions  Equipment  Leak | **Severity**  **Marginal (3)**  Medical treatment for a minor injury or minor loss/damage to facility, system or equipment | **Probability**  **Remote**  Medium  **Severity**  **Marginal** | LOX Tank Maintenance and Operating procedures include warnings and cautions about the risk of component failure with instructions to preclude occurrence, including potential indications observable to the maintainer, operator and crew. (C1, C2)  Hazardous procedures reviewed by multiple disciplines including Safety to ensure compliance to AFSPCMAN 91-710. Procedure Safety Requirements ensure safety control area is established, warning signs are posted, and that non-essential personnel are removed from the area prior to commencing hazardous operations. (C1, C2)  All personnel are trained in accordance with the <Title> Program Launch Operations Training Plan. Training Plan outlines the training and on- the-job requirements for personnel in order to ensure only qualified personnel are performing assigned tasks (C1, C2, C3)  Periodic inspection and maintenance of the GSE are performed to ensure equipment calibration and serviceability. Inspection prior to use confirms GSE availability to support the operation. (C1, C2)  Pre-task briefings are conducted prior to performing any operation to ensure personnel are familiar with the tasks and the associated hazards (C1, C2, C3)  PPE for this procedure includes approved gloves, goggles and/or safety glasses, face shields, and hearing protection. (C1)  All personnel working within a hazardous area must wear clean, long sleeved, flame-retardant, anti-static coveralls unless otherwise specified. (C1)  Prior to this operation, confirm that the area is clean and free of combustible materials and spill kits are readily available. (C1)  Procedure shall include contingency emergency shutdown and safing procedures. | **Probability**  **Improbable**  Medium  **Severity**  **Marginal** |  |