NASA TECHNICAL STANDARD National Aeronautics and Space Administration Washington, DC 20546	**ANNEX Revision B w/Change 1 to NASA-STD-8719.24** Approved: 2022-03-30 Superseding: Annex Revision B To NASA-STD-8719.24

ANNEX TO NASA-STD-8719.24
NASA PAYLOAD SAFETY REQUIREMENTS:

REQUIREMENTS TABLE

Measurement System Identification:
Imperial (English)

DOCUMENT HISTORY LOG

Status	Document Revision	Approval Date	Description
Baseline		2011-08-26	Initial Release *(JWL4)*
Change	1	2012-01-26	- Page 3: Corrected PSWG Chair signature block; - Pages 187 Vol 3, para13.1.1.1 and Vol 7, removed revision from ST/SG/AC.10.1; - Vol 7 page 404, bolded "hazardous materials" definition header *(JWL4)*
Change	2	2012-06-19	Throughout document: Corrected 18 typographical errors (Administrative Change) *(JWL4)*
Revision	A	2015-09-30	Added Attachment 5 to Volume 1 on Payload Safety Introduction Briefing (PSIB) and related information that is to be presented at the PSIB. Added NASA electronic forms NF 1825, NASA ELV Payload Safety Hazard Report Form; NF 1826, NASA ELV Payload Safety Post-Tailoring Equivalent Level of Safety Request; and NF 1827, NASA ELV Payload Safety Waiver Request. Added requirements addressing pyrovalves (Vol. 3, Section12.1.2.6) and payload recovery missions involving sample or payload returns. Added some additional requirements for Composite Overwrapped Pressure Vessels (COPVs) and a COPV Mechanical Damage Control Plan (Vol. 3, Section 12.2.5). Revised definition for "catastrophic." Numerous improvements to requirements to improved clarity and correctness. *(SH)*
Change	1	2018-03-05	Typing errors and format issues are corrected. An obsolete Air Force reference is removed. A NASA spec for pyrovalves is added and revisions are made to payload lifting requirements to reflect updates to NASA's lifting standard and allow for non-load test slings to be used verses tailoring the requirements. Wording for clarity updated and a definition.
Change	2	2018-06-13	Updated the hyperlink (http://kscsma.ksc.nasa.gov/ELVPayloadSafety) for the NASA Expendable Launch Vehicle (ELV) Payloads website throughout the document.
Revision	B	2022-03-30	Revision B incorporates Revision A w/Change 2. Removed Expendable Launch Vehicle (ELV) from document title changing title to NASA Payload Safety Requirements. Revised Forward to remove ELV reference and change signature block from T. Wilcutt to W. DeLoach. General document revision include editorial updates of applicable and reference documents, terms and acronyms to ensure accuracy and consistency with U.S. Air Force Space Command, the United States Space Force Space Command, Range Safety User Requirements 91-710 and NASA program documentation, e.g., NPR 8715.1, NASA Safety & Health Programs and NPR 8715.7, NASA Payload Safety Program.

Change	1	2023-05-22	Revision B w/Change 1 incorporates Revision B with the following change., 1) Forward; revised for clarity of document purpose., 2) Signature page revised to include additional signature block for Payload Project System Safety Engineer., 3) Removed and replaced all hyperlinks redirected to NASA OSMA Payload Safety Program webpage throughout document., 4) Revised Table of Contents under V3, by deleting a repeated Chapter 6 in chapter description., 5) V1, V3, V6 & V7, Updated applicable and reference documents, terms, and acronyms to ensure accuracy and consistency with transition from U.S.A.F. and Air Force Space Command (AFSPC) to the United States Space Force (USSF), Space Systems Command and Department of the Air Force., 6) V1, 2.4 FAA Responsibilities; updated to reflect new FAA 14 CFR requirements and revised hyperlink., 7) V1, Table 3.2, Table Risk Priority line, changed from: Medium: ELS Required, to: Medium: Compliance Rationale, to avoid a conflict with usage of the term ELS., 8) V1, A2.2.1.3.8., Identified examples of hazard report closure verification., 9) V1, A2.2.1.3.9., Included Office of Safety and Mission Assurance (OSMA) in body of paragraph., 10) V1, A2.2.2.4.1. Included NASA Planetary Protection Officer (PPO) in the body of the paragraph., 11) V1, A2.2.3., Included examples of hazard report closure verification for PHA's., 12) V1, A2.2.3.1., Updated PHA hazards list for consistency throughout document., 13) V1, A2.2.4.1., Included examples of hazard report closure verification for SSHA's., 14) V1, A2.2.4.1.1., Updated SSHA hazards list for consistency throughout document., 15) V1, A2.2.4.2., Included examples of hazard report closure verification for SHA's., 16) V1, A2.2.4.2.1., Updated SHA hazards list for consistency throughout document., 17) V1, A2.2.4.3., Included examples of hazard report closure verification for O&SHA's., 18) V1, A2.2.4.3.1., Updated O&SHA hazards list for consistency throughout document., 19) V6, 1.3., Included reference to FAA and FAA related 14 CFR., 20) V7, Revised definition of commercial launch for purpose of clarity., 21) V7, Included definition of the NASA Planetary Protection Officer (PPO)., 22) General document revision to include multiple minor grammatical and editorial updates throughout this document that have no technical impact., 23) V1, 1.1, Revised paragraph for clarity of scope of Objective., 24)) V1, 1.2.1, Revised paragraph for clarity of directive of upper level NPR scope., 25) V1, 1.2.3, Revised paragraph for clarity of directive of upper level NPR scope., 26) Revised title of NASA Form 1826 to reflect correct form title throughout document.

FOREWORD

This NASA technical standard provides uniform engineering and technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA programs and projects, including requirements for selection, application, and design criteria of an item. This standard establishes technical safety requirements for NASA payload projects that fly onboard unmanned launch vehicles. The Annex to NASA-STD-8719.24 is a tailored version of the United States Space Force (USSF) Space Systems Command Manual (SSCMAN) 91-710, Range Safety User Requirements, jointly developed and approved, by NASA and the USSF SSC Space Launch Delta (SLD) 30 and SLD 45 Safety representatives using Volumes 1, 3, 6, and 7, and NASA safety standards. The requirements specified in this document are provided in a matrix format that was developed to facilitate project-specific tailoring of the safety requirements for each NASA payload project.

This standard was developed by the NASA Office of Safety and Mission Assurance (OSMA). Requests for information, corrections, or additions to this standard should be submitted to the OSMA by email to Agency-SMA-Policy-Feedback@mail.nasa.gov or via the "Email Feedback" link at; https://standards.nasa.gov.

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William Russ DeLoach
Chief, Safety & Mission Assurance

Approval Date

NASA Payload Safety Program
Office of Safety and Mission Assurance
National Aeronautics and Space Administration
Washington, D.C.   20546

Project Safety Requirements Effective Date:

Project Safety Requirements Revision: Basic

NASA PAYLOAD SAFETY REQUIREMENTS

NASA PAYLOAD PROJECT (NAME)

Project Contract No:
Contract Date:

NASA CENTER: (name)

Proprietary

The information contained in the document is technical in content and may be proprietary as defined by the International Traffic in Arms Regulations (ITAR) or by Export Administration Regulations (EAR) requirements. Contact the NASA KSC Export Control Office, 321-867-9209, for an ITAR or EAR regulatory determination. If not required delete this statement.

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PREFACE

The Original Text column of the following requirements matrix contains the National Aeronautics and Space Administration (NASA) payload safety requirements that are to be tailored for each NASA Payload project, as required by NPR 8715.7, "NASA Payload Safety Program." The NASA Payload safety requirements are the result of a joint effort by NASA and the United States Space Force (USSF) Space Launch Delta (SLD) 30 and SLD 45 Range Safety representatives to establish an approved baseline from the USSF SSCMAN 91-710, "Range Safety User Requirements," and applicable NASA safety requirements and also address unique issues associated with NASA payload safety design and operations. The NASA Payload safety requirements apply to all NASA Payload projects launched from a USSF, NASA, or other range/launch site.

The NASA Payload safety requirements supplement NPR 8715.7 and satisfy USSF SSCMAN 91-710, when applied to NASA launches from USSF launch ranges. As such, they provide a streamlined starting point for the safety requirements tailoring process that is required for each NASA Payload project per NPR 8715.7.

The NASA Payload safety requirements (as tailored for each specific project) are mandatory for each NASA Payload project and are to be applied to associated contracts and/or agreements. Additional requirements may be imposed by other organizations, including other launch ranges, commercial payload processing facility operators, or launch vehicle contractors. This document does not alter or otherwise modify the authority or roles and responsibilities delineated by statute or policy applicable to the USSF, NASA, or other organizations participating in a NASA Payload project. As outlined in USSF SSCMAN 91-710, the SLD Commanders have overall launch authority and responsibility for public safety from USSF ranges. The Directors of NASA Wallops Flight Facility (WFF), and the Kennedy Space Center (KSC), have authority and responsibility for launches originating from WFF and KSC respectively.

USSF SSCMAN 91-710 range safety requirements not applicable to NASA Payloads were eliminated from the following NASA Payload safety requirements. Additionally, in some cases, entire volumes or chapters are not applicable and are not included in the requirements matrix. This results in irregular numbering of paragraphs where certain paragraph(s) were removed that were not applicable. The absence of these requirements does not alter USSF SLD 30 and SLD 45 Range Safety authority. The project may add back any USSF SSCMAN 91-710 requirements that are pertinent to their project upon agreement by the project's Payload Safety Working Group (PSWG) and SLD 30th and SLD 45th Range Safety representatives.

Questions pertaining to the requirements in this document and applicable local safety requirements should be brought to the attention of the payload project's PSWG. Per NPR 8715.7, Payload Project Offices will contact the NASA Payload Safety Manager as early as practical in the project's Concept and Technology Development, Phase A, to establish the project's PSWG and initiate the payload safety review and approval process, which includes the requirements tailoring process.

The NASA Payload Safety Manager is responsible for maintaining and keeping the NASA Payload safety requirements current and coordinating all changes with the NASA Payload Safety Agency Team and the USSF SLD 30 and SLD 45 Range Safety Offices. The NASA Payload Safety Manager contact information and the NASA Payload safety requirements are available on the NASA Payload Safety Program website at: https://sma.nasa.gov/sma-disciplines/elv-payload-safety.

Note: This Preface provides background information that is applicable to all NASA Payload projects. It is not to be tailored and shall remain as part of each final project-specific safety requirements document.

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VOLUME 1: POLICIES AND PROCEDURE REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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1.1. Objective	I		
This standard is implemented in accordance with NPR 8715.7, Payload Safety Program, by NASA payload projects, to develop and process payloads safely throughout the payload project's life cycle. The Annex to NASA-STD-8719.24 is a tailored version of the United States Space Force (USSF) Space Systems Command Manual (SSCMAN) 91-710, Range Safety User's Manual, Volumes 1, 3, 6, & 7, and is jointly approved by NASA and the USSF SLD 30 and SLD 45. The objective of this publication is to identify and apply USSF and NASA payload safety requirements to ensure the launch area, payload processing facility, launch complex personnel and all aspects of prelaunch and launch operations are performed safely, to include protection of the public and property, in accordance with NASA, the USSF and OSHA policies, requirements and standards. These requirements safeguard people and resources (including flight hardware, ground support equipment (GSE) and facilities) from hazards associated with payloads that will fly on unmanned Launch Vehicles (i.e. Payloads), including hazards associated with payload related GSE. This document is a baseline and shall be tailored for each NASA payload project (mission). The Payload Safety Working Group (PSWG) is the payload project's primary interface for the safety review and approval process. The PSWG members represent their respective organizations and are responsible for coordinating, as necessary, with their organization to ensure payload project compliance with their organization's safety policies, processes, and requirements whenever the payload is being processed on their organizations property or in their jurisdiction. The PSWG shall include the NASA (or JPL) Payload Project System Safety Engineer, the payload contractor safety representative(s), the NASA Kennedy Space Center (KSC) Launch Services Division Safety Engineer (optional), the launch vehicle contractor safety engineer, the launch site range safety engineer, the payload processing facility safety engineer, and other invitees such as the mission's Launch Site Integration Manager (LSIM) and subject matter experts (see Volume 3, Paragraph 2.1) and payload or sample recovery organization safety representative as needed. PSWG activities typically conclude with the signing of the Certificate of Payload Safety Compliance. If there are any open action items, the payload project will provide the appropriate local safety authorities and mission officials with updates and complete the Safety Verification Tracking Log (SVTL). NPR 8715.7, this standard, and the PSWG safety review and approval process upholds and does not remove or alter the safety responsibility and authority of any organization having safety authority jurisdiction where the payload project is processed. The mutual goal of USSF, NASA, and the NASA payload project, shall be to conduct all missions safely, with a strong commitment to public safety. ***Note: Range Safety is a member of the PSWG working as a PSWG member in the project's safety review and approval process. All correspondence (safety submittals, review comments, etc.) is processed and coordinated through the PSWG. The phrase "PSWG and Range Safety" is used throughout this document not to imply that Range Safety is separate from the PSWG but to emphasize Range Safety's role, authority, and responsibility in public safety and launch site safety.***	Select Status		
1.2. Applicability	I		

VOLUME 1: POLICIES AND PROCEDURE REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
1.2.1. Payload Projects. This standard is incorporated by reference in NPR 8715.7and applicable to all NASA Payload projects. The requirements in this document apply to each payload project and its design, fabrication, launch area testing, vehicle integration, launch processing, launch, ascent flight phase through payload separation, and planned recovery; payload-provided upper stages; interface hardware that is flown as part of a payload; and GSE (Ground Support Equipment) used to support payload-related operations. During the period from post launch ascent flight phase through payload separation the requirements of this document apply only to the extent that a hazard could credibly result in a mishap causing a fatal injury or loss of the flight termination system. This document does not address in-flight spacecraft operational safety. This document applies to payload processing facilities and the launch site area and does not apply to payload integration, operations and testing performed at NASA Centers, JPL and other contractor facilities that take place prior to payload shipment to the launch site area. The mission success and any scientific objectives of the payload are the responsibility of the Payload Project Office and are beyond the scope of this document. When conflicting safety requirements are encountered, the most stringent shall be applied. When additional safety requirements are needed, NPR 8715.7, USSF SSCMAN 91-710, and local safety requirements shall be applied as determined by the PSWG and Range Safety.	**Select Status**		
1.2.2. Tailoring:	**I**		
1.2.2.1. This document is a template for developing a specific payload project's safety requirements document. The tailored edition shall be placed on contract, other agreement, or effected through the applicable range Universal Documentation System. Requirements were identified to address the safe design and operational concerns encountered in a 'typical' spacecraft. Every attempt was made to capture the intent of all original requirements from applicable baseline requirements (e.g., USSF SSCMAN 91-710). The contents of this publication provide additional clarification, remove non-applicable requirements, and reflect current practices and procedures of Ranges, Launch Vehicle Contractors, Payload Processing Facility Contractors, etc. The PSWG and Range Safety reserves the right to identify applicable requirements not addressed, and any oversights, omissions, or inaccuracies during the tailoring process with the payload project office. See Attachment A1.1 of this volume, for further tailoring instructions.	**Select Status**		
1.2.2.2. Developing a tailored edition of this document. The tailored edition should look like this document with the following exceptions:	**Select Status**		
1.2.2.2.1. The tailored edition shall be constructed in the following manner:	**Select Status**		
1.2.2.2.1.1. Insert a document heading/title that reads, "NASA Payload Safety Requirements" for Project Name, date of the applicable contract/agreement/ etc.", centered at the top of each page.	**Select Status**		
1.2.2.2.1.2. Date of tailored edition.	**Select Status**		
1.2.2.2.1.3. The term "PROPRIETARY" shall be placed on page 1, centered directly over the ITAR/EAR regulatory determination statement for each payload project.	**Select Status**		
1.2.2.2.2. Remaining heading information shall be left justified.	**Select Status**		

VOLUME 1: POLICIES AND PROCEDURE REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
1.2.3. New Programs. This standard is applicable to all NASA Payload projects under all new programs in accordance with NPR 8715.7..	Select Status		
1.2.4. Previous Approvals. All new NASA Payload projects must comply with the requirements in this document. However, similar previously approved projects, systems or operations and related noncompliances may be updated and submitted for consideration by the PSWG in assessing the safety of the new payload project. Existing projects and noncompliance approvals approved before the initial publication of this document shall be updated to reflect any changes since last approval and resubmitted to the PSWG for PSWG and Range Safety assessment.	Select Status		
1.3. Basis for the Requirements	I		
This publication is based on, but not limited to, the responsibilities or standards contained in or applied by NPR 8715.7 Preface and SSCMAN 91-710, Volume 1, Section 1.3.	I		

VOLUME 1: POLICIES AND PROCEDURE REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES	I		
2.1. General	I		
The roles, responsibilities, and authorities for ensuring safety for NASA Payload projects are provided in NPR 8715.7, USSF SSCMAN 91-710, and below. For NASA Payload safety roles, responsibilities and safety review and approval processes, see NPR 8715.7. For Space Force Range Safety roles, responsibilities, and safety review and approval processes, see USSF SSCMAN 91-710.	I		
2.2. Headquarters Space Systems Command Responsibilities	I		
The Headquarters, Space Systems Command (HQ SSC) operates the USSF ranges, including providing base support, personnel, and other government assets. The SSC Commander (SSC/CC) is responsible for establishing range safety policy for USSF ranges as outlined in Space System Command Instruction (SSCI) 91-701, The Space Systems Command Launch and Range Safety Program Policy and Requirements. HQ SSC is also responsible for establishing common range safety user requirements as outlined in this publication for the USSF SLD 30 and SLD 45 to implement and enforce. This publication also identifies interfaces with other DoD, Federal Aviation Administration (FAA), civil and commercial Range Users.	I		
2.3. Space Launch Delta Responsibilities	I		
2.3.1. Commanders, SLD 30 and SLD 45:	I		
2.3.1.1. The SLD Commanders (SLD/CCs) have overall authority and responsibility for public safety at USSF ranges as directed by the SSC/CC. This delegation is provided via the MAJCOM chain of command and AFI 91-202, The US Air Force Mishap Prevention Program, as supplemented.	I		
2.3.5. Range Safety Offices. Unless otherwise noted, the use of the term Range Safety in this publication refers to SLD 30/SE, SLD 45/SE, or other local range safety organization.	I		
2.3.5.1. Enforcing safety requirements to ensure that public safety, launch area safety, and launch complex safety are provided by and for all programs using the ranges.	I		
2.3.5.3. Providing oversight, review, approval, and monitoring for all public safety and launch area safety concerns during prelaunch operations at the launch complex and launch vehicle or SLD 30 and SLD 45 payload processing facilities.	I		
2.3.5.5. Reviewing and approving flight plans, design, inspection, procedures, testing, and documentation of all hazardous and safety critical launch vehicles, payloads, and ground support equipment, systems, subsystems, facilities, and material to be used at the Eastern Range (ER) and Western Range (WR).	I		

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2.4. Federal Aviation Administration Responsibilities	I		
In accordance with 51 U.S.C., Subtitle V, Commercial Space Transportation, Chapter 509, Commercial Space Launch Activities, U.S.C. §§ 50901 - 50923, the Federal Aviation Administration (FAA) has responsibility for public safety of licensed launches. To avoid a duplication of payload safety requirements, NASA payload safety requirements in this publication have been written with the intent of achieving commonality with 14 CFR, Chapter III Commercial Space Transportation, FAA, Subchapter C Licensing, Part 450, Subpart C Safety Requirements. In accordance with Subpart C, documented hazard analysis are performed on payloads/spacecraft systems, payload ground support equipment, and payload ground operations control and processing, to eliminate or mitigate system hazard causes contributing to the following hazards, to include; over-pressurization hazards, ordnance/explosives hazards, propellant (fire/explosion) hazards, mechanical (kinetic (impact) energy) hazards, electrical energy hazards, thermal energy (cryogens) hazards, ionizing and non-ionizing radiation hazards, and hazardous material (toxic) release hazards. Hazardous ground operations assessed include, propellant loading and handling, transportation and critical lifts, vehicle/payload testing and vehicle/payload or system activation processing operations. NASA-STD-8719.24 is a tailored version of the USSF SSCMAN 91-710, Range Safety User's Manual, Volumes 1, 3, 6, & 7, and is jointly approved by NASA and the USSF SLD 30 and SLD 45. ***FAA 14 CFR 450 Licensing Requirements can be found on the FAA/AST web site at:*** Vehicle Operator Licenses | Federal Aviation Administration (faa.gov)	I		
2.5. Payload Project Responsibilities	I		
2.5.2. The payload Project Manager (PM) shall be responsible for payload project safety and for developing and maintaining a safety management program encompassing all applicable safety requirements, identifying a qualified key system safety person with authority for resolution of identified hazards and direct access to the PM, and establishing and funding a supporting system safety organization/function with direct interfaces and access to other functional elements of the project. Once assigned a project the PM shall notify the NASA Payload Safety Manager of the new project as early as possible, obtain a Payload Project System Safety Engineer, help coordinate the establishment of the PSWG, and ensure compliance with their responsibilities and the safety review and approval process listed in NPR 8715.7. The payload project shall provide a System Safety Plan (SSP), detailing the safety program, for review and approval in accordance with Attachment A1.2 of this volume.	Select Status		
2.5.3. Design, Test, and Inspection Requirements Payload projects shall be responsible for the design, inspection, and testing of all hazardous and safety critical payload, project provided ground support equipment, systems, subsystems, facilities, and materials to be used in accordance with the requirements of this publication and applicable local safety requirements. Payload project requests to eliminate or reduce testing shall be justified with clear and convincing evidence presented to Range Safety and the PSWG for approval. Payload project responsibilities include the following:	Select Status		
2.5.3.1. Providing safe systems, equipment, facilities, and materials in accordance with this publication.	Select Status		
2.5.3.2. Developing and obtaining PSWG and Range Safety review and approval for all required data and/or documents necessary for their planned operations. The submittal, review, and approval of data are defined by this document and NPR 8715.7.	Select Status		

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2.5.3.5. Performing risk analyses and implementing design and mission plans consistent with acceptable risk to the general public for deorbiting spacecraft in accordance with NASA-STD-8719.14 Process for Limiting Orbital Debris.	**Select Status**		
2.5.3.6. Coordinating their safety programs with the PSWG in conjunction with Range Safety and any additional safety authorities needed to ensure their activities meet national policy goals and provide for public, payload processing facility and launch site safety and resource protection while minimizing impact on mission requirements.	**Select Status**		
2.5.3.8. Verifying compliance with this publication. The use of subcontractors does not relieve the payload project of responsibility. The payload project shall provide contractual direction and monitor subcontractor performance to verify compliance.	**Select Status**		
2.5.3.9. As applicable, when involved in joint projects, interfacing and integrating with other payload projects or associated contractors in their safety programs.	**Select Status**		
2.5.4 Radioactive Material Launches. Payload projects shall be responsible for notifying the NASA Nuclear Flight Safety Officer (NFSO), the PSWG, and Range Safety and ensuring compliance with National Security Presidential Memorandum (NSPM-20), dated 20 August 2019, Presidential Memorandum on Launch of Spacecraft Containing Space Nuclear Systems. NSPM-20 has superseded Paragraph 9 of PD/NSC-25, dated 08 May 1996, Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space, with implementation through DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems and USSF SSCMAN 91-710, Range Safety User Requirements.	**Select Status**		
2.5.5. Conduct of Operations. Payload projects shall be responsible for the conduct of operations as outlined below and in Volume 6 and its attachments:	**Select Status**		
2.5.5.1. Conducting operations in a safe manner.	**Select Status**		
2.5.5.2. Plan and conduct hazardous and safety critical operations potentially affecting launch area personnel and/or public in accordance with (IAW) SLD 30 or SLD 40 Safety approved procedures and IAW the current edition of the applicable operations safety plan (OSP) for the launch complex, recovery site, facility, or area in use and for ordnance and propellant operations and areas.	**Select Status**		
2.5.5.3. Observing, evaluating, and enforcing compliance with safety requirements.	**Select Status**		
2.5.7. Occupational Safety and Health:	**I**		
2.5.7.1. Payload projects are fully responsible for the safety and health of their employees and shall comply with NPR 8715.1, NASA Safety and Health Programs, NASA Agency health management policy and programs as defined in NPD 1800.2, NASA Occupational Health Program, NPR 1800.1, NASA Occupational Health Program Procedures and the Occupational Safety and Health Administration (OSHA) regulations/standards. Further, they have an inherent responsibility to protect any government employees and property when such are involved in contractor operations or on contractor-leased facilities. Space Force Range Safety shall assume no liability for payload project or contractor compliance or noncompliance with OSHA requirements.	**Select Status**		

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2.5.8. Resource Safety. Payload projects are responsible for resource safety of their owned or leased facilities, equipment, and flight hardware.	Select Status		

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CHAPTER 3 RANGE SAFETY POLICY	I		
3.1. General	I		
3.1.1. Each Launch Vehicle shall have a risk management plan consistent with USSF range launch risk guidance. The payload project shall demonstrate an acceptable level of mishap risk to the PSWG through the completion of the system safety hazard analyses and risk assessments described in Attachment A1.2.	Select Status		
3.2. Prelaunch and Launch Operations	I		
3.2.1.1. Range Safety shall review, approve, and through Pad Safety, monitor, and impose safety holds, when necessary, on all prelaunch and launch operations conducted on the ranges. These actions are required to ensure that the hazards associated with propellants, ordnance, radioactive material, and other hazardous systems do not expose the public, launch area, or launch complex to risks greater than those considered acceptable by public law and state documents. These documents include but are not limited to PL 99-499 42 U.S.C. 11001-11050, Superfund Amendments and Reauthorization Act (SARA), Title III: Emergency Planning and Community Right-to-Know Act (CPRCA); 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals; 40 CFR 355, Emergency Planning and Notification; 40 CFR 68, Chemical Accident Prevention Provisions, subpart G, Risk Management Plan; Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements; and, for the Western Range, California Occupational Safety and Health Administration (CAL-OSHA).	Select Status		
3.2.1.2. Range Safety shall conduct and oversee launch vehicle, payload, mission flight control, and Range Safety launch support operations to ensure that risks to the public, launch area, and launch complex do not exceed acceptable limits consistent with mission and national needs.	Select Status		
3.3. Launch Area Safety	I		
The following requirements are in addition to those specifically identified for launch area safety in 3.2.1 of this volume. (See Attachment 4 of this volume and Volume 7 of this publication for the definitions of terms related to risk.)	Select Status		
3.3.1. The ranges shall ensure that all personnel and USAF or third party resources located on any USSF range, including Cape Canaveral Space Force Station (CCSFS) or Vandenberg Space Force Base (VSFB) or on any supporting site within the ER or WR, are provided an acceptable degree of protection from the hazards associated with range operations.	Select Status		
3.3.2. Table 3.2 shows nominal launch area and launch complex hazard consequence and probability categories correlated to different levels of acceptability for prelaunch hazards not associated with launch or Range Safety launch commit criteria. Numbers provided in Table 3.2 are guides only and are not necessarily hard limits. NASA safety risks assessment often do not address specific monetary values or downtime. NASA safety risks focus more on credible scenarios that may result in loss of life, personal injury, illness, mission loss, or system loss or damage.	Select Status		

VOLUME 1: POLICIES AND PROCEDURE REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
3.3.7. Range Safety shall evaluate all launch vehicle, payload, ground support, and facility systems used on the ranges to test, checkout, assemble, handle, support, or launch space launch vehicles or payloads with regard to their hazard potential and ensure they are designed to minimize risks to personnel and fall within acceptable exposure levels for launch area and launch complex safety.	**Select Status**		

Table 3.2. Acceptability Guidelines for Launch and Recovery Sites Hazard Consequences and Probability Categories

Hazard Severity		Potential Consequences				Probability*				
Category		Injury/Illness/Environment	Equipment Loss ($)	Unit Downtime	Data Compromise	A	B	C	D	E
I	Catastrophic	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact.	>10,000,000	>4 Months	Data is never recoverable or primary program objectives are lost.					
II	Critical	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.	1,000,000 to 10,000,000	2 Weeks to 4 Months	May cause repeat of test program.					
III	Marginal	Could result in one or more of the following: injury or occupational illness resulting in one or more lost workday(s), reversible moderate environmental impact.	100,000 to 1,000,000	1 Day to 2 Weeks	May cause repeat of test period.					
IV	Negligible	Could result in one or more of the following: minor injury or occupational illness not resulting in a lost workday, minimal moderate environmental impact.	< 100,000	< One Day	May cause repeat of data point, or data may require minor manipulation.					

Risk Priority: **High-Unacceptable** **Serious – Waiver Required** **Medium - Compliance Rationale** **Low – Operation Permitted**

***Probability refers to the probability that the potential consequence will occur in the life cycle of the system (test/activity/operation).**

Table 3.2. (Continued) Acceptability Guidelines for Pre-Launch Area and Launch Complex Hazard Consequences and Probability Categories Use the following list to determine the appropriate Risk Level.				
Probability Description**		Probability Range	Specific Individual Item	Fleet or Inventory***
A	Frequent	3×10^{-2} to 3×10^{-1}	Likely to occur repeatedly	Continuously experienced
B	Probable	3×10^{-3} to 3×10^{-2}	Likely to occur several times	Will occur frequently
C	Occasional	3×10^{-4} to 3×10^{-3}	Likely to occur sometime	Will occur several times
D	Remote	8×10^{-5} to 3×10^{-4}	Unlikely to occur, but possible	Unlikely, but can reasonably be expected to occur
E	Improbable	1×10^{-6} to 8×10^{-5}	Very unlikely to occur, but still possible	Unlikely to occur, but possible

**Definitions of descriptive words may need to be modified based on the quantity involved

*** The size of the fleet or inventory as well as the system life cycle shall be defined.

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3.4. Launch Complex Safety	I		
The following requirements are in addition to those also specifically identified for launch complex safety in 3.2.1 and 3.3 of this volume.	I		
3.4.4. When hazards extend to range assets or the general public, the SLD Commander has the ultimate responsibility to ensure proper safety through an appropriate level of oversight into payload project operations.	I		

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CHAPTER 4 PSWG and RANGE SAFETY PROCESSES	I		
4.1. PSWG, Range Safety and Payload Projects Interface Process	I		
4.1.1 The safety review and approval process are covered in the NPR 8715.7 and allows for Range Safety approval processes. A Payload Safety Introduction Briefing (PSIB) is typically the first meeting of the PSWG followed by other meetings to complete Safety Review I, II, and III in accordance with NPR 8715.7. The PSIB shall cover the listed information in Attachment A1.5 of this Volume.	Select Status		
4.6. Equivalent Level of Safety (ELS) Determinations and Waivers	I		
4.6.1. General. Payload projects shall identify the need for any potential Equivalent Level of Safety (ELS) determination and/or waiver regarding requirements in this publication to PSWG and Range Safety for resolution. Potential ELS determinations or waivers shall be identified and presented to the PSWG and Range Safety approval authority at the earliest possible time. Details and requirements for submitting noncompliance requests can be found in Attachment A3.1 of this volume.	Select Status		
4.6.2. ELS Determination. The phrase “ELS” means an approximately equal level of safety. An ELS may involve a change to the level of expected risk that is not statistically or mathematically significant as determined by qualitative or quantitative risk analysis. ELS determination made by NASA and USSF ranges have been referred to in the past as *meets intent certifications*. ELS determinations are normally incorporated during the tailoring process.	I		
4.6.3. Waivers:	I		
4.6.3.1. The term “waiver” refers to a decision that allows a payload project to continue with a launch, including launch process, even though the payload project does not satisfy a specific safety requirement and is not able to demonstrate an ELS. A waiver applies where a failure to satisfy a safety requirement involves a statistically or mathematically significant increase in expected risk as determined through quantitative or qualitative risk analysis, and the activity may or may not exceed the public risk criteria.	I		
4.6.3.2. It is the policy of the NASA and the ranges to avoid the use of waivers. Waivers to the requirements shall be granted only in extremely unique or compelling circumstances and only when the mission objectives of the payload project cannot otherwise be achieved. PSWG, Range Safety, and the payload project shall jointly endeavor to ensure that all requirements of this publication are met as early in the design and operation process as possible to limit the number of required waivers to an absolute minimum.	Select Status		
4.6.3.3. Waivers shall always have the effectivity designated. A "get-well" plan shall be required except for those with lifetime effectivity.	Select Status		
4.6.3.4. The FAA shall be included in the waiver process for licensed programs at USSF ranges per the memorandum of agreement between Headquarters USSF and FAA/AST on Resolving Requests for Relief from Common Launch Safety Requirements.	Select Status		

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4.6.3.5. The SLD Commanders shall approve or disapprove all waivers affecting public safety as defined in SSCMAN 91-710, Volume 1, Chapter 3, Table 3.1 and Table 3.2, for a specific mission based on national or mission needs. When the specific mission risks are greater than an expected casualty (Ec) of 300 x 10^{-6}, the SLD Commanders shall advise the SSC/CC. Refer to SSCI 91-701 for risk approval levels. The latest prescribed Space Force noncompliance request format shall be used.	**Select Status**		
4.6.3.6. The Chiefs of Safety or their designated representatives shall approve or disapprove all USSF waivers other than those affecting public safety.	**Select Status**		
4.6.4. Submittal. The payload project shall submit all waiver requests for review and approval separately. ELS determinations shall normally be documented as part of the tailoring process. All approved waivers and ELS determinations shall be included in the appropriate safety data package.	**Select Status**		
4.6.5. Every applicable waiver shall be reviewed for validity prior to each launch or launch cycle. The payload project shall present a synopsis of each applicable waiver with the rationale concerning its viability for review and approval by Range Safety and the PSWG.	**Select Status**		

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CHAPTER 5 SAFETY AUTHORIZATIONS, SAFETY APPROVALS, AND DOCUMENTATION	I		
5.1. General	I		
The overall safety review and approval process for NASA Payloads is contained in NPR 8715.7.	I		

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CHAPTER 6 INVESTIGATING AND REPORTING MISHAPS AND INCIDENTS	I		
6.1. Mishaps and Incidents Involving Space Force Personnel and Resources	I		
6.1.1. NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping, applies to all NASA mishaps and close calls. For mishaps and incidents occurring on a Space Force range, Department of the Airforce Instruction (DAFI) 91-204, Safety Investigations and Reports, also applies and the ranges shall investigate and report all mishaps and incidents involving USSF personnel and resources.	Select Status		
6.2. Non-Space Force Personnel and Resources on Space Force Property	I		
6.2.1. The USSF ranges shall not report or investigate non-Space Force mishaps under DAFI 91-204 auspices. However, Range Safety shall assist and participate in non-Space Force mishap investigations that affect or could affect public safety, launch area safety, or Space Force resources and may assist in non-Space Force mishap investigations that affect or could affect launch complex safety or non-Space Force third party resources.	Select Status		
6.2.2. The PSWG and Range Safety shall be provided with the investigation results of any mishaps or incidents occurring on the ranges.	Select Status		
6.2.3. Regardless of the payload project or Range User, the SLD Commander may conduct formal investigations into any mishap and incident on Space Force property that affects or could affect public safety, launch area safety, or launch complex safety. However, the scope of such an investigation into contractor mishaps is limited to the protection of the public, other Range Users, and Space Force personnel and resources.	I		
6.3. Reporting Space Launch System Anomalies	I		
6.3.1. Any anomaly with potential safety implications and close calls shall be reported in accordance with NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting Investigating, and Recordkeeping. Any anomaly with potential safety implications occurring in a system during prelaunch processing, launch, flight, or post-launch processing shall be promptly reported to the PSWG and Range Safety for review. Anomalies occurring during launch, flight, or post-launch shall be promptly reported to Range Safety and local safety authorities. Payload projects shall notify the PSWG and Range Safety office of all anomaly reviews/meetings prior to the review/meeting and shall provide copies of the briefings, reports, meeting minutes, and actions identified and taken to address the anomalies.	Select Status		

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CHAPTER 7 CHANGES TO THIS PUBLICATION	I		
7.1. This publication shall be updated as needed to coincide with updates to USSF SSCMAN 91-710, Range Safety and NASA requirements and to incorporate document improvements. The latest version with any changes shall be provided on the NASA Payload Safety Program website at https://sma.nasa.gov/sma-disciplines/elv-payload-safety.	Select Status		
7.2. Requests for changes to Annex to NASA-STD-8719.24 shall be submitted via a hyperlink on NASA Technical Standards web page: https://standards.nasa.gov/standard/NASA/NASA-STD-871924-ANNEX.	Select Status		
7.3. All changes to this publication shall first be coordinated jointly among the NASA Payload Safety Agency Team and the Space Force Space Systems Command Ranges (SLD 30 and SLD 45 Safety Offices). All affected NASA payload projects shall be informed of any changes to this publication. The NASA Payload Safety Manager is responsible for keeping this document current and incorporating changes.	Select Status		

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ATTACHMENT 1 POLICIES AND PROCEDURES	I		
A1.1. NASA PAYLOAD SAFETY REQUIREMENTS TAILORING PROCESS	I		
A1.1.1. Scope. This attachment describes the rationale for tailoring, the tailoring process, and the requirements for documenting tailored editions of the publication. The NASA Payload Safety Requirements tailoring matrix (MS Excel) is found on the NASA Technical Standards System webpage at: https://standards.nasa.gov/standard/NASA/NASA-STD-871924-ANNEX.	I		
A1.1.2. Applicability. The tailoring process is applicable to all NASA Payload projects.	Select Status		
A1.1.3. Purpose. Tailoring provides a means for formulating a specific edition of this publication, incorporating only those requirements that apply to a particular project. Additionally, tailoring allows for the project to propose whether or not they will meet the requirements as written or achieve an ELS through an acceptable alternative. A tailored version of the publication is denoted by the project's name in the title. Departures from this policy shall be approved by the PSWG and Range Safety. Tailoring refers to the process used of assessing the applicability of requirements and evaluating the project's potential implementation in order to generate a set of specific requirements for the project. The tailored edition shall be placed on the payload project's contract, grants, cooperative agreements, or other agreements.	Select Status		
A1.1.4. Formation of a Payload Safety Working Group. A PSWG shall be formed to assist the project as needed in tailoring per this publication.	Select Status		
A1.1.5. Tailoring Rationale. Tailoring shall be accomplished based on the following rationale described below. Alternative means of identifying deletions, changes, additions, and payload project information are allowable provided that they are distinguishable from the original text and each other and are mutually agreed to by the payload project, PSWG, and Range Safety.	Select Status		
A1.1.6. Deletion of a Requirement:	I		
A1.1.6.1. When a requirement is going to be complied with and is applicable to the project, a "C" shall remain in the STATUS column of the tailored document. When a requirement is not applicable to a specific payload project, then a "N/A" shall be placed in the STATUS column and rationale provided under the RATIONALE/COMMENTS column.	Select Status		
A1.1.6.2. The original paragraph number and headings shall remain, but the non-applicable text shall be identified with the abbreviation N/A in the STATUS column with rationale provided in RATIONALE/COMMENTS column.	Select Status		
A1.1.7. Change to a Requirement: Equivalent Level of Safety	I		
A1.1.7.1. Equivalent Level of Safety **(**ELS) determinations may be provided and approved by the PSWG and Range Safety through the change process.	I		

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A1.1.7.2. A change is allowed to tailor the requirement to a particular system as long as the intent of the requirement is met and the ELS is maintained. An "NC" for noncompliance shall be placed in the tailored STATUS column and sufficient rationale is provided in the RATIONALE/COMMENTS column to allow for PSWG and Range Safety assessment.	I		
A1.1.7.3. The change shall be fully captured by showing the entire new paragraph with the change in the TAILORED TEXT column of the tailored document. When the change is an ELS, the abbreviation "NC" shall be placed in the STATUS column of the tailored document following the paragraph number. The new paragraph with the change shall be provided under the TAILORED TEXT column with sufficient rationale provided under the RATIONALE/COMMENTS column for PSWG and Range Safety assessment. If additional space is needed for the rationale (i.e. to show analysis or data, or to provide lengthy rationale) then an addendum to the tailored document should be used referencing the paragraph number. ELS' that are requested after the final project specific tailored document has been completed and signed shall be requested using the NASA Payload Safety Post Tailoring Request, NF 1826, found on the NASA Electronic Forms Library webpage at https://nef.nasa.gov. When the change is merely an administrative change then the abbreviation "T" shall be placed in the STATUS column of the tailored document after the paragraph number. The new paragraph with the change shall be placed under the TAILORED TEXT column and rationale provided under the RATIONALE/COMMENTS column. When the paragraph is not a requirement and is for information only the STATUS column of the tailored shall be marked with an "I" and rationale provided if deemed necessary under the RATIONALE/COMMENTS column.	Select Status		
A1.1.7.4. The existing numbering system shall remain the same to the maximum extent possible.	Select Status		
A1.1.7.5. Additional paragraphs may be added; however, using the remaining unaffected paragraph numbers is not allowed.	I		
A1.1.7.6. All changes shall be captured in the TAILORED TEXT column of the project specific tailored document. All changes shall be highlighted in bold. Deletions of text, including partial deletions, shall be shown with the original text marked with strikethrough. Insertions of text, including partial insertions, shall be shown with the new text marked with underline.	Select Status		
A1.1.8. Addition to a Requirement:	I		
A1.1.8.1. An addition to a requirement is allowed when there are no existing requirements addressing new technology, when unforeseen hazards are discovered, when federal or industry standards change, and for similar reasons.	Select Status		
A1.1.8.2. An addition shall be added with new paragraph numbers in the section for which it is appropriate or in a new section if no other section applies.	Select Status		
A1.1.8.3. Additions shall be placed in the TAILORED TEXT column in the tailored document with a "T" placed in the STATUS column and rationale provided under the RATIONALE/COMMENTS column. All changes shall be highlighted in bold. Insertions/ additions of text, including partial insertions, shall be shown with the new text underlined.	Select Status		
A1.1.9. Payload Project Information Only	I		

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A1.1.9.1. Requirements having only an indirect effect on the payload project, but which are still required of the project as a whole shall remain in the tailored publication as information only. Examples of such requirements include Pad Safety responsibilities, other range contractor responsibilities, and payload project facilities manager responsibilities.	**Select Status**		
A1.1.10. Waivers	**I**		
A1.1.10.1. Waivers are not rationale for the deletion of requirements. The requirements shall remain in the tailored document and the waiver process shall be used for the disposition of the requirement. When a requirement is not going to be met and there is a resultant increase in risk as determined by the PSWG in conjunction with Range Safety then a waiver request must be submitted. If the waiver is approved, then a "NC" is placed in the STATUS column of the tailored document. The waiver title and number(s) shall be placed under the RATIONALE/COMMENTS column. The NF 1827, NASA Payload Safety Waiver Request, may be found on the NASA Electronic Forms Library website at: https://nef.nasa.gov/.This form is used for all waivers. If deemed necessary by the USSF, a USSF Relief request will also be required.	**Select Status**		
A1.1.11. Risk-Cost Benefit Analysis:	**I**		
A1.1.11.1. Technical issues regarding such items as applicable requirements, policy, criteria, or data may be evaluated on a risk-cost benefit basis to determine if the risk is acceptable to waive the requirements.	**I**		
A1.1.11.2. A risk-cost benefit analysis, based on the criteria defined in SSCMAN 91-710, Volume 1, Chapter 3, Table 3.1 and Chapter 3, Table 3.2 of this volume may be submitted to Range Safety.	**I**		
A1.1.11.3. Based on risk-cost benefit analysis data, Range Safety and the Range User shall reach agreement on the disposition of the requirement in question.	**I**		
A1.1.11.4. If the application of a USSF SSCMAN 91-710 range safety user requirement, results in significant reduction in risk at a significant cost benefit, it may be determined by Range Safety to be sufficient to impose the requirement; however, if the benefit is insignificant and/or the cost is high, the requirement may be waived or determined to provide an ELS, all with consideration for public safety.	**I**		
A1.1.12. Preparation of a Project Specific Draft Tailored Edition of NASA Payload Safety Requirements document:	**I**		
A1.1.12.1. The payload project shall produce a payload project mission specific draft edition of this document per NPR 8715.7 and this standard. The NASA Payload Safety Requirements tailoring matrix (MS Excel.xls) is found on the NASA Technical Standards System webpage at: https://standards.nasa.gov/standard/NASA/NASA-STD-871924-ANNEX.	**Select Status**		
A1.1.12.2. The purpose of a draft project specific tailored matrix version is to eliminate all non-applicable requirements, leaving only applicable requirements from which detailed tailoring can be performed and to allow for PSWG and Range Safety review prior to finalizing.	**Select Status**		
A1.1.12.3. The project specific draft shall be delivered to the PSWG as part of Safety Review I no later than 30 days prior to the project's mission PDR, in accordance with NPR 8715.7, Table 3-1. Overview of Deliverables for the Payload Safety Process and Approvals.	**Select Status**		

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A1.1.13. Final Publication of the Project Specific NASA Payload Safety Requirements:	I		
A1.1.13.1. The goal for final publication of the project specific tailored matrix is as soon as possible but should be no later than 30 days prior to the project's mission CDR or as scheduled by the PSWG (see NPR 8715.7 for deliverables schedule). Tailoring can be an ongoing process and tailored documents should be considered living documents that may change throughout the life of the project.	Select Status		
A1.1.13.2. The tailoring process and delivery schedule is found in NPR 8715.7, Table 3-1. Overview of Deliverables for the Payload Safety Process and Approvals.	I		
A1.1.14. The tailored edition shall look like this NASA Payload Safety Requirements tailoring matrix with the following exceptions:	Select Status		
A1.1.14.1. The document title/heading on page 1 shall read, "NASA Payload Safety Requirements and the Payload Project name. The "Payload Project Name" shall be centered at the top of each page.	Select Status		
A1.1.14.2. The date of the applicable contract/CSOSA/agreement/etc. shall be shown under the title on page 1.	Select Status		
A1.1.14.3. The date of the tailored edition shall be on the cover page of the document.	Select Status		
A1.1.14.4. The information contained in the document is technical in content and may be proprietary as defined by the International Traffic in Arms Regulations (ITAR) or by Export Administration Regulations (EAR) requirements. Each payload project shall contact the NASA KSC Export Control Office, 321-867-9209, for an ITAR or EAR regulatory determination. If not required delete this statement. The term "PROPRIETARY" shall be placed on page 1, centered directly over the ITAR/EAR regulatory determination statement for each payload project.	Select Status		
A1.1.14.5. All deleted information shall be marked as "N/A" under the STATUS column of the project's tailored version of this document.	Select Status		
A1.1.15. Effectivity of Tailored Project Specific NASA Payload Safety Requirements document:	I		
A1.1.15.1. Each project specific version of the NASA Payload Safety Requirements document shall contain a preface paragraph detailing its effectivity.	Select Status		
A1.1.15.2. At a minimum, the payload and the time period to which the project specific NASA Payload Safety Requirements applies shall be addressed.	Select Status		
A1.1.16. Assumptions:	I		
A1.1.16.1. Each project specific tailored version of the NASA Payload Safety Requirements tailoring matrix shall contain a preface paragraph detailing the critical assumptions that were made in writing the tailored edition.	Select Status		

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A1.1.16.2. The nature of the assumptions shall be such that a change may invalidate the tailored document or require a change or update. An example of such a critical assumption is that the design of any hazardous system does not change from that presented before publication of the project specific tailored document.	**Select Status**		
A1.1.16.3. The assumption(s) described in the tailored document shall include sufficient detail to categorize the scope of the tailored requirement to the specific systems or subsystems affected by the proposed change. If two or more systems/subsystems are affected by the tailored paragraph, then the assumption(s) shall state which of those systems/subsystems is intended to be included in the scope of the tailoring. If there is a difference in the tailoring for the two or more systems/subsystems, then the tailored paragraph shall be repeated with appropriate tailoring unique to each individual system/subsystem.	**Select Status**		
A1.1.17. Approvals:	**I**		
A1.1.17.1. Once completed and finalized the project specific Payload Safety Requirements shall be approved and signed by the Project Manager (PM), the preparer, the project's NASA SMA Technical Authority, Range Safety Representative, PSWG Chairperson and others as deemed necessary by the PSWG in accordance with NPR 8715.7 and this standard. Once signed each significant addition, change, or deletion shall be approved in accordance with this document and NPR 8715.7. Changes that are ELS that come up after the tailoring was completed shall be recorded on NF 1826 NASA Payload Safety Post-Tailoring Request. Waivers (increased risk changes) shall be recorded on the NF 1827 NASA Payload Safety Waiver Request. If deemed necessary by the USSF, a USSF Relief request will also be required. The NASA Payload Safety Post-Tailoring and Waiver Requests are found on the NASA Electronic Forms Library webpage at https://nef.nasa.gov.	**Select Status**		
A1.1.17.2. Each complete, final project-specific tailored document affecting public safety shall be approved and signed by the SW Commander.	**Select Status**		
A1.1.17.3. Any revisions to the project-specific tailored version of the NASA Payload Safety Requirements document shall be made in accordance with NPR 8715.7 and USSF SSCMAN 91-710 change processes.	**Select Status**		

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ATTACHMENT 2 SAFETY PLAN REQUIREMENTS	I		
A2.1. INTRODUCTION	I		
A2.1.1. Purpose. This attachment establishes the minimum requirements for a payload project's System Safety Plan (SSP). The payload project SSP shall be consistent with MIL-STD-882, Standard Practice for System Safety, Task 102, System Safety Program Plan. The payload project SSP shall include the key system safety roles, responsibilities, and interfaces of the payload contractor, NASA, and other relevant organizations. The program includes the corresponding requirements for a payload project SSP and identifies hazard analysis and risk assessment requirements.	Select Status		
A2.1.2. Tailoring. Tailoring of this attachment and the requisite SSP is highly recommended. The tailoring process is defined in Attachment A1.1 of this volume. When conflicting requirements or deficiencies are identified in safety requirements the payload project shall submit notification, with proposed solutions or alternatives and supporting rationale, to the PSWG and Range Safety for resolution.	Select Status		
A2.1.3. Demonstration of an Acceptable Level of Mishap Risk. Payload projects shall demonstrate an acceptable level of mishap risk to the PSWG and Range Safety through the completion of the system safety hazard analyses and risk assessments described in this attachment.	Select Status		
A2.2. SYSTEM SAFETY PLAN TASKS	I		
A2.2.1. To achieve the system safety objectives and obtain the PSWG and Range Safety approval, the following tasks shall be completed by the payload project in the approximate order that they are listed and in conjunction with the milestones that are identified.	Select Status		
A2.2.1.1. Task 1: Establish a Payload Project System Safety Plan. By the time of the payload project's Payload Safety Introduction Briefing, the payload project shall have established a Safety Program documented in the project's SSP (see A2.2.2) that meets the tailored requirements of this publication which includes the following:	Select Status		
A2.2.1.2. **Project Manager (PM).** Establishing a safety management system. The payload Project Manager (PM) shall be responsible for the following:	Select Status		
A2.2.1.2.1. Establishing, controlling, incorporating, directing, and implementing the system safety plan policies.	Select Status		

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A2.2.1.2.2. Ensuring that mishap risk is identified and eliminated or controlled within established program risk acceptability parameters. Decisions regarding resolution of identified hazards shall be based on assessment of the risk involved. To aid in the achievement of the objectives of system safety, hazards shall be characterized as to hazard severity categories and hazard probability levels, when possible. Since the priority for system safety is eliminating hazards by design, a risk assessment procedure, considering only hazard severity, will generally suffice during the early design phase to minimize risk. When hazards are not eliminated during the early design phase, a risk assessment procedure based upon the hazard probability, hazard severity, as well as risk impact, shall be used to establish priorities for corrective action and resolution of identified hazards. All catastrophic and critical hazards shall be documented on the NASA Form NF 1825 NASA Payload Safety Hazard Report (see A2.2.1.8.1) or an equivalent form that contains all information required on NF 1825.	**Select Status**		
A2.2.1.2.3. Establishing internal reporting systems and procedures for investigation and disposition of system related mishaps and safety incidents, including close calls involving flight hardware and ground support equipment and reporting such matters as required by NPR 8621.1. See Volume 6, 4.6.2 for the Accident Notification Plan. For all such situations at the payload processing facility and launch site area, the local safety authority and the PSWG Chairperson shall be contacted immediately after initial mishap response. The SW Commander and NASA may conduct formal investigations into any mishap and incident that affects or could affect public safety, launch area safety, or launch complex safety. However, the scope of such an investigation into contractor mishaps is limited to the protection of the public, other payload projects, and Space Force personnel and resources.	**Select Status**		
A2.2.1.2.4. Reviewing and approving the safety analyses, reports, and documentation required by this publication and submitted to the PSWG for the PSWG and Range Safety to establish knowledge and acceptance of residual risks.	**Select Status**		
A2.2.1.3. Payload Project System Safety Engineer. Establishing a Payload Project System Safety Engineer safety position for each project in accordance with NPR 8715.7. The individual in this position shall be directly responsible to the payload Project Manager for safety matters. At a minimum, the Payload Project System Safety Engineer shall be responsible for the requirements in NPR 8715.7 and for the following:	**Select Status**		
A1.2.2.1.3.1. Reviewing and approving all safety analyses, reports, and documentation required by this publication and submitted to PSWG for PSWG and Range Safety review and approval.	**Select Status**		
A1.2.2.1.3.2. Reviewing and approving all hazardous and safety critical test plans and procedures and verifying that all safety requirements are incorporated.	**Select Status**		
A1.2.2.1.3.3. Developing a planned approach for safety task accomplishment, providing qualified people to accomplish the tasks, establishing the authority for implementing the safety tasks through all levels of management, and allocating appropriate resources, both manning and funding, to ensure the safety tasks are completed.	**Select Status**		
A1.2.2.1.3.4. Establishing a system safety organization or function and lines of communication within the project organization and with associated organizations (government and contractor).	**Select Status**		
A2.2.1.3.5. Establishing interfaces between system safety and other functional elements of the project, as well as between other safety disciplines such as nuclear, range, explosive, chemical, and biological.	**Select Status**		

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A2.2.1.3.6. Designating the organizational unit responsible for executing each safety task.	Select Status		
A2.2.1.3.7. Establishing the authority for resolution of identified hazards.	Select Status		
A2.2.1.3.8. Establishing a single closed-loop hazard tracking system by development of a method or procedure to document and track hazards and their controls and providing an audit trail of hazard mitigation to include hazard closure verification of the following: 1) design, 2) analysis to determine satisfactory margins of safety, 3) material selection and certification, 4) contamination control, 5) assembly processes, 6) NDE inspection, 7) qualification testing, 8) certified procedures, 9) visual inspections during: (a) manufacture, (b) assembly, (c) installation, (d) technical training and certifications.	Select Status		
A2.2.1.3.9. Maintaining and making available to the PSWG and Range Safety Hazard Reports of all identified hazards. Hazard Reports shall be documented on NF 1825 NASA Payload Safety Hazard Report Form found on the NASA Electronic Forms Library webpage at: https://nef.nasa.gov/search?query=NF1825&center=7&center=1 , or an equivalent form that contains all information required on NF 1825. The payload project shall track until closed all open hazards using a Safety Verification Tracking Log (SVTL) to track identified hazards to closure. Establishing the order of precedence for satisfying system safety requirements and resolving identified hazards as follows:	Select Status		
A2.2.1.3.9.1. Designing for Minimum Risk. From program inception, design to eliminate hazards. If an identified hazard cannot be eliminated, reduce the associated risk to an acceptable level, as defined by PSWG and Range Safety, through design selection.	I		
A2.2.1.3.9.2. Incorporating Safety Devices. If identified hazards cannot be eliminated or their associated risk reduced through design selection, that risk shall be reduced to a level acceptable to the PSWG and Range Safety through the use of fixed, automatic, or other protective safety design features or devices. Provisions shall be made for periodic functional checks of safety devices when applicable.	Select Status		
A2.2.1.3.9.3. Providing Warning Devices. When neither design nor safety devices can effectively eliminate identified hazards or reduce associated risk, devices shall be used to detect the condition and to produce a warning signal to alert personnel of the hazard. Warning signals and their application shall be designed to minimize the probability of incorrect personnel reaction to the signals and shall be standardized within like types of systems.	Select Status		
A2.2.1.3.9.4. Developing Procedures and Training. Where it is impractical to eliminate hazards through design selection or reduce the associated risk with safety and warning devices, procedures and training may be used when acceptable to the PSWG and Range Safety. Procedures may include the use of personal protective equipment. Precautionary notations shall be standardized as specified by the PSWG and Range Safety. Tasks and activities judged to be safety critical by the PSWG and Range Safety require certification of personnel proficiency.	Select Status		
A2.2.1.3.9.5. Defining system safety plan milestones and relate them to major program milestones, project element responsibility, and required inputs and outputs.	Select Status		
A2.2.1.3.9.6. Establishing System Safety Plan reviews and audits.	Select Status		

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A2.2.1.3.9.7. Conducting, documenting, and making the following documentation available to the PSWG and Range Safety upon request:	Select Status		
A2.2.1.3.9.7.1. The payload project system safety plan and supporting risk assessment data.	Select Status		
A2.2.1.3.9.7.2. Associate contractor system safety plan and supporting risk assessment data.	Select Status		
A2.2.1.3.9.7.3. Support contractor system safety plan and supporting risk assessment data.	Select Status		
A2.2.1.3.9.7.4. Subcontractor system safety plan and supporting risk assessment data.	Select Status		
A2.2.1.3.9.7.5. Providing support for the following:	Select Status		
A2.2.1.3.9.7.5.1. Safety reviews and audits performed by representatives of the PSWG, Payload Safety Agency Team, or others.	Select Status		
A2.2.1.3.9.7.5.2. Presentations to government certifying activities such as phase safety reviews, munitions safety boards, nuclear safety boards, NPR 8715.26, NASA Nuclear Flight Safety program review or flight safety review boards to the extent specified by this publication. These may also include special reviews such as flight and article readiness reviews or pre-construction briefings.	Select Status		
A2.2.1.3.9.7.6. Safety reviews shall be held in accordance with NPR 8715.7 and are in association with the project's schedule per NPR 7120.5. Generally, the safety reviews shall address the following:	Select Status		
A2.2.1.3.9.7.6.1. Program systems and operations overview.	Select Status		
A2.2.1.3.9.7.6.2. Presentation of required documentation and hazard analyses.	Select Status		
A2.2.1.3.9.7.6.3. Noncompliances to the project specific tailored requirements.	Select Status		
A2.2.1.3.9.7.6.4. Open safety issues.	Select Status		
A2.2.1.3.9.8. Establishing an incident alert and notification, investigation, and reporting process, to include notification of the PSWG Chairperson and Range Safety.	Select Status		
A2.2.1.3.9.9. Establishing a process to evaluate engineering change proposals (ECPs), specification change notices (SCNs), software problem reports (SPRs), program or software trouble reports (PTRs, STRs) for their safety impact on the system, and notify the PSWG and Range Safety if the level of risk of the system changes.	Select Status		

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A2.2.2. Task 2: Develop a System Safety Plan. The payload project shall develop and implement a PSWG and Range Safety approved System Safety Plan (SSP) encompassing the total safety program for payload design, production, processing and testing, vehicle integration, and launch through payload separation from the launch vehicle. For any planned return-to-earth recovery or sample return missions see Volume 6, section 4.7. The SSP shall describe in detail tasks and activities of system safety management and system safety engineering required to identify, evaluate, and eliminate or control hazards, to reduce the associated risk to a level acceptable to the PSWG and Range Safety. The plan provides a formal basis of understanding between the payload project and the PSWG and Range Safety on how the SSP will be conducted to meet the requirements of NPR 8715.7 and this publication. The plan shall account for all required tasks and responsibilities on an item-by-item basis. The payload project shall submit a draft SSP to the PSWG, including Range Safety for review at the Payload Safety Introduction Briefing. A final SSP shall be submitted no later than 30 days prior to project's mission PDR, or as scheduled by the PSWG, for review and approval (see NPR 8715.7 for review and approval process). The SSP shall comply with this document and include the following information:	**Select Status**		
A2.2.2.1. System Safety Organization. The System Safety Organization section shall describe the following:	**Select Status**		
A2.2.2.1.1. The location of the system safety and flight safety analysis organizations or functions within the overall project organization, using charts to show the organizational and functional relationships and lines of communication.	**Select Status**		
A2.2.2.1.2. The organizational relationship between other project functional elements having responsibility for tasks with range safety impacts and the system safety management and engineering organization.	**Select Status**		
A2.2.2.1.3. Review and approval authority of applicable tasks by key system safety personnel.	**Select Status**		
A2.2.2.1.4. The responsibility and authority of key system safety personnel, other payload project organizational elements involved in the range safety effort, contractors, and system safety groups.	**Select Status**		
A2.2.2.1.5. A description of the methods by which safety personnel may raise issues of concern directly to the Project Manager (PM) or the project manager's supervisor within the corporate organization.	**Select Status**		
A2.2.2.1.6. Identification of the organizational unit responsible for executing each task.	**Select Status**		
A2.2.2.1.7. Identification of the authority in regard to resolution of all identified hazards.	**Select Status**		
A2.2.2.1.8. The staffing of the system safety organization for the duration of the program to include personnel loading and a summary of the qualifications of key system safety personnel assigned to the effort, including those personnel identified with approval authority for the payload project prepared documentation.	**Select Status**		
A2.2.2.1.9. The process by which the payload project management decisions will be made, including such decisions as timely notification of unacceptable risks, necessary action, incidents, or malfunctions, or request for noncompliances to safety requirements or project waivers.	**Select Status**		
A2.2.2.1.10. Details of how resolution and action relative to system safety will be accomplished at the project management level possessing resolution authority.	**Select Status**		

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A2.2.2.2. System Safety Plan Milestones. The SSP shall:	Select Status		
A2.2.2.2.1. Define system safety project milestones and relate them to major project milestones, program element responsibility, and required inputs and outputs.	Select Status		
A2.2.2.2.2. Provide and maintain a program schedule of safety tasks, including start and completion dates, reports, and reviews.	Select Status		
A2.2.2.2.3. Identify subsystem, component, or software safety activities as well as integrated system level activities such as design analyses, tests, and demonstrations applicable to the SSP but specified in other engineering studies and development efforts to preclude duplication.	Select Status		
A2.2.2.3. System Safety Data. The SSP shall:	Select Status		
A2.2.2.3.1. Identify deliverable data by title, number, and means of delivery such as hard copy or electronic submission. ***Note: NPR 8715.7, this publication and MIL-STD-882 provide initial Data Item Descriptions and deliverables identification. Electronic submittals are preferred, and secure websites shall be used to allow for PSWG and Range Safety review.***	Select Status		
A2.2.2.3.2. Identify non-deliverable system safety data and describe the procedures for accessibility by the PSWG and Range Safety and retention of data of historical value.	Select Status		
A2.2.2.4. System Safety Interfaces. The SSP shall identify, in detail:	Select Status		
A2.2.2.4.1. The interface between system safety and all other applicable safety disciplines such as USSF Range Safety, NASA Range Safety, the NASA Nuclear Flight Safety Officer (NFSO), the NASA Planetary Protection Officer (PPO), and the NASA Center safety, local facility safety, explosive and ordnance safety, chemical and biological safety, laser safety, and any others.	Select Status		
A2.2.2.4.2. The interface between system safety, design and/or systems engineering, and all other support disciplines such as maintainability, quality control, reliability, software development, human factors engineering, occupational health support (health hazard assessments), and any others.	Select Status		
A2.2.2.4.3. The interface between system safety and all system integration and test disciplines.	Select Status		

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A2.2.3. Task 3: Perform and Document a Preliminary Hazard Analysis. The payload project shall perform and document a preliminary hazard analysis (PHA) to identify safety critical areas, to provide an initial assessment of hazards, and to identify requisite hazard controls and follow-on actions. A preliminary hazard list shall be provided at the Payload Safety Introduction Briefing (PSIB). The results of the PHA shall be submitted with the SDP I (preliminary MSPSP) for the project's mission PDR Safety Review 1 meeting in accordance with NPR 8715.7. Based on the best available data, including mishap data from similar systems and other lessons learned, hazards associated with the proposed design or function shall be evaluated for hazard severity, hazard probability, and operational constraint. Safety and health studies identifying provisions and alternatives needed to eliminate hazards or reduce their associated risk to a level acceptable to the PSWG and Range Safety shall be included. Hazards identified shall be documented on the form NF 1825 NASA Payload Safety Hazard Report or an equivalent form that contains all information required on NF 1825. The NF 1825 can be found on the NASA Electronic Forms Library webpage at: https://nef.nasa.gov/. Hazard report closure verifications consist of the following: 1) design, 2) analysis to determine satisfactory margins of safety, 3) material selection and certification, 4) contamination control, 5) assembly processes, 6) NDE inspection, 7) qualification testing, 8) certified procedures, 9) visual inspections during: (a) manufacture, (b) assembly, (c) installation, (d) technical training and certifications. At a minimum, the PHA shall consider the following for identification and evaluation of hazards, to include: :	**Select Status**		
A2.2.3.1. Over-pressurization hazards, ordnance/explosives hazards, propellant (fire/explosion) hazards, mechanical (kinetic (impact) energy) hazards, electrical energy hazards, thermal energy (cryogens) hazards, ionizing and non-ionizing radiation hazards, and hazardous material (toxic) release hazards. The payload/spacecraft should be designed, 1) to eliminate the hazard or 2) to mitigate the hazards to the lowest acceptable level.	**Select Status**		
A2.2.3.2. Safety related interface considerations among various elements of the system such as material compatibility, electromagnetic interference, inadvertent activation, fire and explosive initiation and propagation, and hardware and software controls. This shall include consideration of the potential contribution by software, including software developed by other contractors and sources, to subsystem and system mishaps.	**Select Status**		
A2.2.3.3. Safety design criteria to control safety-critical software commands and responses such as inadvertent command, failure to command, untimely command or responses, inappropriate magnitude, or designated undesired events shall be identified and appropriate action taken to incorporate them in the software and related hardware specifications.	**Select Status**		
A2.2.3.4. Environmental constraints including the operating environments such as drop, shock, vibration, extreme temperatures, humidity, noise, exposure to toxic substances, health hazards, fire, electrostatic discharge, lightning, electromagnetic environmental effects, ionizing and non-ionizing radiation including laser radiation.	**Select Status**		
A2.2.3.5. Operating, test, maintenance, built-in-tests, diagnostics, and emergency procedures (human factors engineering, human error analysis of operator functions, tasks, and requirements; effect of factors such as equipment layout, lighting requirements, potential exposures to toxic materials, effects of noise or radiation on human performance; explosive ordnance render safe and emergency disposal procedures; life support requirements and their safety implications in manned systems, crash safety, egress, rescue, survival, and salvage).	**Select Status**		
A2.2.3.6. Those test unique hazards that will be a direct result of the test and evaluation of the article or vehicle.	**Select Status**		

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A2.2.3.7. Facilities, real property installed equipment, support equipment such as provisions for storage, assembly, checkout, proof testing of hazardous systems and assemblies that may involve toxic, flammable, explosive, corrosive, or cryogenic materials and wastes; radiation or noise emitters; electrical power sources.	Select Status		
A2.2.3.8. Training and certification pertaining to hazardous and safety critical operations and maintenance of hazardous and safety critical systems.	Select Status		
A2.2.3.9. Safety related equipment, safeguards, and possible alternate approaches such as interlocks; system redundancy; fail-safe design considerations using hardware or software controls; subsystem protection; fire detection and suppression systems; personal protective equipment; heating, ventilation, and air-conditioning; and noise or radiation barriers.	Select Status		
A2.2.3.10. Malfunctions to the system, subsystems, or software. Each malfunction shall be specified, the cause and resulting sequence of events determined, the degree of hazard determined, and appropriate specification and/or design changes developed.	Select Status		
A2.2.4. Task 4: Perform and Document Subsystem, System, Facility, and Operating and Support Hazard Analyses:	Select Status		
A2.2.4.1. Subsystem Hazard Analysis - The payload project shall perform and document a subsystem hazard analysis (SSHA) to identify all components and equipment that could result in a hazard or whose design does not satisfy safety requirements. The purpose of the SSHA is to verify subsystem compliance with safety requirements contained in subsystem specifications and other applicable documents; identify previously unidentified hazards associated with the design of subsystems including component failure modes, critical human error inputs, and hazards resulting from functional relationships between components and equipment comprising each subsystem; and recommend actions necessary to eliminate identified hazards or control their associated risk to acceptable levels. The SSHA shall include government furnished equipment, non-developmental items, and software. Areas to consider are performance, performance degradation, functional failures, timing errors, design errors or defects, or inadvertent functioning. The human shall be considered a component within a subsystem, receiving both inputs, and initiating outputs, during the conduct of this analysis. The SSHA may indicate the need for revised tailoring of some requirements of this publication depending on the level of risk identified or the discovery of any previously unidentified hazards. Hazards identified shall be documented on the NF 1825 NASA Payload Safety Hazard Report. This form can be found on the NASA Electronic Forms Library webpage at: https://nef.nasa.gov/. An equivalent form may be used that contains all information required on NF 1825. Hazard report closure verifications consist of the following: 1) design, 2) analysis to determine satisfactory margins of safety, 3) material selection and certification, 4) contamination control, 5) assembly processes, 6) NDE inspection, 7) qualification testing, 8) certified procedures, 9) visual inspections during: (a) manufacture, (b) assembly, (c) installation, (d) technical training and certifications. The analysis shall include a determination of the following hazards	Select Status		

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A2.2.4.1.1. The modes of failure that could impact safety including reasonable human errors as well as single point and common mode failures, and the effects on safety when failures occur in subsystem components for the following: over-pressurization hazards, ordnance/explosives hazards, propellant (fire/explosion) hazards, mechanical (kinetic (impact) energy) hazards, electrical energy hazards, thermal energy (cryogens) hazards, ionizing and non-ionizing radiation hazards, and hazardous material (toxic) release hazards. The payload/spacecraft should be designed, 1) to eliminate the hazard or 2) to mitigate the hazards to an acceptable level	**Select Status**		
A2.2.4.1.2. The potential contribution of hardware and software, including that which is developed by other contractors and sources, events, faults, and occurrences such as improper timing on the safety of the subsystem.	**Select Status**		
A2.2.4.1.3. That the safety design criteria in the hardware, software, and facilities specifications have been satisfied.	**Select Status**		
A2.2.4.1.4. A general assertion that the method of implementation of hardware, software, and facilities design requirements and corrective actions has not impaired or decreased the safety of the subsystem nor has it introduced any new hazards or risks.	**Select Status**		
A2.2.4.1.5. The implementation of safety design requirements from top level specifications to detailed design specifications for the subsystem. The implementation of safety design requirements developed as part of the PHA shall be analyzed to ensure that it satisfies the intent of the requirements.	**Select Status**		
A2.2.4.1.6. Test plan and procedure recommendations to integrate safety testing into the hardware and software test programs.	**Select Status**		
A2.2.4.1.7. That system level hazards attributed to the subsystem are analyzed and control of the potential hazard is implemented in the design.	**Select Status**		
A2.2.4.1.8. SSHA Analysis Techniques. If no specific analysis techniques are directed or if the payload project recommends that a different technique other than that specified by the PSWG and Range Safety should be used, the payload project shall obtain approval of techniques to be used before performing the analysis.	**Select Status**		
A2.2.4.1.9. SSHA Software:	**I**		
A2.2.4.1.9.1. Software used to control safety critical computer system functions shall be developed in accordance with Volume 3, Chapter 16 of this publication. Safety related software problems detected during or after software verification (and prior to launch) shall be reported to the PSWG and Range Safety in time to support the ongoing phase of the software development process.	**Select Status**		
A2.2.4.1.9.2. Payload projects shall identify all safety critical computer system functions in accordance with Volume 3, Chapter 16 and develop a SSHA for each.	**Select Status**		
A2.2.4.1.9.3. Software shall be put under formal configuration control of a Software Configuration Control Board (SCCB) in accordance with Volume 3, Chapter 16 as soon as a baseline is established. This will ensure that hardware/software changes do not conflict with or introduce potential safety hazards due to hardware/software incompatibilities.	**Select Status**		

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A2.2.4.1.9.4. Safety-critical software, as defined per NASA-STD-8739.8, NASA Software Assurance and Software Safety Standard, that have problems identified during or after software verification (and prior to launch) shall be reported to the PSWG and Range Safety.	Select Status		
A2.2.4.1.10. Updating the SSHA. The payload project shall update the SSHA as a result of any system design changes, including software design changes that affect system safety.	Select Status		
A2.2.4.1.11 SSHA Submittal. A draft SSHA shall be submitted with or included in Safety Data Package II (updated MSPSP) no later than 30 days prior to project's mission CDR and the finalized SSHA shall be submitted with or included in Safety Data Package III (final MSPSP) (See Attachment V3.1 of Volume 3).	Select Status		
A2.2.4.2. System Hazard Analysis. The payload project shall perform and document a system hazard analysis (SHA) to identify hazards and make a general determination of the safety risk posture of the total system design, including software, and specifically of the subsystem interfaces. The purpose of the SHA is to verify system compliance with safety requirements contained in system specifications and other applicable documents; identify previously unidentified hazards associated with the subsystem interfaces and system functional faults; assess the risk associated with the total system design, including software, and specifically of the subsystem interfaces; and recommend actions necessary to eliminate identified hazards and/or control their associated risk to acceptable levels. The SHA may indicate the need for revised tailoring of some requirements of this publication depending on the level of risk identified or the discovery of any previously unidentified hazards. Hazards identified shall be documented on the NF 1825 NASA Payload Safety Hazard Report form or an equivalent form that contains all information required on NF 1825. The NF 1825 can be found on the NASA Electronic Forms Library webpage at: https://nef.nasa.gov/. Hazard report closure verifications consist of the following: 1) design, 2) analysis to determine satisfactory margins of safety, 3) material selection and certification, 4) contamination control, 5) assembly processes, 6) NDE inspection, 7) qualification testing, 8) certified procedures, 9) visual inspections during: (a) manufacture, (b) assembly, (c) installation, (d) technical training and certifications. The analysis shall include a review of subsystem interrelationships to determine the following:	Select Status		
A2.2.4.2.1. Possible effects of hazards to include; over-pressurization hazards, ordnance/explosives hazards, propellant (fire/explosion) hazards, mechanical (kinetic (impact) energy) hazards, electrical energy hazards, thermal energy (cryogens) hazards, ionizing and non-ionizing radiation hazards, and hazardous material (toxic) release hazards. The payload/spacecraft should be designed, 1) to eliminate the hazard or, 2) to mitigate the hazards to an acceptable level.	Select Status		
A2.2.4.2.2. Compliance with specified safety design criteria.	Select Status		
A2.2.4.2.3. Possible independent, dependent, and simultaneous hazardous events including system failures; failures of safety devices; common cause failures and events; and system interactions that could create a hazard or result in an increase in mishap risk.	Select Status		
A2.2.4.2.4. Degradation in the safety of a subsystem or the total system from normal operation of another subsystem.	Select Status		
A2.2.4.2.5. Design changes that affect subsystems.	Select Status		

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A2.2.4.2.6. Effects of reasonable human errors.	Select Status		
A2.2.4.2.7. Potential contribution of hardware and software, including that which is developed by other payload projects and other sources or commercial off-the-shelf hardware or software, events, faults, and occurrences such as improper timing on the safety of the system.	Select Status		
A2.2.4.2.8. That the safety design criteria in the hardware, software, and facilities specifications have been satisfied.	Select Status		
A2.2.4.2.9. That the method of implementation of the hardware, software, and facilities design requirements and corrective actions has not impaired or degraded the safety of the system nor has introduced any new hazards.	Select Status		
A2.2.4.2.10. SHA Analysis Techniques. If no specific analysis techniques are directed or if the payload project recommends that a different technique than that specified by the PSWG and Range Safety should be used, the payload project shall obtain approval of techniques to be used before performing the analysis. The SHA may be combined with and/or performed using similar techniques to those used for the SSHA.	Select Status		
A2.2.4.2.2. SHA Software:	**I**		
A2.2.4.2.2.1. Software used to control safety critical computer system functions shall be developed in accordance with Volume 3, Chapter 16 of this publication.	Select Status		
A2.2.4.2.2.2. Payload projects shall identify all safety critical computer system functions in accordance with Volume 3, Chapter 16 and develop a SHA for each.	Select Status		
A2.2.4.2.2.3. Software shall be put under formal configuration control of a Software Configuration Control Board (SCCB) in accordance with Volume 3, Chapter 16 as soon as a baseline is established. This will ensure that hardware/software changes do not conflict with or introduce potential safety hazards due to hardware/software incompatibilities.	Select Status		
A2.2.4.2.2.4. Problems identified that require the reaction of the software developer shall be reported to Range Safety in time to support the ongoing phase of the software development process.	Select Status		
A2.2.4.2.2.5. Updating the SHA. The payload project shall update the SHA as a result of any system design changes, including software design changes that affect system safety.	Select Status		
A2.2.4.2.2.6. SHA Submittal. A draft SHA shall be submitted with or in Safety Data Package II (updated MSPSP) no later than 30 days prior to project's mission CDR and the finalized SHA shall be submitted with or included in the Safety Data Package III (final MSPSP) (See Volume 3, Attachment A1).	Select Status		

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A2.2.4.3. Operating and Support Hazard Analyses. The payload project shall perform and document an operating and support hazard analysis (O&SHA) to examine procedurally controlled activities. The purpose of the O&SHA is to evaluate activities for hazards or 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. The O&SHA identifies and evaluates hazards resulting from the implementation of operations or tasks performed by persons, considering the following criteria: the planned system configuration and/or state at each phase of activity; the facility interfaces; the planned environments or the ranges thereof; the supporting tools or other equipment, including software controlled automatic test equipment, specified for use; operational and/or task sequence, concurrent task effects and limitations; biotechnological factors, regulatory or contractually specified personnel safety and health requirements; and the potential for unplanned events including hazards introduced by human errors. The human shall be considered an element of the total system, receiving both inputs and initiating outputs during the conduct of this analysis. The O&SHA shall identify the safety and occupational health requirements, or alternatives needed to eliminate, or control identified hazards or to reduce the associated risk to a level that is acceptable under either regulatory or local specified criteria. The O&SHA may indicate the need for revised tailoring of some requirements of this publication depending on the level of risk identified or the discovery of any previously unidentified hazards. Hazards identified shall be documented on the NF 1825 NASA Payload Safety Hazard Report found on the NASA Electronic Forms Library webpage at: https://nef.nasa.gov/.An equivalent form may be used that contains all the information required on NF 1825. Hazard report closure verifications consist of the following: design, 2) analysis to determine satisfactory margins of safety, 3) material selection and certification, 4) contamination control, 5) assembly processes, 6) NDE inspection, 7) qualification testing, 8) certified procedures, 9) visual inspections during: (a) manufacture, (b) assembly, (c) installation, (d) technical training and certifications. The O&SHA shall assess hazards, to include the following:	**Select Status**		
A2.2.4.3.1. Over-pressurization hazards, ordnance/explosives hazards, propellant (fire/explosion) hazards, mechanical (kinetic (impact) energy) hazards, electrical energy hazards, thermal energy (cryogens) hazards, ionizing and non-ionizing radiation hazards, and hazardous material (toxic) release hazards. Ground operation hazards assessed include, propellant loading and handling, transportation and critical lifts, vehicle/payload testing and vehicle/payload or system activation processing operations. The payload/spacecraft should be designed, 1) to eliminate the hazard or 2) to mitigate the hazards to an acceptable level.	**Select Status**		
A2.2.4.3.2. Activities that occur under hazardous conditions, their time periods, and the actions required to minimize risk during these activities and time periods.	**Select Status**		
A2.2.4.3.3. Changes needed in functional or design requirements for system hardware and software, facilities, tooling, or support and test equipment to eliminate or control hazards or reduce associated risks.	**Select Status**		
A2.2.4.3.4. Requirements for safety devices and equipment, including personnel safety and life support equipment.	**Select Status**		
A2.2.4.3.5. Warnings, cautions, and special emergency procedures such as egress, rescue, escape, render safe, explosive ordnance disposal, and back out, including those necessitated by failure of a computer software-controlled operation to produce the expected and required safe result or indication.	**Select Status**		
A2.2.4.3.6. Requirements for packaging, handling, storage, transportation, maintenance, and disposal of hazardous materials.	**Select Status**		

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A2.2.4.3.7. Requirements for safety training and personnel certification.	**Select Status**		
A2.2.4.3.8. Effects of non-developmental hardware and software across the interface with other system components or subsystems.	**Select Status**		
A2.2.4.3.9. Potentially hazardous system states under operator control.	**Select Status**		
A2.2.4.3.10. Assessment of Procedures. The O&SHA shall document system safety assessment of procedures involved in system production, deployment, installation, assembly, test, operation, maintenance, servicing, transportation, storage, modification, demilitarization, and disposal.	**Select Status**		
A2.2.4.3.11. O&SHA Analysis Techniques. If no specific analysis techniques are directed or if the payload project recommends that a different technique other than that specified by the PSWG and Range Safety should be used, the Range User shall obtain approval of techniques to be used before performing the analysis.	**Select Status**		
A2.2.4.3.12. Updating the O&SHA. The payload project shall update the O&SHA as a result of any system design or operational changes.	**Select Status**		
A2.2.4.3.13. O&SHA Submittal. A draft O&SHA shall be submitted as part of Safety Data Package III at least 90 days prior to the payload shipment to the processing site and finalized as part of Safety Review III (See Attachment A2.1 of Volume 6).	**Select Status**		
A2.2.5. Task 5: Perform and Document an Overall Payload Project Safety Assessment. The payload project shall perform and document an overall Safety Assessment. The purpose of this task is to perform and document a comprehensive evaluation of the mishap risk being assumed before payload processing or testing with considering all potential hazards. The Safety Assessment shall be developed using data from the hazard analyses required in Task 4 (A2.2.4) and data packages required by this publication and NPR 8715.7, and shall summarize the following information:	**Select Status**		
A2.2.5.1. The safety criteria and methodology used to classify and rank hazards, plus any assumptions on which the criteria or methodologies were based or derived including the definition of acceptable risk as specified by the PSWG and Range Safety.	**Select Status**		
A2.2.5.2. The results of analyses performed to identify hazards inherent in the system, including those hazards that still have a residual risk and the actions that have been taken to reduce the associated risk to a level specified as acceptable by the PSWG and Range Safety. See Table 3.2 of this volume.	**Select Status**		
A2.2.5.3. The results of the safety program efforts, including a list of all significant hazards along with specific safety recommendations or precautions required to ensure safety of personnel, property, or the environment. The list shall be categorized as to whether or not the risks may be expected under normal or abnormal operating conditions.	**Select Status**		
A2.2.5.4. Conclusion with the payload project safety manager and the payload Project Manager signed statement that all identified hazards have been eliminated or their associated risks controlled to levels acceptable to the PSWG and Range Safety and that the payload and its systems are ready to test and ready for payload processing.	**Select Status**		

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A2.2.5.5. Recommendations applicable to hazards at the interface of payload project systems with other systems, as required.	Select Status		
A2.2.5.6. A formal request for approval to conduct operations at the payload processing facility and the range.	Select Status		

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ATTACHMENT 3 SUBMITTING NONCOMPLIANCE REQUESTS	I		
A3.1. INTRODUCTION	I		
A3.1.1. Purpose. Equivalent levels of safety (ELS) and waivers are used when payload projects cannot meet the requirements of this publication.	I		
A3.1.2. Content. This attachment describes the noncompliance categories and the process for submitting ELSs and waivers.	I		
A3.1.3. Applicability:	I		
A3.1.3.1. The noncompliance process is applicable to all projects and is provided as the waiver process in NPR 8715.7 for NASA waivers and for AF Range Safety noncompliances follow USSF SSCMAN 91-710. The PSWG will provide guidance on these noncompliance and waiver processes.	I		
A3.1.3.3. The flight plan approval process does not fall within the intent of this attachment except when it involves launch vehicle and/or payload hardware.	I		
A3.1.4. Grandfathering Criteria. Previously approved systems with or without granted ELSs and waivers are required to be resubmitted for review and approval by the project specific PSWG and Range Safety.	Select Status		
A3.1.5. Noncompliance Categories. Noncompliances shall be processed and approved by NASA in accordance with NPR 8715.7 and this publication. In addition, noncompliances impacting Space Force Range Safety responsibilities shall be submitted to the PSWG to be processed and approved by the Space Force in accordance with the following:	Select Status		
A3.1.5.1. Public Safety. Public safety noncompliance deals with safety requirements involving risks to the public, including foreign countries, their personnel, and/or their resources.	Select Status		
A3.1.5.2. Launch Area Safety. Launch area safety noncompliances deal with safety requirements involving risks that are limited to personnel and/or resources on USSF ranges, including CCSFS and VSFB and may be extended to KSC. Launch area safety involves multiple licensed users, government tenants, or USAF squadrons.	Select Status		
A3.1.5.3. Launch Complex Safety. Launch complex safety noncompliances deal with safety requirements involving risk that is limited to the personnel and/or resources under the control of a single licensed user, full time government tenant organization, or USAF squadron/detachment (control authority). Launch complex safety is limited to risks confined to a physical space for which the single control authority is responsible.	Select Status		
A3.1.6. Effectivity of Noncompliances: Duration of the noncompliance (if approved) shall be stated on the noncompliance request.	Select Status		
A3.1.7. Conditions for Issuance of ELSs and Waivers:	I		

VOLUME 1: POLICIES AND PROCEDURE REQUIREMENTS	**STATUS**	**TAILORED TEXT**	**RATIONALE/ COMMENTS**
A3.1.7.1. Hazard Mitigation. All reasonable steps shall be taken to meet the intent of the publication requirements and mitigate associated hazards to acceptable levels, including design and operational methods.	**Select Status**		
A3.1.8. Risk-Cost Benefit Analysis: When required, a risk-cost benefit analysis, based on the criteria defined in SSCMAN 91-710, Volume 1, Chapter 3, Table 3.1 and Chapter 3, Table 3.2 of this volume, may be submitted to Range Safety.	**I**		
A3.2. SUBMITTING NONCOMPLIANCE REQUESTS	**I**		
A3.2.1. Format. ELSs proposed during project specific NASA Payload Safety Requirements tailoring do not require the submittal of NF 1826 NASA Payload Safety Post-Tailoring Request (See Attachment A1.1 of this Volume). Payload projects shall submit noncompliances to the PSWG in writing using the approved NASA noncompliance forms, NF 1826 NASA Payload Safety Post-Tailoring Request, and NF 1827 NASA Payload Safety Waiver Request. Additionally, the payload project shall submit the appropriate Space Force noncompliance relief request for all noncompliances to USSF SSCMAN 91-710 impacting Space Force Ranges. These forms are found on the Payload Safety Program website at https://sma.nasa.gov/sma-disciplines/elv-payload-safety under the "Payload Safety Forms" button.	**Select Status**		
A3.2.3. Process: The PSWG in conjunction with Range Safety can provide guidance in the noncompliance submittal process. NASA noncompliance process is found in NPR 8715.7 and this publication. The Space Force noncompliance process is as follows:	**Select Status**		
A3.2.3.1. Requests for ELS s and waivers shall be submitted through the PSWG to the appropriate local safety authority. ELSs or waivers impacting USSF Range Safety shall be submitted through the PSWG to the office of the appropriate Space Wing SLD30 or SLD45 Chief of Safety as early as they are known to be necessary.	**Select Status**		
A3.2.3.2. Public safety ELSs and waivers such as those including flight plan approval, FTS design, and toxic propellant storage normally require extensive risk analyses that can take one to two years to perform; therefore, these ELSs and waivers shall be initiated during the planning phase and be closed out by Range Safety (ELSs) or the SLD30 or SLD45 Commander (waivers) approval or design change before manufacture of the booster, spacecraft, FTS, or other system in question.	**Select Status**		
A3.2.3.3. Launch area safety and launch complex safety ELSs and waivers normally require two weeks to two months to process depending on the nature of the noncompliance and the requested effectivity.	**I**		
A3.2.3.4. SLD30 and SLD45 shall coordinate all noncompliance requests with affected agencies, as appropriate. A coordinated review and resolution of requests for relief from common USSF-FAA launch safety requirements shall be per procedures developed between the USSF and the FAA. SLD30 and SLD45 shall also coordinate all noncompliance requests with the affected Range User.	**I**		
A3.2.4. Approvals: The PSWG in conjunction with Range Safety can provide guidance on the noncompliance approval process. NASA noncompliances shall be approved in accordance with NPR 8715.7. The Space Force s approvals are as follows:	**Select Status**		
A3.2.4.1. Programs launching from only the ER or WR require only the appropriate SLD30/SE or SLD45/SE approvals.	**Select Status**		

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A3.2.4.2. Programs launching from both ranges require approvals from SLD30/SE or SLD45/SE.	Select Status		
A3.2.4.3. Waivers dealing with public safety shall be approved by the SLD Commanders.	Select Status		
A3.2.4.4. Waivers other than public safety shall be approved by the Chiefs of Safety or their designated representatives.	Select Status		
A3.2.4.5. ELSs shall be approved by appropriate SLD30/SE or SLD45/SE Chiefs of Safety or their designated representatives.	Select Status		

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ATTACHMENT 4 ACCEPTABLE RISK CRITERIA	I		
A4.1. INTRODUCTION	I		
Per NPR 7120.5, NASA Space Flight Program and Project Management Processes and Requirements, the payload project will implement the NASA continuous risk management process and develop a stand-alone Risk Management Plan that includes the content required by NPR 8000.4, Risk Management Procedural Requirements. The payload project shall follow KSC's Safety and Mission Assurance Launch Services Division Risk Management System for risks impacting NASA KSC or KSC contracted facilities and shall apply USSF SSCMAN 91-710 for risks impacting Space Force Ranges. ***Note: See Volume 1 Chapter 3 of this document and NASA Payload Safety Hazard Report NF 1825 for additional guidance.***	Select Status		

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ATTACHMENT 5 PAYLOAD SAFETY INTRODUCTION BRIEFING	**I**		
A5.1. INTRODUCTION	**I**		
A5.1.1. Purpose. To identify the information to be presented at the Payload Safety Introduction Briefing (PSIB).	**I**		
A5.1.2. Content. This attachment lists and describes the information to be presented at the PSIB.	**I**		
A5.2. PAYLOAD SAFETY INTRODUCTION BRIEFING (PSIB)	**I**		
A5.2.1. The Payload Safety Introduction Briefing (PSIB) is normally the first formal meeting of the PSWG. PSIB presenters typically include the payload project, PSWG Chairperson, Range Safety, Launch Site Integration Manager (or equivalent), and other members of the PSWG as needed. The payload project is expected to provide the following information to a level of detail that is based on information availability and is consistent with the complexity of the mission, the maturity of the conceptual design, and the launch vehicle and launch site location.	**Select Status**		
A5.2.1.1. Overview of the System Safety Plan as defined by the project's DRAFT System Safety Plan (see Volume 3, paragraph 4.1.1.).	**Select Status**		
A5.2.1.2. Identification of organizational roles and responsibilities.	**Select Status**		
A5.2.1.3. Description of payload, instruments, and anticipated ground support equipment.	**Select Status**		
A5.2.1.4. Description of the flight path in terms of azimuth and trajectory. Identification and description of planned return-to-earth payload recovery or sample return activities and support if applicable.	**Select Status**		
A5.2.1.5. Identification of potential mission-unique ground support equipment required for pad operations.	**Select Status**		
A5.2.1.6. Identification and a preliminary assessment of potential hazards associated with payload and payload to launch vehicle integration, multiple payloads from the same or other projects, and ground systems documented in a preliminary hazard list.	**Select Status**		
A5.2.1.7. Overview of the project's requirements tailoring process and planned activities for tailoring NASA-STD-8719.24 Annex, identifying any known critical concerns to be addressed during the tailoring process.	**Select Status**		
A5.2.1.8. Identification of non-applicable chapters and sections using the NASA-STD-8719.24 Annex Table of Contents, Volume 3 and Volume 6, as they relate to payload systems, instruments, operations and hazards known to date. ***Note: A NASA-STD-8719.24 Annex Table of Contents Form is provided on Payload Safety Program website at https://sma.nasa.gov/sma-disciplines/elv-payload-safety under the "Forms" button.***	**Select Status**		
A5.2.1.9. A list of any known tailoring issues, previously approved noncompliances (i.e., waivers, ELS), and previously approved alternative approaches.	**Select Status**		

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A5.2.1.10. Any potential hazardous failure modes, failure probability, and performance characteristics of the payload during ground operations.	Select Status		
A5.2.1.11. Identification of planned studies and analyses that support safety requirements, including scheduled completion.	Select Status		
A5.2.1.12. Description of processing flow and anticipated schedule, integrated with major project milestones.	Select Status		
A5.2.1.13. Identification of facility requirements, including launch complex, hazardous assembly and checkout areas, and ordnance and propellant storage requirements.	Select Status		
A5.2.1.14. Identification and discussion of potential contingency operations, for example, depressurization, propellant offload, and accessibility after fairing installation.	Select Status		
A5.2.1.15. Recommendations for future safety Technical Interchange Meetings, reviews, working groups, subject matter expert support, resolution of unmet requirements, Design Reviews, and other topics as deemed necessary.	Select Status		
A5.2.2. The PSWG Chairperson, in conjunction with Range Safety, presents an overview of the payload safety review process including PSWG membership activities, safety review milestones, and deliverables. Additionally, the payload project is reminded to follow NPR 8621.1 NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping for mishaps, close calls and contingencies. ***Note: Mishap and close call reporting, investigating, and record keeping as well as contingency preparedness and planning fall under the NASA Program Manager for Mishap Investigations and the various programs and projects in accordance with NPR 8621.1 and are not under the purview of the NASA Payload Safety Program.***	Select Status		
A5.2.3. The Launch Site Integration Manager (or equivalent), as the payload project's liaison at the launch site, typically provides an overview covering their coordination efforts and support for the payload at the processing facility.	Select Status		

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CHAPTER 1 INTRODUCTION	I		
1.1. General	I		
1.1.1. All NASA Payload projects are subject to the requirements of this volume to ensure safety by design, testing, inspection, and hazard analysis.	I		
1.2. Organization of the Volume	I		
1.2.1. Main Chapters. The main chapters of this volume include common requirements for all payloads. Appendices include additional requirements to supplement the main chapters.	I		
1.2.2. Open Text. The open text contains the actual mandatory performance-based requirements. The only tailoring expected for these requirements would be the deletion of non-applicable requirements. For example, solid rocket motor performance requirements would be deleted for payloads that do not use solid rocket motors.	I		
1.2.3. Bordered Paragraphs:	I		
1.2.3.1. Bordered paragraphs are non-mandatory and are used to identify some of the potential detailed technical solutions that meet the performance requirements. In addition, the bordered paragraphs contain lessons learned from previous applications of the performance requirement, where a certain design may have been found successful, or have been tried and failed to meet the requirement. These technical solutions are provided for the following reasons:	I		
1.2.3.1.1. To aid the tailoring process between the PSWG and payload projects in evaluating a potential system against all the performance requirements.	I		
1.2.3.1.2. To aid the PSWG and payload projects in implementing lessons learned.	I		
1.2.3.1.3. To provide benchmarks that demonstrate what the PSWG in conjunction with Range Safety considers an acceptable technical solution/ implementation of the performance requirement and to help convey the level of safety the performance requirement is intended to achieve.	I		
1.2.3.2. The technical solutions in the bordered paragraphs may be adopted into the tailored version of the requirements for a specific program when the payload project intends to use that solution to meet the performance requirement. At this point, they become mandatory requirements to obtain PSWG and Range Safety approval. This process is done to:	I		
1.2.3.2.1. Provide an appropriate level of detail necessary for contractual efforts and to promote efficiency in the design process.	I		
1.2.3.2.2. Avoid contractual misunderstandings that experience has shown often occur if an appropriate level of detail is not agreed to. The level of detail in the bordered paragraphs is necessary to avoid costly out-of-scope contractual changes and to prevent inadvertently overlooking a critical technical requirement.	I		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
1.2.3.3. The payload project always has the option to propose alternatives to the bordered paragraph solutions. Payload project proposed solutions shall be evaluated against requirements in this manual. Payload project proposed alternative solutions shall achieve an Equivalent Level of Safety and be approved by the PSWG and Range Safety. After meeting these two requirements, the Range User proposed solutions become part of the tailored requirements for that specific program.	I		
1.2.3.4. The PSWG and Range Safety shall determine whether payload project proposed detailed technical solutions meet the intent of the requirements contained in this publication.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES	I		
2.1. Payload Safety Working Group (PSWG)	I		
2.1.1. A unique PSWG is established for each NASA payload project. The PSWG consists of safety engineers and personnel from the NASA payload project (NASA and contractor), launch services provider contractor organization (NASA Kennedy Space Center Launch Services SMA for projects using NASA Launch Services Program), launch site range safety, the launch services provider contractor organization, the payload processing facility safety representative, the payload or sample recovery organization (as needed), subject matter experts and others as needed, and with participation from the Launch Site Integration Manager (LSIM) as required. The PSWG proactively works with the project to identify potential hazards and safety issues and advises on strategies for early abatement, mitigation, or resolution. The PSWG is responsible for the review and approval of the safety deliverables required by this document. Specific responsibilities of the PSWG include review and approval of documents such as project specific tailored NASA Payload Safety Requirements document, the Safety Data Packages (SDPs)/Missile System Prelaunch Safety Packages (MSPSPs), System Safety Plans (SSPs), test plans, test reports, and other documents as specified in this standard. PSWG activities typically conclude with the signing of the Certificate of Payload Safety Compliance. If there are any open action items, the payload project will provide the appropriate local safety authorities and mission officials with updates and complete the Safety Verification Tracking Log (SVTL). Test and operational procedures are approved by the local safety authority responsible for ensuring safety in the area where the test or operation is to take place.	Select Status		
2.1.2. During the review and approval process, the PSWG in coordination with Range Safety and the payload project shall ensure timely coordination with other authorities as appropriate. Other authorities include, but are not limited to, Radiation Protection Officer (RPO)/Radiation Safety Officer (RSO), Occupational Health, Bioenvironmental Engineering, Civil Engineering, Environmental Planning, Explosive Ordnance Disposal, and the Fire Department.	Select Status		
2.2. Payload Project Responsibilities	I		
Payload projects are responsible for establishing and maintaining a system safety plan in accordance with Volume 1, Attachment A1.2 of this publication, and the design, inspection, and testing of all hazardous and safety critical payloads and payload-related ground support equipment, systems, subsystems, and materials to be used at the payload processing facility and launch site area in accordance with the requirements of this volume and NPR 8715.7. These responsibilities include the following:	Select Status		
2.2.1. Timely submission of an SSP.	Select Status		
2.2.2. Timely submission of hazard analyses.	Select Status		
2.2.3. Timely submission of all required SDPs/MSPSPs including Hazard Reports.	Select Status		
2.2.4. Timely submission of all SDPs associated Test Plans and Test Reports.	Select Status		
2.2.5. Coordinating with and supporting local safety authorities in carrying out tasks necessary for approval of design, inspection, and testing.	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
2.2.6. Timely submission of safety data deliverables per NPR 8715.7 and this document.	**Select Status**		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 3 GENERAL DESIGN POLICY	I		
3.1. General	I		
3.1.1. All systems shall be designed to tolerate a minimum number of credible failures, based on the degree of fault tolerance required.	Select Status		
3.1.2. The number of designed inhibits required to prevent an overall system failure or mishap is based on the failure or mishap result. Specific inhibit requirements are addressed in the design criteria for each of the systems addressed in this volume.	Select Status		
It is the payload project's responsibility (with support as needed from the launch services provider) to provide relevant analysis or data to the PSWG to characterize system failure or mishap results when determining the proper number of inhibits.	I		
3.2. Systems Without Specific Design Criteria	I		
Those systems that do not have specific design criteria or systems not addressed in this volume shall be designed to the following general criteria:	Select Status		
3.2.1. If a system failure may lead to a catastrophic hazard, the system shall have no less than three inhibits (dual failure tolerant).	Select Status		
3.2.2. If a system failure may lead to a critical hazard, the system shall have no less than two inhibits (single failure tolerant).	Select Status		
3.2.3. If a system failure may lead to a marginal hazard, the system shall have a single inhibit (no failure tolerant).	Select Status		
3.2.5. Systems shall be able to be brought to a safe state with the loss of an inhibit.	Select Status		
3.2.6. Independent and Verifiable Inhibits.	Select Status		
3.2.6.1. Each design inhibit shall be independent of any other inhibit (i.e., loss or removal of one inhibit shall not result in the loss or removal of any other inhibit). Additionally, control of inhibits shall also be independent.	Select Status		
3.2.6.2. Each design inhibit shall be verifiable after installation or through a process of pre-installation testing and implementation of written procedures that ensure the integrity of the inhibit during and after installation.	Select Status		
3.2.6.3 Two or more design inhibits that protect against a specific failure shall have design and/or implementation differences between them to protect against a common cause failure of the inhibits. Inhibits are not considered independent if a single failure can negate more than one inhibit.	Select Status		
3.2.7. Design inhibits shall consist of electrical and/or mechanical hardware.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
3.2.8. Operator controls shall not be considered a design inhibit. Operator controls are considered a control of an inhibit. This includes software controls.	**Select Status**		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 4 DOCUMENTATION REQUIREMENTS	I		
4.1. System Safety Plan and Hazard Analyses	I		
4.1.1. Documentation requirements and submittal timeframes are provided in NPR 8715.7 and this publication. A preliminary System Safety Plan (SSP) shall be developed in accordance with Volume 1, Attachment A1.2 of this publication and shall be provided at the Payload Safety Introduction Briefing (PSIB). Additionally, a preliminary hazard list, a preliminary list of known tailoring issues, a Ground Operations Flow Overview, and a list of non-applicable chapters and sections from the Table of Contents, Volume 3 and 6 sections (see Volume 1, Attachment A1.5) shall be provided at the PSIB.	Select Status		
4.1.2. The final SSP shall be developed in accordance with Volume 1, Attachment A1.2 of this publication and submitted to the PSWG no later than 30 days prior to the project's mission PDR timeframe. ***Note: When necessary, changes to the final SSP may be made in coordination with the PSWG and Range Safety.***	Select Status		
4.1.3. Preliminary Hazard analyses with Hazard Reports developed to date shall be developed and submitted to the PSWG no later than 30 days prior to the project's mission PDR timeframe for review and approval in accordance with Volume 1, Attachment A1.2 of this publication.	Select Status		
4.1.3.2. Final plan for resolution of all hazards identified in the hazard analyses shall be submitted to the PSWG no later than 90 days prior to payload shipment to the processing site for review and approval. All open hazard control verifications still requiring verifications shall be listed on a Safety Verification Tracking Log or equivalent (see Payload Safety Program website at https://sma.nasa.gov/sma-disciplines/elv-payload-safety under "Payload Safety Forms") until closed. After Safety Review III, Safety Verification Tracking Logs (SVTLs) shall be updated at least weekly and provided with the related Hazard Reports to the impacted local safety authorities.	Select Status		
4.1.3.3. SSPs and hazard analyses shall comply with this publication and the intent of MIL-STD-882, Department of Defense Standard Practice for System Safety, data requirements or commercial equivalent for commercial FAA-licensed programs. Hazard Reports shall be prepared on NF 1825 NASA Payload Safety Hazard Report Form found on the Payload Safety Program's website at https://sma.nasa.gov/sma-disciplines/elv-payload-safety under "Payload Safety Forms" or an equivalent form that contains all information required on NF 1825.	Select Status		
4.2. Safety Data Package (SDP)/MISSILE SYSTEM PRELAUNCH SAFETY PACKAGE (MSPSP)	I		
4.2.1. SDP Submittal, Review, and Approval Process:	Select Status		
4.2.1.1. Payload projects shall submit an SDP for each project to the PSWG in accordance with NPR 8715.7 and this publication.	Select Status		
The NASA SDP is equivalent to the USSF SSCMAN 91-710 Missile System Prelaunch Safety Package (MSPSP).	I		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
4.2.2. SDP Preparation. An SDP shall be developed in three phases, SDP I, SDP II, and SDP III corresponding to Safety Review I, II, and III. The level of technical detail for each phase shall be commensurate with the level of project detail available. SDPs shall be developed in accordance with Attachment A1 of this volume.	Select Status		
4.3. SDP Associated Test Plans and Test Results	I		
4.3.1. Test plans shall be identified and summarized in the SDP. Plans for any tests requested for review by the PSWG and Range Safety shall be submitted to the PSWG before the intended use and allowing adequate time for review and approval.	Select Status		
4.3.2. Test plans submitted for approval to the PSWG and Range Safety are required to be approved before test performance. Test plans, test reports and test operating procedures for hazardous operations must be approved by the local safety authority responsible for the area where the tests are to take place. Disapproved test plans shall be resubmitted.	Select Status		
4.3.3. Test reports shall be submitted at least 45 calendar days before intended system use.	Select Status		
4.3.4. PSWG, Range Safety, and appropriate local safety authorities shall review, comment, and approve test reports within 10 calendar days of receipt. Disapproved test reports shall be resubmitted. An approved test report is required before system use.	Select Status		
4.4. Nondestructive Examination Plans	I		
4.4.1. Nondestructive examination (NDE) inspections for fracture control shall be performed in accordance with NASA-STD-5009 Nondestructive Evaluation Requirements for Fracture Critical Metallic Components and meet the intent of MIL-HDBK-6870 Inspection Program Requirements Nondestructive for Aircraft and Missile materials and Parts. Unless otherwise specified in a separate part of this document that addresses a particular class of system or equipment, an NDE plan shall include the following:	Select Status		
4.4.1.1. NDE technique and acceptance criteria to be used on each single failure point (SFP) component or SFP weld after initial proof and periodic load tests. NDE shall be performed in accordance with procedures and by qualified and certified preapproved personnel in accordance with written practices meeting the requirements contained in American Society for Nondestructive Testing (ASNT) SNT-TC-1A Recommended Practices for Personnel Qualifications and Certification in Nondestructive Testing.	Select Status		
4.4.1.2. Detailed engineering rationale for each technique and acceptance criteria.	Select Status		
Detailed engineering rationale may include manufacturer stated requirements/recommendations or recognized industry standards such as ANSI and ASME.	I		
4.4.1.3. A determination of whether the equipment is dedicated to only one function or whether it is multipurpose.	Select Status		
4.4.1.4. The environment and/or conditions under which the equipment will be used and stored.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
4.4.1.5. The existence of any SFP component and weld materials susceptible to stress corrosion.	**Select Status**		
4.4.1.6. Corrosion protection and maintenance plans.	**Select Status**		
4.4.2. Unless otherwise specified in a separate part of this document that addresses a particular class of system or equipment, the NDE plan shall be submitted to the PSWG and Range Safety for review and approval as soon as developed and no later than 30 days prior to the project Safety Review I meeting at project's mission PDR, unless otherwise agreed to by the PSWG.	**Select Status**		

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CHAPTER 5 PAD SAFETY CONSOLE DESIGN	**I**		
Pad safety console design requirements are specified in SSCMAN 91-710, Volume 3, Chapter 5, Pad Safety Console.	**I**		

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CHAPTER 6 CHAPTER 6 MATERIAL HANDLING EQUIPMENT, CRANES, HOIST AND PERSONNEL WORK PLATFORMS.	I		
6.1. Overview	I		
6.1.1. This chapter is divided into three major types of equipment: Material Handling Equipment (MHE), cranes and hoists, and Personnel Work Platforms. If the payload project is providing a crane or hoist for payload processing use, then SSCMAN 91-710, Section 6.2 shall be tailored into this document, as applicable.	Select Status		
6.1.2. MHE is comprised of below-the-hook lifting devices (BTHLD), handling structures, support structures, slings, load positioning (e.g., Hydra Set ®) and load indicating devices (LID), lifting assemblies, and rigging hardware. Slings, BTHLDs, lifting assemblies, rigging hardware, and LIDs are governed by industry standards (e.g., Occupational Safety and Health Administration [OSHA], ASME). Handling structures, support structures, and LPDs are governed by accepted engineering practices and requirements of this Chapter. Data requirements are provided in Attachment 2 of this volume. These requirements are applicable to new or modified MHE. The requirements are also applicable to permanent or short-term use MHE and apply whether the equipment is owned, rented, or leased by the government, contractors, or commercial operators. Periodic/recurring test and inspection requirements are found in Volume 6, 6.1.8.	Select Status		
6.1.3. Periodic load test intervals may be extended by no more than 90 days from the original lifting device expiration date due to programmatic or institutional needs, subject to the center LDEM, PSWG and Range approval. To extend the periodic load test interval, the following conditions shall be met: a. The payload project provides documented rationale to the LDEM, PSWG and Range Safety, and b. The LDEM, PSWG and Range Safety determines there is no increase in risk.	Select Status		
6.2. Material Handling Equipment (MHE)	I		
The design and initial test requirements for MHE used at the payload processing facility and launch site area for handling (lifting, supporting, or manipulating) critical and non-critical hardware are included below.	Select Status		
6.2.1. MHE General Requirements:	Select Status		
6.2.1.1. MHE Requirements Validation:	Select Status		
6.2.1.1.1. The Range User shall validate the requirements by providing a Compliance Check List in accordance with Attachment 1, A1.3.	Select Status		
6.2.1.1.2. The payload project certifies the design is in accordance with the requirements, provides documentation verifying compliance through Safety Data Package submittal or reference documents, and maintains all MHE under a documented configuration management system. Operation, testing, inspection, and maintenance of slings shall be in accordance with manufacturer recommendations, this standard, NASA-STD-8719.9, and OSHA.	Select Status		

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6.2.1.1.3. Supporting data for leased and/or commercial-off-the-shelf (COTS) equipment shall include the following information:	Select Status		
6.2.1.1.3.1. COTS name, description, model number, and part number.	Select Status		
6.2.1.1.3.2. Rated capacity (allowable working load).	Select Status		
6.2.1.1.3.3. Certifications of compliance with industry consensus standards from a Nationally Recognized Testing Laboratory (NRTL), manufacturer, or other qualified organization.	Select Status		
6.2.1.1.3.4. MHE shall have documented traceability of material, manufacturer, and acceptance testing to required codes and standards (e.g., OSHA, ASME).	Select Status		
6.2.1.1.3.5. Applicable operating and maintenance (O&M) information, data, and/or manuals.	Select Status		
6.2.1.2. MHE Single Fault Tolerance:	I		
6.2.1.2.1. Critical MHE shall be designed without single failure points (SFPs).	Select Status		
6.2.1.2.2. Exceptions shall be identified, justified, and submitted to the PSWG for Range Safety and PSWG approval. Supporting data shall include the following information: (See also Attachment 1, A1.2.5.6 of this volume.)	Select Status		
6.2.1.2.2.1. A list of all identified SFPs.	Select Status		
6.2.1.2.2.2. Risk assessment.	Select Status		
6.2.1.2.2.3. Risk mitigation considerations and inhibits.	Select Status		
6.2.1.2.2.4. A map of SFP locations (for example, weld map, system components).	Select Status		
6.2.1.2.2.5. Inspection and NDE requirements.	Select Status		
6.2.1.2.3. SFP components and welds shall be accessible for nondestructive inspection, maintenance, and repair.	Select Status		
6.2.1.3. MHE Inspection and Test Requirements:	I		
6.2.1.3.1. MHE Test Weights and Load Test Devices:	I		
6.2.1.3.1.1. Load tests shall be conducted with certified weights and/or certified weight fixtures.	Select Status		

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6.2.1.3.1.2. These weights shall be identified and permanently and clearly marked with the total weight and owner or agency identification number.	Select Status		
An example of marking requirements for test weights can be found in KSC-DE-512-SM, Ground Systems Development Standard	I		
6.2.1.3.1.3. Reinforcing steel (rebar) shall not be used for lift points.	Select Status		
6.2.1.3.1.4. Calibrated load devices such as dynamometers may be used to test slings and other lifting devices except cranes and hoists.	Select Status		
6.2.1.3.1.5. Requirements for Fabrication of New Test Weights and Weight Fixtures.	I		
6.2.1.3.1.5.1. Weight fixtures shall be designed, and load tested in accordance with requirements contained in 6.2.3.1.	Select Status		
6.2.1.3.1.5.2. Weight fixtures shall be designed so that the loaded fixture center of gravity is centered below the crane hook for all required weight combinations.	Select Status		
6.2.1.3.1.5.3. Lifting lugs shall be provided if required to enable handling of empty test weight fixtures.	Select Status		
Table 6.1. Attachment Point Preferences.	I		
A single crane hook attachment points on the fixture (e.g., a screw operated pin) is preferable to multiple attachment points that require use of slings.	I		
6.2.1.3.1.5.4. Weight interlocking features shall be provided on both the weight fixture and the weights to help prevent sliding of weights and to help even stacking.	Select Status		
6.2.1.3.1.5.5. Weight lifting lugs shall be proof tested to 125% of the total weight before initial weight use.	Select Status		
6.2.1.3.2. MHE Non Destructive Evaluation (NDE):	I		
6.2.1.3.2.1. NDE plans shall be developed for MHE used to handle critical systems and equipment and MHE containing SFPs. Surface inspections and volumetric inspections shall be performed on all MHE per PSWG and Range Safety approved NDE plan after load tests.	Select Status		
6.2.1.3.2.2. The NDE plan shall include detailed methodology, acceptance criteria, frequency of inspection, and a clear schematic showing the exact location of the items to be inspected. For details of the NDE plan, see 4.4 of this volume.	Select Status		
6.2.1.3.2.3. NDE shall be performed by qualified and certified personnel in accordance with written practices meeting the requirements contained in American Society for Nondestructive Testing (ASNT) SNT-TC-1A Recommended Practice for Personnel Qualifications and Certification in Nondestructive Testing.	Select Status		
6.2.1.4. MHE Marking and Tagging Requirements:	I		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

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6.2.1.4.1. Marking Requirements. All equipment (new and modified) shall be permanently marked in accordance with applicable ASME B30 series standards, codes, and standards and have a permanently attached identification tag with the following information:	Select Status		
6.2.1.4.1.1. Manufacturer.	Select Status		
6.2.1.4.1.2. Part number.	Select Status		
6.2.1.4.1.3. Serial number.	Select Status		
6.2.1.4.1.4. Date of manufacture or initial acceptance.	Select Status		
6.2.1.4.1.5. Rated capacity.	Select Status		
6.2.1.4.1.6. Weights of the top assembly and separate subassemblies.	Select Status		
6.2.1.4.1.7. Weight of bridge and trolley (cranes only).	Select Status		
6.2.1.4.2. Tagging Requirements:	I		
6.2.1.4.2.1. Systems/equipment requiring periodic testing shall be tagged and test data included in its data package.	Select Status		
6.2.1.4.2.2. The tags shall be of durable material, preferably corrosion resistant metal, properly secured with corrosion and abrasion resistant wire or string, and marked (stamped or etched) with the following minimum information:	Select Status		
6.2.1.4.2.2.1. Part number, serial number, or other unique identifier (reference designator).	Select Status		
6.2.1.4.2.2.2. Date of most recent certification/test.	Select Status		
6.2.1.4.2.2.3. Test load.	Select Status		
6.2.1.4.2.2.4. Date of next load test or certification as applicable.	Select Status		
6.2.1.4.2.2.5. Date of most recent NDE (if applicable).	Select Status		
6.2.1.4.2.2.6. Date of next NDE (if applicable).	Select Status		
6.2.1.4.2.2.7. A quality assurance or quality control indication certifying the data on the tag.	Select Status		
6.2.1.4.2.3. The tags shall be accessible for inspection.	Select Status		
6.2.1.4.2.4. If a lifting assembly is disassembled for testing or inspection, each component and subassembly shall be individually tagged with the reference designator; for example, removal and separate storage of a shackle bolt from the shackle after the proof load.	Select Status		
Load-bearing components not traceable to a load test will invalidate the load test of the whole assembly.	I		

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Lifting equipment that has the necessary design features, maintenance/inspection, and test intervals to lift critical loads will be marked conspicuously so that the operator and assurance personnel can distinguish that the equipment (unless a permanent part of lifting device) is qualified for critical lifts.	I		
6.2.1.4.2.4.1. The PSWG and Range Safety will accept the tethering of the shackle pin to the associated shackle as a method of validating the proofed assembly. This is a substitute to tagging the pin individually. The methods above apply for shackle/ shackle pin verification as a proofed assembly. Tethering requirements in accordance with paragraph 5.2.6, are always applicable in the prevention of a dropped object hazard.	Select Status		
6.2.1.5. All MHE designs shall include a center-of-gravity analysis to ensure that the MHE/GSE/Flight Hardware does not tip, fall, slide, or allow any sudden load shift.	Select Status		
6.2.2. Slings:	I		
A sling is a flexible lifting assembly used between the load and hoisting device hook, including one or multiple lengths of wire rope, synthetic fiber materials, or steel chains made into forms for handling loads. Slings sometimes incorporating hooks and associated attachment rigging hardware such as shackles, D-rings, turnbuckles, and eyebolts used to lift, lower, and position a load. Common types of slings include wire rope slings, synthetic round slings, metal mesh slings, synthetic web slings, and chain slings. Rigging hardware are components used to lift, lower, and position a load and are typically used in combination with slings and below-the-hook lifting devices (BTHLD). Common types include shackles, links, rings, swivels, turnbuckles, eyebolts, hoist rings, wire rope clips, wedge sockets, and rigging blocks. Although slings and BTHLDs may use rigging hardware as part of their assembly, each of these three, slings, BTHLDs, and rigging hardware, follow this standard, NASA-STD-8719.9, and OSHA (slings only), and is addressed by a different ASME B30 series standard (i.e., ASME B30.9 for Slings, ASME B30.20 for BTHLDs, and ASME B30.26 for Rigging Hardware). A "structural sling" is a rigid or semi-rigid fixture used between the actual object being lifted and the lifting device like lifting beams or spreader bars. "Structural slings" are considered a BTHLD per ASME B30 series standards (ASME B30.20) (See 6.2.3 below).	I		
6.2.2.1. Sling Design Standards and Requirements:	I		
6.2.2.1.1. Slings shall be designed and manufactured in accordance with, NASA-STD-8719.9, American Society of Mechanical Engineers (ASME) B30.9, Slings, and 29 CFR 1910.184, Slings. Sling design shall maintain the minimum design factors listed in Table 6-1.	Select Status		
6.2.2.1.2. Carbon steel or wrought iron chain slings shall not be used.	Select Status		
6.2.2.1.3. Wire rope slings shall be formed with swaged or zinc-poured sockets or spliced eyes.	Select Status		
6.2.2.1.4. Wire rope clips or knots shall not be used to form wire rope slings.	Select Status		
6.2.2.1.5. All synthetic slings shall be designed with an ultimate factor of safety of 5 or higher.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.2.2.1.6. Natural fiber rope or natural fiber web slings shall not be used.	Select Status		
6.2.2.1.7. Rotation resistant rope shall not be used for fabricating slings.	Select Status		
6.2.2.2. Sling Inspection and Test Requirements:	I		
6.2.2.2.1. Before their first operational use at the payload processing facility and launch site area, and following modifications or repairs, slings and rigging hardware shall be inspected and Proof Load tested to 200% of their rated load in accordance V3, Table 6.1. NDE shall be performed in accordance with paragraph 6.2.1.3.2. MHE NDE.	Select Status		
6.2.2.2.2. For slings used to support critical operations, volumetric and surface NDE testing shall be performed on all sling assembly SFP components, such as pins, bolts, shackles, and links after the proof load test IAW the PSWG and Range Safety approved NDE plan in accordance with paragraph 4.4 of this volume.	Select Status		
Note: Slings and rigging hardware designated as non-load test slings or rigging hardware by the lifting device owner's qualified person and approved as such by the PSWG, Range Safety, and the payload Center's LDEM in accordance with NASA-STD-8719.9 are exempt from periodic testing (see 6.1.3). Slings, rigging hardware, and BTHLDs may be designated as non-load test slings/rigging hardware/BTHLDs due to considerations such as usage, inspection and testing history, and potential for test-induced damage, subject to PSWG, Range Safety, and payload Center's LDEM approval. Non-load test slings/rigging hardware/BTHLDs are not subject to periodic load testing requirements.	I		

Table 6-1: Slings, Rigging Hardware, and BTHLDs Design Minimum Requirements

Equipment	Design Load Safety Factor[1]	Proof Load Test Factor[4]	Periodic Load Test Factors[3]
Alloy Steel Chain Slings	5	2.0	1.0
Wire Rope Slings	5	2.0	1.0
Metal Mesh Slings	5	2.0	1.0
Synthetic Web Slings	5	2.0	1.0
Linear Fiber Slings	5	2.0	1.0
Structural Slings and BTHLDs	Lesser of 3 times yield or 5 times ultimate	1.25[2]	1.0
Rigging Hardware (Shackles, D-rings, Turnbuckles, Eye Bolts, Lifting Lugs, Safety Hoist Rings, etc.)[5]	5	2.0	1.0

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Table 6-1: Slings, Rigging Hardware, and BTHLDs Design Minimum Requirements (Continued) 1. Design factor based on ultimate material strength, except for structural slings. 2. Unless otherwise specified by design, due to material characteristics, geometry, design factors, etc., but in any case, at least 125 percent of the slings rated capacity. 3. Based on manufacturer's rated load. Not applicable to non-load test slings, rigging hardware, or BTHLDs. 4. Proof load test shall be performed only by manufacturer, or an equivalent entity approved by the PSWG, Range Safety, and the payload Center's LDEM. If the sling is fabricated of components from different sources (COTS or unique in-house manufactured parts) the manufacturer is the entity that fabricates the entire sling. • Note 1: Equivalent entity is an organization capable of testing in accordance with the manufacturer's procedure, and with sufficient knowledge and experience with design and properties of the lifting device in question to understand when a test might be harmful or otherwise inappropriate for that lifting device, and knowledgeable of required points of inspection. • Note 2: Periodic load test shall be accomplished within 1 year prior to use unless sling, rigging hardware, or BTHLD is designated as a non-load test sling, rigging hardware, or BTHLD. Safety factor is defined as the ratio of a load that predicts a failure to a rated load. A 3:1 safety factor against the worst case failure mode that will result in local yielding is acceptable. 5. Shackles, D-rings, turnbuckles, eye bolts, lifting lugs , safety hoist rings, etc. are considered rigging hardware are typically used with slings and BTHLDs, and may be tested as part of the sling assembly, individually, or both, as dictated by worst case stress and stability considerations per NASA-STD-8719.9, Lifting Standard			
6.2.2.2.3 Synthetic round slings with internal cores shall be inspected prior to first use at the payload processing facility and launch site area to detect damaged internal core (e.g., hand-over-hand tactile inspection; fiber-optic light transmission) that may not be evident from visual inspection of the external surface.	Select Status		
6.2.3. Below-the-Hook Lifting Devices (BTHLDs):	I		
A BTHLD are all structural and mechanical lifting devices and equipment, except for slings, LPDs, and load cells, used to connect a crane/hoist hook and a load being lifted, including lifting beams (and arms) and attachment hardware such as bolts and pins (lifting assemblies). See 6.2.2 above for slings and rigging hardware requirements. Standards for BTHLDs are covered by ASME B30.20, Below-the Hook Lifting Devices, but the device may contain components such as slings, hooks, and rigging hardware addressed by other ASME B30 series standards (Safety Standard for Cableways, Cranes, Derricks, Hoist, Hooks, Jacks, and Slings) or other standards.	I		
6.2.3.1. BTHLD Design Standards and Requirements:	Select Status		
6.2.3.1.1. BTHLDs shall be designed by a structural engineer and manufactured to the specified rated loads and load geometry of Design Category B (with a minimum yield safety factor of 3) in accordance with ASME BTH-1, Design of Below-the-Hook Lifting Devices, and ASME B30.20. A structural analysis that qualifies the unit for 125 percent initial Proof Load test, and an NDE plan, shall be submitted to the PSWG, Range Safety, and the LDEM for review and approval. See Table 6-1 for Proof Load Test Factors.	Select Status		
6.2.3.1.2. Material used in the construction of BTHLDs shall exhibit a ductile failure mode (for example, ultimate strain not less than 20 percent elongation). The intent is to have advanced warning of an upcoming failure via visually detectable deformation of structural components.	Select Status		

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6.2.3.2. BTHLD Inspection and Test Requirements:	Select Status		
6.2.3.2.1. Before their first operational use by the project at the payload processing facility and launch site area and following modifications or repairs, BTHLDs shall be inspected and Proof Load tested to 125% of the rated load in accordance with ASME B30.20 methodology and the PSWG and Range Safety approved NDE plan. The rated load shall not exceed 80% of the actual test load. If the BTHLD contains components such as slings and shackles, then these components shall be Proof Load tested individually to their respective proof load levels (200% of the rated load for slings and shackles) and the whole assembly then Proof Load tested to 125% of the rated load.	Select Status		
6.2.3.2.2. For BTHLDs used to support critical operations, volumetric and surface NDE shall be performed on all SFP components and welds after the initial Proof Load test IAW a PSWG and Range Safety approved NDE plan. See paragraph 6.2.1.3.2. Material Handling Equipment Non Destructive Examination requirements.	Select Status		
6.2.3.2.3. A BTHLD Periodic Load test shall be performed in accordance with V6, 6.1.8.2.	Select Status		
6.2.3.2.4. BTHLDs are the structural, mechanical, and electrical components used to lift, support, and position a load. Common BTHLDs include spreader bars, beam clamps, barrel lifters, and vacuum lifts and the associated slings, hooks, and other rigging hardware. Some BTHLDs are referred to as structural slings. While slings and rigging may be part of a BTHLD, they are not, by themselves, considered BTHLDs. With the exception of slings, load leveling devices, e.g., Hydra Sets, and load cells, all structural and mechanical lifting devices and equipment used to connect a crane/hoist hook and a load being lifted are BTHLDs, including lifting beams (and arms) and attachment hardware like bolts and pins. See 6.2.2 above for slings and rigging hardware requirements.	I		
6.2.3.2.5 When BTHLDs are composed of more than one lifting device or rigging hardware component, the components shall be tested as an assembly, individually, or both, as dictated by worst case stress considerations. When testing as an assembly, the load test value shall be based upon the rated load for the assembly.	Select Status		
When BTHLDs are composed of more than one lifting device or rigging hardware component, the components shall be tested as an assembly, individually, or both, as dictated by worst case stress considerations. When testing as an assembly, the load test value shall be based upon the rated load for the assembly.	I		
When testing as individual components, rigging hardware periodic test intervals may be in accordance with the rigging hardware requirements of section 6.2.2.2, and individual BTHLDs and rigging hardware component load test values may be based upon the component rated load within the assembly rather than the individual component rated load.	I		
6.2.4. Handling Structures:	I		
Handling structures are those structures used to handle and manipulate hardware or equipment, such as spin tables, equipment racks, and rotating devices.	I		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.2.4.1. Handling Structure Design Standards and Requirements:	I		
6.2.4.1.1. Handling structures shall be designed with a yield factor of safety of 3 based on rated loads.	Select Status		
6.2.4.1.2. Handling structures whose failure would not result or propagate into a catastrophic event may be designed to a yield factor of safety of 2 based on limit loads.	Select Status		
6.2.4.1.3. Handling structures shall be designed to accommodate the worst case seismic load as specified by that location's building code and approving authorities. Handling structures at the WR shall be designed to accommodate the worst case seismic load in accordance with Chapter 17.	Select Status		
6.2.4.1.4. Material (including fittings and attachment hardware) used in the construction of handling structures shall exhibit a ductile failure mode (ultimate strain not less than 20 percent elongation). The intent is to have advanced warning of an upcoming failure via visually detectable plastic deformation of structural components. Exceptions may be considered with PSWG and Range Safety approval, on a case-by-case basis.	Select Status		
6.2.4.2. Handling Structure Inspection and Test Requirements:	I		
6.2.4.2.1. Before their first operational use, all new, altered, modified or repaired handling structures shall be inspected in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan and load tested to 150 percent of the rated load.	Select Status		
6.2.4.2.2. Handling structures designed to a factor of safety less than 3, but greater than or equal to 2, shall be initially inspected and load tested to 125 percent of rated load.	Select Status		
6.2.4.2.3. For handling structures used to support critical operations, volumetric and surface NDE shall be performed on all SFP components and welds after the initial proof load test in accordance with PSWG and Range Safety approved NDE plan.	Select Status		
6.2.5. Support Structures: Support structures are those structures used to support hardware or equipment, such as support stands and fixed and portable launch support frames.	I		
6.2.5.1. Support Structure Design Standards and Requirements:	I		
6.2.5.1.1. Support structures shall be designed with a yield factor of safety of 3 based on rated loads.	Select Status		
For large structures, requirements from American Institute of Steel Construction (AISC), American Society of Civil Engineers (ASCE) 7 and pertinent building codes may also be considered.	I		
6.2.5.1.2. Support structures whose failure would not result or propagate into a catastrophic event may be designed to a yield factor of safety of 2 based on rated loads.	Select Status		

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6.2.5.1.3. Material (including fittings and attachment hardware) used in the construction of support structures shall exhibit a ductile failure mode (for example, ultimate strain not less than 20 percent elongation). The intent is to have advanced warning of an upcoming failure via visually detectable deformation of structural components. Exceptions may be considered with PSWG and Range Safety approval, on a case-by-case basis.	**Select Status**		
6.2.5.1.4. Support structures whose materials of construction do not meet the ductile material failure criteria above shall be designed to an ultimate factor of safety of 5. Also, the design analysis shall include a fracture mechanics analysis to show a service life cycle factor of safety of 100:1 and/or detailed NDE surface and/or volumetric requirements.	**Select Status**		
6.2.5.1.5. Portable ground support equipment, such as equipment racks, shall be designed not to tip when fully loaded and/or moved. For heavy moveable support and handling equipment, lifting lugs and forklift handling, such as fork tubes, shall be incorporated to provide for safe handling.	**Select Status**		
6.2.5.2. Support Structure Inspection and Test Requirements:	**I**		
6.2.5.2.1. Before their first operational use, all new, altered, modified, or repaired support structures designed to a yield factor of safety of at least 3 shall be inspected and Proof Load tested to 150 percent of rated load in accordance with applicable industry methodology. A PSWG and Range Safety approved NDE plane shall be performed in accordance with paragraph 4.4 of this volume.	**Select Status**		
6.2.5.2.2. Support structures designed to a factor of safety less than 3 but greater than or equal to 2 shall be inspected and Proof Load tested to 125 percent of rated load. A PSWG and Range Safety approved NDE plane shall be performed in accordance with paragraph 4.4 of this volume.	**Select Status**		
6.2.5.2.3. Before every use, support structures shall be visually inspected in accordance with applicable industry methodology and the PSWG approved NDE plan. Structures showing evidence of damage or rejectable criteria shall not be used in operations.	**Select Status**		
6.2.5.2.4. Support structures shall be periodically inspected, and rated load tested within four years of intended use in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan to the same load level used in the initial testing.	**Select Status**		
6.2.5.2.5. For support structures used to support critical loads or that create critical hazards, volumetric and surface NDE shall be performed on all SFP components and welds after the initial proof load, inspected and load tested to the same level used in initial testing within one year of intended use in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan.	**Select Status**		
6.2.5.2.6. Support structures fabricated (including fittings and attachment hardware) of ductile materials at the operating environmental conditions may be exempted by the PSWG, Range Safety or local safety authorities from periodic load testing on a case-by-case basis.	**Select Status**		

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6.2.6. Load Positioning Device (LPD) and Load Measuring/Indicating Devices (LID) (e.g., Hydra Set ®)	I		
Load positioning devices (LPD) are mechanical devices (e.g., Hydra Set ®), attached to a crane/hoist hook, and used to make fine adjustments to the load position during lifting operations. Load indicating devices (LID) are mechanical devices (e.g., load cells, dynamometers), attached to a crane/hoist hook, and used to measure the weight of the load being lifted.	I		
6.2.6.1. LPD and LID Design Standards and Requirements. LPD and LID design allows use for a range of loads, with a specification of not-to-exceed rating. These devices should be used within 20% to 80% range of their rated load capacity due to lower accuracy in the extreme low and high ranges of the rated load.	Select Status		
6.2.6.1.1. LPD and LID design shall ensure that positive control is maintained at all times, and no actions are initiated or continued without the appropriate controls command being given.	Select Status		
6.2.6.1.2. Failure of the LPD or LID shall not result in dropping or un-commanded movement of the suspended or supported load.	Select Status		
6.2.6.1.3. LPD shall be designed with a minimum ultimate factor of safety of 5.	Select Status		
6.2.6.1.4. LIDs shall be designed in accordance with ASME B30.26, Rigging Hardware.	Select Status		
6.2.6.1.5. A LPD and/or LID inspection plan, identifying all SFP and NDE requirements, methodology, and acceptance criteria, shall be submitted to the PSWG and Range Safety for review and approval.	Select Status		
6.2.6.1.6. Operator Training. Hydra-Set operators shall be trained and certified.	Select Status		
6.2.6.2. LPD and LID Inspection and Test Requirements:	I		
6.2.6.2.1. Before their first operational use, new, altered, repaired, or modified and LIDs shall be inspected, and load tested to 200 percent of rated load to verify controls and performance (for example, structural, mechanical, electrical). LPD and LIDs shall be load tested by the manufacturer or if authorized, in accordance with the manufacturer instructions to prevent system damage.	Select Status		
6.2.6.2.2. NDE shall be performed during inspection and test per the NDE plan.	Select Status		
6.2.6.2.3. For LPDs and LIDs used to support critical operations, volumetric and surface NDE shall be performed on all SFP components and welds after the initial proof load test IAW the PSWG and/or SLD 30/SE and SLD 45/SE approved NDE plan.	Select Status		
6.2.6.2.4. Before every use, LPDs and LIDs shall be visually inspected for proper function, loose hardware, excessive wear and contamination, corrosion, cracks, or damage, and hydraulic system deterioration. Hydra-Sets or load cells showing evidence of damage or rejectable criteria shall not be used in operations.	Select Status		

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6.2.6.2.5. LPDs and LIDs used to support critical lifts shall be inspected and load tested to 100 percent of the rated load within 1 year of intended use and calibrated in accordance with manufacturer instructions. Load testing to 100 percent shall be performed in accordance with the manufacturer instructions to prevent system damage.	Select Status		
6.2.6.2.6. LPDs and LIDs used to support critical lifts shall undergo operational tests in conjunction with proof and periodic load tests and at least once per year. The LPD shall be operated to approximately the mid-stroke position with a test load of 50 to 100 percent of the LPD rated capacity. Using a dial indicator or equivalent, the load should not move up or down more than .005 inches in 5 minutes. No hydraulic leaks, or structural damage or corrosion of the piston rod should be visible.	Select Status		
6.2.7. Rigging Hardware. Rigging hardware consists of shackles, links, rings, swivels, turnbuckles, eyebolts, hoist rings, wire rope clips, wedge sockets, rigging blocks, etc., and may be components of BTHLDs.	Select Status		
6.2.7.1. Rigging Hardware Design Standards and Requirements. All rigging hardware shall be designed, manufactured, handled, and stored in accordance with ASME B30.26. All hardware will be marked and identified accordingly.	Select Status		
6.2.7.2. Rigging Hardware Inspection and Test Requirements.	Select Status		
6.2.7.2.1. Before first use, all new, modified, or repaired rigging hardware shall be load tested to the proof loads specified in ASME B30.26 prior to initial use.	Select Status		
6.2.7.2.2. For rigging hardware used to support critical operations, volumetric and surface NDE shall be performed on all SFP components and welds after the initial proof load test IAW the SLD 30/SE and SLD 45/SE approved NDE plan. Any rigging hardware meeting removal criteria outlined in ASME B30.26 shall be removed from service.	Select Status		
6.2.8. MHE Data Requirements. MHE initial and recurring data requirements shall be submitted in accordance with Attachment 1 of this volume, A1.2.4.6.2 and A1.2.5.6. MHE periodic/recurring data requirements shall be submitted in accordance with requirements in Volume 6.	Select Status		
6.2.8.1. For MHE used in safety critical operations, provide initial proof load test plans and test results.	Select Status		
6.2.8.2. Data Requirements Submission for Major Item MHE Designs. Unless otherwise agreed to by PSWG and Range Safety or otherwise stated in this Chapter, all design engineering documents pertaining to major MHE items, such as cranes, shall be submitted to the PSWG and Range Safety for review and approval 30 days prior to the following design review meetings: introductory; conceptual (30%); preliminary (60%); critical (90%); and final (100%). All design engineering drawings and specification packages shall have a space or block on the first drawing sheet reserved for the approval signature of the Range Safety reviewing official. All Review Item Discrepancies (RID) shall be addressed at each design review and resolved as soon as possible.	Select Status		
6.4. Removable, Extendible, and/or Hinged Personnel Work Platforms	I		
Requirements for the design, inspection, and test of personnel work platforms are included below.	I		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.4.1. Removable, Extendible, and/or Hinged Personnel Work Platform Design Requirements:	**I**		
6.4.1.1. Safety factors for the design of platforms shall be consistent with those of the overall structures on which they are permanently mounted. In no case shall the safety factors be less than that of the overall structure, the applicable national consensus standard AISC, the Aluminum Association, or a yield factor of safety of 2, whichever is greater.	**Select Status**		
6.4.1.2. Hinges, attaching points, and other high stress or abuse prone components and their interface hardware shall be designed with a yield factor of safety of at least 3. Yield strength shall be less than or equal to 85 percent of ultimate strength or the ultimate factor of safety shall be 5.	**Select Status**		
6.4.1.3. The greater of (1) a minimum of 60 pounds per square foot or (2) 300 pounds per occupant shall be used for the uniformly distributed live load.	**Select Status**		
6.4.1.4. A minimum of 2,000 pounds shall be used for concentrated loading (point loading).	**Select Status**		
6.4.1.5 Guardrail systems and toe boards shall be provided and designed in accordance with 29 CFR 1910 Subpart D , Walking -Working Surfaces	**Select Status**		
6.4.1.6. Personnel platforms shall have a means of positive mechanical restraint when in the open, raised, folded back, or use position to prevent unintentional movement. Bolting shall not be acceptable. Latches, levers, tethered pins shall be used.	**Select Status**		
6.4.1.7. Movable platform structures shall be grounded with the bonding conductor size in accordance with the NEC Article 250-102, Bonding Jumpers.	**Select Status**		
6.4.2. Removable, Extendible, and Hinged Personnel Work Platform Marking Requirements.	**I**		
6.4.2.1. All platforms shall be clearly marked with two-inch letters minimum indicating maximum load capacity.	**Select Status**		
6.4.2.2. The following information shall be imprinted on a metal tag attached to the platform:	**Select Status**		
6.4.2.2.1. Maximum distributed load.	**Select Status**		
6.4.2.2.2. Maximum concentrated load (point load).	**Select Status**		
6.4.3. Removable, Extendible, and/or Hinged Personnel Work Platform Inspection and Test Requirements. At a minimum, the following tests shall be performed:	**Select Status**		
6.4.3.1. All new, repaired, or modified platforms shall be load tested to 125 percent of their rated capacity before initial use. After the proof load test, volumetric NDE testing shall be performed on all SPF components and welds in accordance with the PSWG and Range Safety approved NDE plan. For repaired or modified platforms, volumetric NDE testing of all repaired or modified SPF components and welds is required. Periodic inspection requirements for work platforms are found in Volume 6.	**Select Status**		

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6.4.3.2. Visual inspection shall be performed annually on all hinges, attaching points, and other high stress or abuse prone components on all platforms.	Select Status		
6.4.4. Removable, Extendible, and/or Hinged Personnel Work Platform Data Requirements. Personnel work platform data shall be submitted in accordance with Attachment 1, A1.2.5.8 of this volume.	Select Status		
6.5. Lifting Personnel with a Crane	I		
Personnel shall not ride the hook or load at any time. Conventional methods of reaching a worksite shall be utilized unless they would be more hazardous or not possible.	Select Status		
6.5.1 Man-Rated Baskets and personnel platforms used with cranes shall be designed, certified and load tested, and operated in accordance with 29 CFR 1926.550, Cranes and Derricks, ASME B30.23, Personnel Lifting Systems and 29 CFR 1926.1427, Operator Training, Certification, and Evaluation for all lifts of personnel. Manlifts and extensible boom platforms are also discussed in 29 CFR 1910.67, Vehicle-mounted Elevating and Rotating Work Platforms	Select Status		
6.6. Flight Hardware Used to Lift Critical Loads and Clampbands.	I		
6.6.1. Flight Hardware Used to Lift Critical Loads Design Requirements. Lift fittings such as lugs and plates permanently attached to flight hardware shall be designed so that the loss of one fitting and/or structure will not result in the dropping of the load. If this requirement cannot be met, the minimum ultimate factor of safety shall be 1.5.	Select Status		
Flight hardware used to lift critical loads includes clamp bands.	I		
6.6.2. Flight and GSE Clampbands. Flight and GSE clampbands shall be designed with a minimum ultimate safety factor of 1.5 x limit load. Limit load shall include the effects of all expected lateral, compressive and tensile loads experienced by clampbands during ground and flight environments.	Select Status		
6.6.3. Flight Hardware Used to Lift Critical Loads and Clampband Initial Test Requirements. At a minimum, the following tests shall be performed on permanently attached flight hardware lift fittings and clampbands prior to their first operational use at the Ranges:	Select Status		
6.6.3.1. Clampbands and lift fittings shall be load tested to 100 percent of limit load as an integral part of the lifting assembly during structural load testing. All components shall be tested together as a system, if practical.	Select Status		
6.6.3.2. After the load test, volumetric and surface NDE testing shall be performed on all clampbands, lift fitting SFP components and SFP welds.	Select Status		
6.6.4. Flight Hardware Used to Lift Critical Loads and Clampband Data Requirements. Data requirements for flight hardware used to lift critical loads and clampbands shall be submitted in accordance with Volume 3, Attachment 1, A1.2.5.6.8.	Select Status		

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CHAPTER 7 ACOUSTIC HAZARDS	I		
7.1. Acoustic Design Standards	I		
7.1.1. Equipment and systems shall be procured, designed and operated to ensure that personnel are not exposed to hazardous continuous and impulsive noise levels that exceed the limits established by NPR 1800.1, Occupational Health Program Procedures, latest revision, Hearing Conservation Section. In all cases, noise shall be at the lowest practical levels. Any work area where environmental noise level is at or above 85 dB A-weighted or where the environmental impulse noise level is at or above 140 dB C-weighted, regardless of duration of exposure of number of impulses, shall constitute a hazardous noise area. NASA's allowable noise exposure limit is the equivalent to an 85 dBA, 8-hour TWA exposure using a 3 dB exchange rate as calculated by the following formula where L stands for exposure level and T stands for duration: T(min) = 480/2(L-85)/3 . Exposures exceeding those calculated by the preceding formula levels shall be controlled, reduced, or eliminated through a hierarchical combination of engineering controls, administrative controls, and hearing protection devices. Noise dose shall include all impact/impulse noise measured up to and including 140 dB peak. The action level is 82 dBA, 8 hour TWA, using a 3 dB exchange rate.	Select Status		
7.1.2. "Buy Quiet and Quiet by Design" provisions are integral to the site selection and design of new or modified facilities and equipment.	Select Status		
7.1.3. Workspace noise shall be reduced to levels that permit necessary direct person-to-person and telephone communication. Areas requiring occasional telephone use or occasional direct talk at distances up to 1.5 m (5 ft) shall not exceed 75 dBA. Areas requiring frequent telephone use or direct talk at distances up to 1.5 m (5 ft) shall not exceed 65 dBA.	Select Status		
7.1.4. Payload project shall coordinate with local authorities to ensure that potential acoustic hazards are evaluated by qualified personnel.	Select Status		
7.1.5. Caution alarms and audio warning signals shall be distinguishable by their intensity, duration and source, and be compatible with the acoustical environment of the intended receiver as well as other personnel in the signal areas.	Select Status		
7.2. Acoustic Data Requirements	Select Status		
Acoustic data requirements shall be submitted in accordance with Attachment A1.2.4.12.2 of this volume.	Select Status		

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CHAPTER 8 NON-IONIZING RADIATION SOURCES	I		
8.1. ELECTROMAGNETIC RADIATION Emitters	I		
The following requirements apply to electromagnetic radiation emitters unless exempted by AFI 48-109, Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program, any Wing Supplements/Instructions and local authorities as identified by the PSWG in conjunction with Range Safety.	Select Status		
The following general categories of RF and microwave radiation devices are typically exempt from review, unless the results of a hazard analysis indicate that personnel and/or an integrated systems hazard exists, requiring mitigation by design or operational controls: - ***Devices with transmitter power of 7 watts or less and an antenna gain of unity (walkie-talkies, car phones, cellular phones).*** - ***RF/microwave radiation devices designed for and operated in a completely enclosed configuration where no open-air transmission is possible.*** - ***RF/microwave radiation devices designed to operate in a hard-lined, closed loop configuration where no open-air transmission is possible.***	I		
8.1.1. Electromagnetic Field Radiation (EMFR) Emitter Design Standards:	I		
8.1.1.1. EMFR emitters shall be designed to ensure that personnel are not exposed to hazardous energy levels in accordance with ANSI/IEEE C95.1, Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 Khz. to 300 Ghz, AFI 48-109, any Wing Supplements/Instructions and local guidance and requirements as identified by the PSWG and Range Safety. ***Note: Kennedy NASA Procedural Requirement KNPD 1860.1, KSC Radiation Protection Program provide local requirements for KSC.***	Select Status		
8.1.1.2. Where total protection is not possible through the design process, clearance areas and access controls shall be established.	Select Status		
8.1.1.3. The payload project shall contact the local range and/or facility authorities with responsibility for EFMR safety and deconflicting EMFR transmissions as identified by the PSWG in conjunction with Range Safety and provide EMFR system design data as needed for the authorities to evaluate EMFR levels, determine the hazard potential for personnel, and ultimately provide approval of the EMFR system.	Select Status		
8.1.2. EMFR Emitter Design:	I		
8.1.2.1. EMFR Emitter General Design Requirements:	I		

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8.1.2.1.1. EMFR emitters shall be designed and located to allow test and checkout without presenting a hazard to personnel, ordnance, or other electronic equipment. All systems shall be reviewed by PSWG, Range Safety, and the local Radiation Protection Officer (RPO) or equivalent e.g., Radiation Safety Officer (RSO), and when required obtain the appropriate approvals.	Select Status		
8.1.2.1.2. Where necessary, safety devices shall be provided to protect operating personnel and exposed initiators during ground operations	Select Status		
Interlocks and interrupts are examples of safety devices that may be used to protect operating personnel and exposed initiators during EMFR emitter ground operations.	I		
8.1.2.1.4. Fail-safe systems shall be incorporated so that inadvertent operation of any hazardous EMFR emitting system is prevented.	Select Status		
8.1.2.2. Special Considerations for Electroexplosive and Critical Subsystem Exposure to Electro Magnetic Frequency Radiation (EMFR):	I		
8.1.2.2.1. Electroexplosive subsystems shall not be exposed to EMFR that is capable of firing the electroexplosive device (EED) by pin-to-pin bridge wire heating or pin-to-case arcing.	Select Status		
8.1.2.2.2. EMFR power at the EED shall not exceed 20 dB below the pin-to-pin direct current (DC) no-fire power of EED.	Select Status		
8.1.2.2.3. EMFR shielding of pyrotechnics/explosives shall be IAW AIAA S-113A-2016, Criteria for Explosive Systems and Devices on Space and Launch Vehicles, paragraph, 5.1.7.3 Electromagnetic Compatibility (EMC): The shielding for firing circuits shall provide a minimum 20 dB safety margin between worst-case electrical noise and the electrical explosive device demonstrated no-fire rating. Shielding for other circuits shall provide a minimum 6 dB safety margin between worst-case electrical noise and the minimum activation power/no-damage rating. To verify EMFR emitters, in proximity to Electro Explosive Devices (EED's), or other ordnance subsystems, are below the EED no-fire threshold, an analysis shall be performed in accordance with NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics, Appendix B; Hazards of Electromagnetic Radiation to EED's, to determine safe separation distances between EMFR Radio Frequency(RF) source emitters and EED's and other exposed ordnance subsystems.	Select Status		
NASA-STD-7002, Payload Test Requirements, defines EMI test program requirements.	I		
8.1.2.2.4. The effect of payload and launch system emitters on their own electroexplosive subsystem shall be evaluated by analysis or electromagnetic compatibility (EMC) testing.	Select Status		
8.1.3. EMFR Emitter Initial Test Requirements:	I		

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8.1.3.1. All EMFR emitters shall have their EMFR hazard area verified by the RPO/RSO or a designated representative before the first operation and/or test.	Select Status		
8.1.3.2. Safety features shall be tested, verified and documented before first operation/test.	Select Status		
8.1.3.2.1. Test plans shall be submitted for review and approval to the appropriate local safety authority as identified by the PSWG and Range Safety.	Select Status		
8.1.3.2.2. Test results shall be submitted to local safety authorities as identified by the PSWG and Range Safety.	Select Status		
8.1.4. EMFR Emitter Data Requirements:	I		
8.1.4.2. EMFR Emitter Design and Test Data. The EMFR emitter design and test data requirements shall be submitted in accordance with Attachment 1, A1.2.4.10.2.2 of this volume.	Select Status		
8.2. Laser Systems (Class 1M, 2M, 3B, and 4)	I		
8.2.1. Laser System Design Standards:	Select Status		
8.2.1.1. Laser systems shall be designed to ensure that personnel are not exposed to hazardous emissions in accordance with the requirements of ANSI Z136.1, Safe Use of Lasers, 21 CFR 1040, Performance Standards for Light Emitting Products, AFI 48-139, Laser and Optical Radiation Protection Program and local guidance as defined by the appropriate local authorities as identified by the PSWG and Range Safety.	Select Status		
8.2.1.2. Where total protection against exposure is not possible through the design process, clearance areas and access controls shall be established.	Select Status		
8.2.1.3. The payload project shall contact the appropriate local authorities as identified by the PSWG in conjunction with Range Safety and provide the laser system data for all Class 1M, 2M, 3B and 4 lasers and operations data for use in evaluation and approval of the laser system. The appropriate local authorities shall evaluate laser levels and determine the hazard potential for personnel.	Select Status		
8.2.2. Laser System General Design Requirements. Requirements found in ANSI Z136.1 apply to Class 1M, 2M, 3B and 4 laser systems that may pose harm, unless exempted by AFI 48-139. The following requirements apply to all laser systems unless exempted by the appropriate local authorities as identified by the PSWG in conjunction with Range Safety	Select Status		

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The following general categories of laser and LED devices, products and systems are typically exempt from emitted laser radiation hazards: - ***Class I and II laser devices and products, except for those that allow access to other classes of laser radiation during servicing operations, provided that the laser product is maintained as a Class I or II laser product through its useful life.*** - ***Service Group 1 (SG1) fiber optic devices/systems.*** - ***Laser Pointers (Class II), laser printers, laser copiers, image scanners, CD ROM players, and other devices, such as those as defined and operated in KNPD 1860.1, KSC Radiation Protection Program.***	**I**		
8.2.2.1. Control measures shall be designed into laser systems to reduce the possibility of human exposure to hazardous laser radiation.	**Select Status**		
Interlocks and interrupts are examples of safety devices that may be used to protect operating personnel and exposed initiators from laser emissions.	**I**		
8.2.2.2. Fail-safe systems shall be incorporated so that inadvertent operation of the laser system is prevented.	**Select Status**		
8.2.2.3. Automatic, independent, redundant controls shall be provided to positively prohibit harmful radiation from areas outside the intended operating area.	**Select Status**		
8.2.2.3.1. Mechanical stops or barriers shall be used for Class 4 laser systems that may lead to a catastrophic hazard in the event of a mishap.	**Select Status**		
8.2.2.3.2. Electrical/software inhibits shall be used to shutter or shut down the laser before or when mechanical stops are encountered.	**Select Status**		
8.2.2.4. In addition to automatic controls, emergency laser shutdown or shuttering capability shall be provided.	**Select Status**		
8.2.2.5. Emergency shutdown or shuttering shall be fail-safe or redundant.	**Select Status**		
8.2.2.6. Laser platforms shall comply with the requirements for mechanical ground support equipment used to handle critical hardware as described in Chapter 6 of this volume.	**Select Status**		
8.2.2.7. Laser system mounts installed on moving or airborne vehicles shall be designed to compensate for the motion of the vehicle.	**Select Status**		
8.2.2.8. Heating effects on unprotected laser platforms shall be considered when siting and setting elevation and azimuth stops.	**Select Status**		
8.2.2.9. Hazardous materials used in laser systems shall meet the ground support requirements of Chapter 10 of this volume.	**Select Status**		

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8.2.2.10. Laser systems with pressurized subsystems such as cryogenic fluids shall meet the requirements of Chapter 11 of this volume.	Select Status		
8.2.2.11. Electrical ground systems used in laser systems shall meet the requirement of Chapter 14 of this volume.	Select Status		
8.2.3. Laser System Test Requirements:	I		
8.2.3.1. The payload project shall contact the appropriate local safety authority as identified by the PSWG in conjunction with Range Safety and/or the RPO/RSO for hazard area verification before first operation and test.	Select Status		
8.2.3.2. Safety features shall be verified before first operational use or test at the payload processing facility and launch site area.	Select Status		
8.2.3.3. Test plans and test results shall be submitted for review and approval to the appropriate local safety authorities as identified by the PSWG and Range Safety.	Select Status		
8.2.4. Laser System Data Requirements:	I		
8.2.4.1. Laser system data requirements shall be submitted in accordance with Attachment 1, A1.2.4.10.3 of this volume.	Select Status		
8.2.4.2. Hazard Evaluation Data. Analysis and supporting data outlining possible laser system failures for all phases of laser system uses shall be submitted in accordance with Attachment 1, A1.2.4.10.3.7 of this volume.	Select Status		
8.2.4.3. Biophysiological Data. Biophysiological data requirements shall be submitted in accordance with Attachment 1, A1.2.4.10.3.8 of this volume.	Select Status		
8.2.4.4. Test Plans and Test Results. Test plan and test results data requirements shall be submitted in accordance with 8.2.3. ***Note: In addition to the hazards associated with exposure to the laser beam, non-beam hazards can result, and ancillary systems require compliance to the applicable section(s) of this document. Examples of these hazards include electrical, fire, explosion, laser generated air contaminants, ionizing and non-ionizing radiation, compressed gases, laser dyes, and acoustic hazards.***	Select Status		
8.2.5. Engineering Controls. The following engineering controls are mandatory for Class 4 Lasers or laser systems and should be applied to Class 3b Lasers or systems. Mandatory compliance to specific requirements may also be required by the RPO/RSO or local health and safety authority, or as specified in the following paragraphs:	Select Status		

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8.2.5.1. Protective Housings shall be provided for all classes of lasers or laser systems, except as allowed by ANSI Z136.1 section 4.3.1.1. The protective housing may require interlocks and labels. ***Note: In some circumstances such as research and development and manufacture/assembly of lasers, operation of the laser or laser system without a protective cover may become necessary. In such cases, the appropriate local safety authority and RPO/RSO shall determine the hazard and assure that controls are instituted appropriate to the class of maximum accessible emission to assure safe operation. These controls may include, but not be limited to:*** ***(1) access restrictions*** ***(2) eye protection*** ***(3) area controls*** ***(4) barriers, beam stops, shrouds, etc.*** ***(5) administrative and procedural controls*** *(6)* ***education and training***.	Select Status		
8.2.5.2. A master switch shall be operated by a key, or by coded access (computer code).	Select Status		
8.2.5.2.1. The authority for access to the master switch shall be vested in the Area Radiation Officer (ARO)/Laser Safety Officer (LSO) for the laser or laser device.	Select Status		
8.2.5.2.2. The master switch shall be disabled (key removed or equivalent) when the laser or laser system is not intended to be used.	Select Status		
8.2.5.3. All energy sources associated with the laser or laser system shall be designed to comply with lockout/tagout requirements required by OSHA.	Select Status		
8.2.5.4. Viewing Portals, Collecting Optics and Display Screens	Select Status		
8.2.5.4.1. All viewing portals and display screens included as an integral part of a Class 2, Class 3a, Class 3b, or Class 4 laser or laser system shall incorporate a suitable means (filters, interlocks, attenuators) to maintain the laser radiation at the viewing position at or below the applicable MPE for all conditions of operation and maintenance. ***Note: Flammability and decomposition products of viewing portals and display screens are important in the selection of material unless proper safeguards are in place to ensure personnel safety.***	Select Status		

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8.2.5.4.2. All collecting optics, such as lenses, telescopes, microscopes, endoscopes, etc., intended for viewing use with a Class 3b, or Class 4 laser or laser system shall incorporate a suitable means (filters, interlocks, attenuators) to maintain the laser radiation at the viewing position at or below the applicable MPE for all conditions of operation and maintenance. ***Note: Normal or prescription eyewear is not considered collecting optics.***	Select Status		
8.2.5.5. Remote interlock connector. The interlock connector facilitates electrical connections to an emergency master disconnect interlock, or to a room, entry way, floor, or area interlock.	Select Status		
8.2.5.5.1. When the terminals of the remote interlock connector are open circuited, the accessible radiation level shall not exceed the appropriate MPE levels.	Select Status		
8.2.5.6. Beam Stops or Attenuators shall be capable of preventing access to laser radiation in excess of the appropriate MPE level when the laser or laser system output is not required.	Select Status		
8.2.5.7. Laser Activation and Warning Systems	Select Status		
8.2.5.7.1. An audible alarm, a warning light (visible through protective eyewear), or a verbal countdown command should be used for Class 3b and shall be used for Class 4 lasers or laser systems during activation or startup.	Select Status		
8.2.5.7.2. The audible warnings shall be distinctive and clearly identifiable sounds which are uniquely associated with the emission of laser radiation.	Select Status		
8.2.5.7.3. For Class 4 lasers or laser systems, the warning system shall be activated a sufficient time prior to emission of laser radiation (emission delay) to allow appropriate action to be taken to avoid exposure to the laser radiation.	Select Status		
8.2.5.8. Remote Firing and Monitoring	Select Status		
8.2.5.8.1. Unless approved by the cognizant RPO/RSO Class 4 lasers and laser systems should be monitored and fired from remote positions.	Select Status		
8.2.5.8.1.1. The remote console should also include a laser activation warning system.	I		
8.2.6. Use of Lasers in Navigable Airspace	I		
8.2.6.1. Laser experiments or programs that involve the use of lasers or laser systems in laser experiments or programs (other than Class 1 or Class 2) in navigable airspace shall ensure the safety of aircraft and the protection of people and property on the ground.	Select Status		
8.2.6.2. Early coordination with the appropriate local authorities as identified by the PSWG in conjunction with Range Safety and Federal Aviation Administration shall occur in the planning stages to ensure proper control of any hazard to airborne personnel or equipment. In accordance with NPR 1800.1, the Senior Environmental Health Officer shall be advised of coordination with the FAA.	Select Status		

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CHAPTER 9 RADIOACTIVE (IONIZING) RADIATION SOURCES	I		
9.1. Radioactive Source Design Standards and Controls	I		
9.1.1. Radioactive systems shall conform to the requirements specified in 10CFR, *Energy*, 49CFR, *Transportation*, AFMAN 40-201, *Radioactive Material (RAM) Management*, and DAFMAN 91-110, *Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems*, *NASA NPR 8715.1, Safety & Health Programs* and any payload processing facility requirements as specified by the PSWG and Range Safety.	Select Status		
9.1.2. Radioactive sources shall be designed to prevent the release of radioactive material.	Select Status		
9.1.3. Radioactive sources shall incorporate shielding in the design to ensure minimum exposure to personnel. Where total protection from radiation exposure by use of shielding is not feasible, access controls shall be used.	Select Status		
9.1.4. Radiation hazard warning signs and/or labels shall be fixed to the container or housing as directed by the Installation Radiation Safety Officer (IRSO)	Select Status		
9.1.5. High voltage sources shall be evaluated to determine their capability of producing X-rays.	Select Status		
9.1.6. High voltage sources shall be properly shielded and shall use interlocks on cabinet doors to interrupt power when a door is open.	Select Status		
9.1.7. Control measures for flight systems shall be handled on a case-by-case basis.	Select Status		
9.1.8. Range Users shall comply with requirements in Air Force Environmental Policy and the National Environmental Policy Act and provide compliance documentation to the IRSO on the ER and/or the Radiation Safety Committee on the WR.	Select Status		
9.1.9. Application for USAF permits shall be submitted in accordance with AFMAN 40-201, *Radioactive Material (RAM) Management* and any Wing Supplements/Instructions.	Select Status		
9.1.10. The Nuclear Regulatory Commission (NRC) license holder or Range User shall submit 3 copies of the NRC license with the USAF permit to the IRSO and SLD 30/SE and SLD 45/SE at least 90 calendar days before planned entry to the range. **Note**: Licensing and permitting requirements and procedures are specified in 10 CFR, AFMAN 40-201, *Radioactive Material (RAM) Management* and any Wing Supplements/Instructions.	Select Status		
The USAF AFMAN 40-201, Radioactive Materials (RAM) Management has superseded AFI 40-201, Managing Radioactive Materials in the USAF, and, AFI 40-201 45TH Space Wing Supplement Radioactive Material (RAM) Management has superseded 45 SWI 40-201, Radiation Protection Program. KSC Requirements are provided in KNPR 1860.1, KSC Ionizing Radiation Protection Program.	I		
9.1.11. Radioactive sources shall be handled under the supervision of the designated Range User, or the Radiation Protection Officer named on the NRC license, state license, or USAF permit as described in *AFMAN 40-201 Radioactive Materials (RAM) Management.*	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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9.1.12. Written approval for use of radioactive materials on USSF ranges is provided by the Wing Radiation Safety Committee. Range Users shall brief the Radiation Safety Committee on the hazards and procedures concerning the handling of radioactive sources and shall comply with any unique requirements of AFMAN 40-201 *Radioactive Materials (RAM) Management.*, and any Wing Supplements or Instructions.	**Select Status**		
9.1.13. The Safety Analysis Summary (SAS) and Radiation Protection Plan shall be submitted at least 180 calendar days before launch.	**Select Status**		
9.1.2. Additional ER and WR Design Controls:	**I**		
9.1.2.1. Additional ER Design Controls:	**I**		
9.1.2.1.1. Written approval for use of radioactive materials on CCSFS is provided by the SLD45/SE Radiation Safety Committee (RSC). ER payload projects shall brief the RSC on the hazards and procedures concerning the handling of radioactive sources and shall comply with any unique requirements of 45th Space Wing Supplement AFI 40-201.	**Select Status**		
9.1.2.1.2. Radioactive sources shall be handled under the supervision of the payload project or the RPO/RSO named on the Nuclear Regulatory Commission (NRC) license, state license or USAF permit.	**Select Status**		
9.1.2.2. Additional WR Design Controls:	**I**		
9.1.2.2.1. Written approval for use of radioactive materials on VSFB is provided by the SLD30/SE RADSAFCOM. WR payload projects shall brief the RADSAFCOM on the hazards and procedures concerning the handling of radioactive sources and shall comply with any unique requirements of SLD 30 Supplement 1 to DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems.	**Select Status**		
9.1.2.2.2. Radioactive sources shall be handled under the supervision of a designated payload project or the RPO/RSO named on the NRC license, state license, or USAF permit as described in AFMAN 40-201.	**Select Status**		
9.1.2.2.3. The final Safety Analysis Summary (SAS) and DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems shall be submitted 180 days before each launch.	**Select Status**		
9.2. Radioactive Sources Carried on Payloads	**I**		
9.2.1. Radioactive Sources Carried on Payloads General Design Requirements - In addition to the design requirements noted in 9.1.1, radioactive materials carried on payloads shall meet the following requirements:	**Select Status**		
9.2.1.1. Radioactive materials carried aboard launch vehicles and payloads shall comply with DAFMAN 91-110 public safety launch risk constraints.	**Select Status**		
9.2.1.2. Radioactive materials carried aboard payloads shall be compatible with and have no adverse safety effects on ordnance items, propellants, high pressure systems, critical structural components, or flight termination systems.	**Select Status**		

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9.2.1.3. Radioactive materials carried aboard payloads shall be designed so that they may be installed as late in the countdown as possible, particularly if personnel will be required to work within the system controlled radiation area (as defined in AFMAN 40-201, and any Wing Supplements/Instructions)) while performing other tasks on payloads.	Select Status		
9.2.2. Radioactive Sources Carried on Payloads Test Requirements:	Select Status		
9.2.2.1. General. To launch radioactive materials, tests shall be performed to characterize the survivability of the radioactive materials and any containment system, in the launch, abort, and destruct environments. The payload project shall also quantify any release of radioactive materials from these environments and provide the information to the appropriate local safety authority as identified by the PSWG and Range Safety.	Select Status		
Abort and destruct environments may induce damaging effects due to reentry, ground impact, explosion and fragment impact, fire, or mechanical crushing.	I		
9.2.2.2. Test Plans, Test Analyses, and Test Results:	I		
9.2.2.2.1. The appropriate local safety authority as identified by the PSWG and Range Safety shall approve test plans, analyses, and results.	Select Status		
9.2.2.2.2. The payload projects shall perform and document the results of radiation surveys of their radioactive sources before coming to the payload processing facility and launch site area.	Select Status		
9.2.2.2.3. The payload project shall coordinate and allow an initial radiation survey to be performed by the RPO/RSO the first time the source arrives at the payload processing facility and launch site area. Follow-on surveys may be required by the RPO/RSO and shall be coordinated and allowed.	Select Status		
9.2.2.2.4. Safeguards, such as interlocks and leak tests, shall be tested and verified by the payload project before bringing a radiation source to the ranges.	Select Status		
9.2.3. Radioactive Sources Carried on Payloads Launch Approval Requirements:	I		
9.2.3.1. A payload project contemplating launch of any radioactive source shall notify Range Safety and PSWG of any intended launch of radioactive materials during the concept phase of the program and comply with DAFMAN 91-110, and any Wing Supplements/Instructions.	Select Status		
9.2.3.2. Certification of compliance with an equivalent government agency safety review and launch approval process is required for all payload projects.	Select Status		

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9.2.3.3. Radioactive Material Launches. Payload projects shall be responsible for notifying the NASA Nuclear Flight Safety Officer (NFSO), the PSWG and Range Safety and ensuring compliance with National Security Presidential Memorandum (NSPM-20), dated 20 August 2019, Presidential Memorandum on Launch of Spacecraft Containing Space Nuclear Systems. NSPM-20 has superseded Paragraph 9 of PD/NSC-25, dated 08 May 1996, Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space, with implementation through DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems and USSF SSCMAN 91-710, Range Safety User Requirements.	**Select Status**		
NSPM-20 establishes an Interagency Nuclear Safety Review Board (INSRB) for major sources. DoD, NASA, and FAA are all members of that Board, and therefore may have insight in to related testing and analysis (e.g., launch abort data and evaluation; failure mode, breakup, and blast data) of relevance to Range Safety.	**I**		
9.2.4. Radioactive Sources Launch Approval Data Requirements. Radioactive sources launch approval data requirements shall be submitted in accordance with Attachment 1, A1.2.4.11 of this volume.	**Select Status**		
9.2.5. Radiation Producing Equipment and Devices Data Requirements. Radiation producing equipment and devices data requirements shall be submitted in accordance with Attachment 1, A1.2.5.13 of this volume.	**Select Status**		

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CHAPTER 10 HAZARDOUS MATERIALS	I		
10.1. Hazardous Materials Selection Criteria	I		
The requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive materials that may result in toxic, fire, or explosion hazards are described in this part. The requirements apply to all of the chemicals included in, but not limited to, those specified in 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals. These requirements also apply to explosives and pyrotechnics as defined in 29 CFR 1910.109, Explosives and Blasting Agents.	Select Status		
10.1.1. Hazardous Materials Flammability and Combustibility:	I		
10.1.1.1. The least flammable material that meets design requirements while minimizing potential ignition sources and fire propagation paths shall be used.	Select Status		
10.1.1.2. Materials that will not burn readily upon ignition shall be used.	Select Status		
10.1.2. Hazardous Materials Toxicity:	I		
10.1.2.1. If more than one material satisfies the performance requirement, the least toxic material shall be used.	Select Status		
10.1.2.2. Material that give off a toxic gas if ignited shall not be used if it is determined in a materials assessment that the material could credibly come in contact with ignition or high heat source(s)	Select Status		
10.1.3. Hazardous Materials Compatibility:	I		
10.1.3.1. Materials, including leakage, shall not come in contact with a non-compatible material that can cause a hazard.	Select Status		
10.1.3.2. Compatibility shall be determined on a case-by-case basis. If contact of material with a non-compatible material can cause a critical or catastrophic hazard, the hazard shall be mitigated to a level acceptable to the PSWG and Range Safety.	Select Status		
10.1.3.3. Non-Flight materials used in processing and testing of flight hardware shall not cause degradation of the flight hardware.	Select Status		
10.1.4. Hazardous Materials Electrostatic Buildup. Hazardous materials shall not retain a static charge that presents an ignition source to ordnance or propellants or a shock hazard to personnel.	Select Status		
10.2. Hazardous Materials Test Requirements	I		
10.2.1. Materials Test Requirements and Databases. Material properties shall be determined by test processes defined in this section or be selected from the PSWG and Range Safety approved material databases.	Select Status		

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Table 10-1. Potential Sources of Hazardous Material Information. **1) NASA Material and Process Technical Information System (MAPTIS) contains material codes and ratings for materials, standard and commercial parts, and components. MAPTIS is accessible via the Internet at http://maptis.nasa.gov** 2) **Material selection from this or other approved NASA material data base, for example, KTI-5212, Material Selection List for Plastic Films, Foams, and Adhesive Tapes.**	**I**		
10.2.1.1. Plastic materials that may pose a hazard because of compatibility or toxicity shall be tested in accordance with the requirements described in NASA-STD-6001, Flammability, Offgassing and Compatibility Requirements and Test Procedures.	**Select Status**		
10.2.1.2. Plastic materials that may pose a hazard because of flammability shall be tested in accordance with the requirements described in NASA-STD-6001, Flammability, Offgassing, and Compatibility Requirements and Test Procedures.	**Select Status**		
10.2.1.3. Plastic materials that may pose a hazard because of electrostatic discharge shall be tested in accordance with the requirements described in KSC/MMA-1985-79, Standard Test Method for Evaluating Triboelectric Charge Generation and Decay.	**Select Status**		
10.2.1.4. Plastic materials that may pose a hazard because of hypergolic propellant ignition/breakthrough shall be tested in accordance with the requirements described in KSC/MTB-175-88, Procedure for Casual Exposure of Materials to Hypergolic Fluids, Exothermic Reaction Test Method.	**Select Status**		
10.2.1.5. The results of these tests shall be submitted to the PSWG and Range Safety for review and approval, based on use.	**Select Status**		
10.2.2. Other Hazardous Material Test Requirements:	**I**		
10.2.2.1. Testing of materials whose hazardous properties are not well defined may be required by the PSWG and Range Safety.	**Select Status**		
10.2.2.2. Toxicity, reactivity, compatibility, flammability and/or combustibility testing requirements shall be determined on a case-by-case basis by the PSWG and Range Safety.	**Select Status**		
10.2.2.3. Testing shall consider the following material characteristics:	**Select Status**		
10.2.2.3.1. Ability to build up a charge (triboelectric test).	**Select Status**		
10.2.2.3.2. Ability of that charge to decay (triboelectric test).	**Select Status**		
A material is considered to have good electrostatic dissipation properties if it can dissipate voltage down to 350 volts in 5 seconds using the triboelectric test.	**I**		
10.2.2.3.3. Flammability.	**Select Status**		

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10.2.2.3.4. Compatibility with other materials and liquids the material may come into contact with.	Select Status		
Issues with material compatibility may result in operational restrictions.	I		
10.2.2.4. Material restrictions may also arise from other limitations such as being humidity dependent (for charge dissipation) or degradable in sunlight (ultraviolet).	Select Status		
10.3. Hazardous Materials Environmental Requirements	I		
10.3.1. The use of ozone-depleting chemicals and hazardous materials that result in the generation of regulated hazardous waste shall be minimized to the greatest extent possible in accordance with federal and state regulations.	Select Status		
10.3.2. Appropriate Environmental Planning organizations as determined by the PSWG, and Range Safety shall review and approve hazardous waste management and disposal procedures and plans.	Select Status		
10.3.3. Payload project business plans shall comply with the range Hazardous Materials (HAZMAT) Plan.	Select Status		
10.4. Hazardous Materials Data Requirements	I		
10.4.1. Hazardous materials data requirements shall be submitted in accordance with Attachment 1, A1.2.4.13 of this volume.	Select Status		
10.5. Process Safety Management and Risk Management Plan	I		
10.5.1. The payload project shall comply with 29 CFR 1910.119 and 40 CFR 68, DAFMAN 91-203, Air Force Occupational Safety, Fire and Health Standards, for Process Safety Management (PSM) and Risk Management Plan (RMP) and will be identified in the System Safety Plan (SSP).	Select Status		
10.5.2. PSWG shall confirm KSC representation on the SLD 45 Process Safety Management (PSM) team.	Select Status		

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CHAPTER 11 GROUND SUPPORT PRESSURE, VACUUM, AND HAZARDOUS STORAGE SYSTEMS	**I**		
These requirements establish minimum safety design, fabrication, installation, testing, inspection, recertification, and data requirements for fixed, portable, or mobile ground support hazardous pressure systems. Ground support systems include aerospace ground equipment (AGE), ground support equipment (GSE), missile support systems, real property installed equipment (RPIE), and industrial property.	**I**		
Ground support hazardous pressure systems are defined as follows: ***(1) pressurized systems used to store and transfer hazardous fluids such as cryogens, flammables, combustibles, and hypergols.*** ***(2) systems with operating pressures that exceed 150 psig.*** ***(3) systems with stored energy levels exceeding 14,240 foot pounds.*** ***(4) pressurized systems that are identified as Safety Critical by the PSWG and Range Safety.***	**I**		
11.1. Ground Support Pressure, Vacuum, and Storage Systems Requirements	**I**		
11.1.1. Pressure and vacuum systems shall be designed, fabricated, inspected, tested, and installed in accordance with NASA-STD-8719.17, and with accepted national industry standards such as ASME, American Petroleum Institute (API), Department of Transportation (DOT), National Board Inspection Code (NBIC) NB-23, NFPA, UL, T.O. 00-25-223, Integrated Pressure Systems and Components (Portable and Installed), and federal, state, and local environmental regulations. Ground-based pressure vessels must be ASME code stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. Vessels, cylinders, and tanks used for ground transportation must be DOT stamped in accordance with Title 49 of the Code of Federal Regulations (49CFR) .	**Select Status**		
11.1.1.1. Negative pressure protection shall be provided for vessels and systems not designed to withstand pressure below 1 atmosphere. This can be accomplished by the use of vacuum relief valves, check valves, ambient automatic pressure valves or other suitable relief devices. Vacuum systems shall be designed in accordance with T.O. 00-25-223, Integrated Pressure Systems and Components (Portable and Installed) and NASA-STD-8719.17. Safety relief devices shall be periodically retested in accordance with NASA STD 8719.17 and NBIC NB-23.	**Select Status**		
11.1.3. The requirements for operating hazardous pressure systems found in Volume 6 of this document shall be taken into consideration in the design and testing of these systems.	**Select Status**		
11.2. Ground Support Pressure Systems Requirements	**I**		
11.2.1. Generic Ground Support Pressure System Requirements	**I**		

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11.2.1.1. Generic Ground Support Pressure System Service Life. All pressure system components shall operate safely and reliably during their intended period of service (service life). Components shall not fail at operating conditions in a time period that is four times the service life of the components. In-service inspections, certification (for non-excluded PVS per NASA STD 8719.17), normal preventive maintenance and calibration shall be performed to maintain the service life in accordance with NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS). The source documents for the service life are the ASME Boiler and Pressure Vessel Code (BPVC), API (American Petroleum Institute), etc.	Select Status		
11.2.1.1.2. Other components shall be designed to have a service life of not less than 5,000 cycles.	Select Status		
Normal preventive maintenance and calibration may be performed to maintain the service life. The source document for the service life is the ASME Boiler and Pressure Vessel Code.	I		
11.2.1.2. Generic Ground Support Pressure System Safety Factor. Safety factor for pressure systems is the ratio of design burst pressure over the maximum allowable working pressure (MAWP) or design pressure, whichever is greater. The safety factor can also be expressed as the ratio of tensile strength over the maximum allowable stress for the material. ASME or DOT codes are specified as compliance documents for various components such as pressure vessels and piping throughout this part. Acceptable safety factors have already been incorporated into the specified code. If an ASME or DOT code is not specified in this part as a compliance document for a component (applicable code does not exist), the minimum safety factor for the component shall be 4 , or burst shall be 4 times MAWP.	Select Status		
11.2.1.3. Generic Ground Support Pressure System Failure Tolerance	I		
11.2.1.3.1. Ground support pressure systems shall be designed to ensure that no two failures can result in a catastrophic event and no single failure (component fails to function or human operator error) can result in a critical event.	Select Status		
11.2.1.3.2. Single-failure tolerant systems shall have at least two, PSWG and Range Safety approved, independent and verifiable inhibits in place during all periods when the critical hazard exists. The structural failure of tubing, piping, welded fittings, or pressure vessels are not to be considered single failure.	Select Status		
11.2.1.3.3. Dual-failure tolerant systems shall have at least three, PSWG and Range Safety approved, independent and verifiable inhibits in place during all periods when the catastrophic hazard exists.	Select Status		
11.2.1.4. Generic Ground Support Pressure System Material Selection and Compatibility	I		
11.2.1.4.1. Materials shall be compatible throughout their intended service life with the service fluids and the materials such as supports, anchors, and clamps used in construction and installation of tankage, piping, and components as well as nonmetallic items such as gaskets, seals, packing, seats, and lubricants.	Select Status		
11.2.1.4.2. At a minimum, material compatibility shall be determined in regard to the following criteria: permeability, flammability, ignition and combustion, functional and material degradation, contamination, toxicity, pressure and temperature extremes, shock, oxidation, and corrosion.	Select Status		

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11.2.1.4.3. Brittle materials shall not be used for pressure system components. The nil-ductility transition temperature of materials shall be below the service temperatures. PVS Minimum Design Metal Temperature (MDMT) shall be determined in accordance with ASME BPVC and B31 piping code. Charpy impact and lateral expansion testing of base materials and welds shall be performed as required in accordance with ASME BPVC and B31 piping code.	Select Status		
Material Selection and Testing ***Material properties should be selected in accordance with reputable government and industry sources such as MAPTIS (Materials and Processing Technical Information Systems) or material test results when testing was done in accordance with Range Safety approved testing methods. Reliable sources include the Department of Transportation, Federal Aviation Administration, Office of Aviation Research (DOT/FAA/AR) Metallic Materials Properties Development and Standardization (MMPDS) Handbook; Composite Materials Handbook (CMH)-17;American Society for Testing Materials (ASTM) standards, and the Air Force Damage Tolerant Design Handbook should be used to verify material is not crack sensitive.***	I		
11.2.1.4.4. Materials that could come in contact with fluid from a ruptured or leaky tank, pipe, or other components that store or transfer hazardous fluids shall be compatible with the fluid so that they do not create a flammable, combustible, or toxic hazard.	Select Status		
11.2.1.4.5. Compatible materials selection shall be obtained from one of the following sources:	Select Status		
11.2.1.4.5.1. Integrated Pressure Systems and Components (Portable and Installed) T.O. 00-25-223.	Select Status		
11.2.1.4.5.2. Chemical Propulsion Information Agency (CPIA) 394, Hazards of Chemical Rockets and Propellants.	Select Status		
11.2.1.4.5.3. NASA-STD-6016 B Standard Materials and Processes Requirements for Spacecraft	Select Status		
11.2.1.4.5.4. NASA-STD-6001, Flammability, Offgassing, and Compatibility Requirements and Test Procedures	Select Status		
11.2.1.4.5.5. The NASA Material and Process Technical Information System (MAPTIS). MAPTIS is accessible via the Internet at http://maptis.nasa.gov	Select Status		
11.2.1.4.5.6. KTI-5212, NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes.	Select Status		
11.2.1.4.5.7. MSFC-STD-3029, NASA/MSFC Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments.	Select Status		
11.2.1.4.5.8. Other sources and documents approved by PSWG and Range Safety sources and documents.	Select Status		
11.2.1.4.6. Compatibility Testing	Select Status		
11.2.1.4.6.1. Materials shall be tested for compatibility if data does not exist.	Select Status		
11.2.1.4.6.2. If compatibility testing is performed, the test plan shall be submitted to the PSWG for PSWG and Range Safety review and approval.	Select Status		

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11.2.1.4.7. Compatibility Analysis. A compatibility analysis containing the following information shall be prepared:	Select Status		
11.2.1.4.7.1. List of all materials used in system.	Select Status		
11.2.1.4.7.2. Service fluid in contact with each material.	Select Status		
11.2.1.4.7.3. Materials that may come in contact with leaking fluid.	Select Status		
11.2.1.4.7.4. As requested, source document or test results showing material compatibility in regard to permeability, flammability, ignition and combustion, functional and material degradation, contamination, toxicity, pressure and temperature extremes, shock, oxidation, corrosion, and environmental conditions.	Select Status		
11.2.1.4.8. Metallic components for pressure vessels, pipes, valves, and fittings shall be fabricated from low carbon stainless steel or other alloys that provide adequate strength, corrosion resistance, and material compatibility. Materials specifications shall be in accordance with ASME BPVC and B31 piping code. Material specifications for PVS used for ground transportation shall be in accordance with 49 CFR.	Select Status		
11.2.1.5. Generic Ground Support Pressure System Corrosion Control. Although corrosion control is primarily the responsibility of the maintainer of the equipment, the designer is responsible for providing hardware that cannot present safety problems caused by corrosion. As a minimum, the following potentially critical areas shall be evaluated and appropriately protected:	Select Status		
Table 11.1 Corrosion Control Guidance ***A Range Safety approved corrosion control standard, such as NASA-STD-5008, Protective Coating Of Carbon Steel, Stainless Steel, And Aluminum On Launch Structures, Facilities, And Ground Support Equipment, or NACE RP0285-latest version, Corrosion Control of Underground Storage Tank Systems by Cathodic Protection (published by the National Association of Corrosion Engineers), should be used as guidance for corrosion control. Corrosion protection of fixed outdoor pressure systems includes supports, anchors, and clamps. Avoid use of 17-4PH stainless steel wherever possible due to its susceptibility to stress corrosion cracking at low heat treatment levels. Any 17-4PH stainless steel specified should be heat treated to condition H1025 or higher. Where 300-series stainless steels are specified, type 303 should be avoided wherever possible due to susceptibility to stress corrosion cracking.***	I		
11.2.1.5.1. Carbon steel surfaces exposed to atmospheric corrosion shall be protected by the application of zinc coatings (inorganic zinc or hot dip galvanizing) or equivalent means.	Select Status		
11.2.1.5.2. Stainless steel surfaces exposed to rocket engine exhaust impingement or acid deposits from solid rocket motor exhaust shall be coated with inhibitive poly amide epoxy primer and aliphatic polyurethane topcoat in accordance with NASA-STD-5008, Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures.	Select Status		

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Nitrile, rubber-based, aluminum-pigmented coating (AR-7) is no longer recommended for coating stainless steel surfaces because it has a high volatile organic compound content and is generally unavailable through commercial suppliers.	I		
11.2.1.5.3. Exterior stainless steel surfaces of pressure systems with potential for exposure to hypergolic propellant shall be coated with a compatible inhibitive coating applied in accordance with NASA-STD-5008 unless usage, storage, care, and maintenance processes are in place to prevent any surface corrosion.	Select Status		
Where exterior stainless steel surfaces of GSE pressure systems could be exposed to hydrazine, the surfaces could be coated with inhibitive polyamide epoxy primer and aliphatic polyurethane topcoat that is hydrazine compatible per NASA-STD-6001, Flammability, Offgassing, and Compatibility Requirements and Test Procedures, and applied in accordance with NASA-STD-5008.	I		
11.2.1.5.6. Dissimilar metals shall be protected through mutual isolation.	Select Status		
11.2.1.6. Generic Ground Support Pressure System Contamination Control	I		
11.2.1.6.1. To avoid a hazardous failure, adequate levels of contamination control shall be established by relating the cleanliness requirements to the actual needs and nature of the system and components.	Select Status		
KSC-C-123, Surface Cleanliness of Fluid Systems, Specifications for, or T.O. 42C-1-11, Cleaning, and Inspection Procedures for Ballistic Missile Systems, should be used as guidance in relating cleanliness requirements to the actual needs and nature of the system and components.	I		
11.2.1.6.2. Materials and fluids used in the design shall be selected to reduce internally generated contamination caused by rate of wear, friction, and fluid decomposition.	Select Status		
11.2.1.6.3. Systems shall have acceptable contamination tolerance levels. The tolerance level of the system and/or components shall be based on considerations of the overall functional requirements and service life.	Select Status		
11.2.1.6.4. The system shall be designed to verify, through sampling, that the lines and components are clean after flushing and purging of the system.	Select Status		
11.2.1.6.5. Each component or section of a system shall be cleaned to the appropriate level before installation. Immediately following cleaning, all components or sections of a system shall be protected to prevent contamination.	Select Status		
11.2.1.6.6. Equipment designed to be cleaned or recleaned in place without significant disassembly shall be provided with high point bleeds and low point drains to facilitate introduction and removal of cleaning fluid.	Select Status		
11.2.1.6.7. Filters shall be installed immediately downstream of all interfaces where control of particulate matter is critical and at other appropriate points as required to control particulate migration.	Select Status		

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11.2.1.6.8. Filter design shall permit easy servicing and ready accessibility.	Select Status		
11.2.1.7. Generic Ground Support Pressure System Identification and Marking. All hazardous pressure system components shall be identified as to function, content, applicable hazard, and, if applicable, direction of flow. The marking and identification shall be accomplished by some means that cannot cause “stress concentration” or otherwise reduce the integrity of the system. Minimum identification and marking requirements are as follows:	Select Status		
11.2.1.7.1. Fixed Pressure Vessels.	I		
11.2.1.7.1.1. Fixed pressure vessels shall be code stamped IAW the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, *Rules for Construction of Pressure Vessels*, or ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, *Alternative Rules – Rules for Construction of Pressure Vessels.*	Select Status		
11.2.1.7.1.2. The maximum pressure at which fixed pressure vessels shall be normally operated and the name of the working fluid shall be painted in a conspicuous location on the vessel facing the roadway approach, if possible. This additional labeling shall be legible at a distance of 50 feet under clear daytime conditions.	Select Status		
11.2.1.7.2. Portable and mobile pressure vessels shall be marked in accordance with the applicable DOT specifications.	Select Status		
11.2.1.7.3. Individual lengths or fabricated assemblies of pipe and tubing shall be identified with part number and/or contractor tracking number, pipe or tube size, schedule number or wall thickness, test pressure, and the date of hydrostatic and/or pneumatic test. Identification data shall be affixed to fabricated assemblies by means of an attached stainless steel band or “dog tag” that has been stamped or electrochemically etched. When the tag does not contain the above identification data, data shall be made available for review on site.	Select Status		
11.2.1.7.4. Fixed ground support piping and tubing runs external to regulation and control panels and consoles shall be identified and marked with commodity, maximum operating pressure (MOP) and flow direction along with applicable hazard warnings and symbols identified and marked in accordance with ASME A13.1, Scheme for the Identification of Piping Systems.	Select Status		
11.2.1.7.5. Fixed ground support piping and tubing runs shall be identified in accordance with MIL-STD-101C, *Color Code for Pipelines and for Compressed Gas Cylinders* or equivalent.	Select Status		
11.2.1.7.6. Shutoff and metering valves, pressure relief valves, regulators, gauges, check valves, quick disconnect ground half couplings, and filters shall have the manufacturer part number, unique serial number, and system reference designation for the component (i.e., CV1, CV2), permanently attached to the body by stamping, engraving, or tagging when acceptable to the PSWG and Range Safety. The following information shall be provided in the SDP (MSPSP):	Select Status		
11.2.1.7.6.1. Manufacturer and/or contractor name.	Select Status		
11.2.1.7.6.2. Manufacturer part number.	Select Status		
11.2.1.7.6.3. Applicable design pressure rating.	Select Status		

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11.2.1.7.6.4. Service media.	**Select Status**		
11.2.1.7.6.5. Month and year of most recent calibration for gauges and transducers.	**Select Status**		
11.2.1.7.6.6. Flow direction arrow, if applicable.	**Select Status**		
11.2.1.7.6.7. System reference designation for the component, such as CV1, CV2.	**Select Status**		
11.2.1.7.6.8. Unique serial number.	**Select Status**		
11.2.1.7.7. All manual pressure system regulation and control panels and consoles shall be clearly marked with a flow schematic, operating parameters, and component identification.	**Select Status**		
11.2.1.7.8. The system shall be designed or marked to prevent incorrect installation of filters.	**Select Status**		
11.2.1.7.9. Flexible hoses shall be provided with an identification tag that is permanently and legibly marked with the manufacturer part number, unique serial number, and system reference designation for the hose (i.e., FH1, FH2), and the following shall be provided in the SDP:	**Select Status**		
11.2.1.7.9.1. Manufacturer name.	**Select Status**		
11.2.1.7.9.2. Manufacturer and/or contractor part number.	**Select Status**		
11.2.1.7.9.3. Hose size, date of manufacture, and effective shelf/use life.	**Select Status**		
11.2.1.7.9.4. Maximum allowable working pressure (MAWP) or manufacturer rated working pressure.	**Select Status**		
11.2.1.7.9.5. Service media.	**Select Status**		
11.2.1.7.9.6. Month and year of most recent hydrostatic test and test pressure.	**Select Status**		
11.2.1.7.9.7. System reference designation for the hose, such as FH1, FH2.	**Select Status**		
11.2.1.7.9.8. Unique serial number.	**Select Status**		
11.2.1.7.10. Pressure relief devices shall be permanently and legibly marked in accordance with ASME BPVC. Pressure relief valves which have been periodically set point tested in accordance with NASA-STD-8719.17 and NBIC NB-23 shall have repair or test only nameplates permanently affixed and marked in accordance with NBIC NB-23 with the appropriate "T/O" or "VR" stamp.	**Select Status**		

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11.2.1.8. Generic Ground Support Pressure System Bonding and Grounding. Electrical bonds are classified according to the purpose for the bond: Class C for power return, Class H for shock hazard, Class R for radio frequency, Class L for lightning, and Class S for electrostatic charge. There may be more than one purpose for bonding a specific interface, and the bond shall meet the requirements of each applicable class maintaining all conductive external parts and surfaces at ground potential at all times and in all anticipated conditions. At a minimum electrostatic charge build-up must be addressed. NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment, and NFPA 77, Recommended Practices on Static Electricity, shall be used for guidance. All pressure systems shall be designed to ensure that all piping, tubing, external parts, shields, and surfaces are at ground potential at all times. To control and dissipate the build-up of electrostatic charges, all pressure systems shall be properly bonded, grounded, and constructed to provide the following:	**Select Status**		
11.2.1.8.1. Any single joint measurement shall exhibit a DC resistance of 1.0 ohm or less.	**Select Status**		
11.2.1.8.2. DC resistance from any point in the piping and tubing system to the nearest earth electrode ground plate shall be 1.0 ohm or less.	**Select Status**		
11.2.1.8.3. A low-impedance path to earth shall be provided for electrical currents resulting from lightning discharges or electrical power system faults to minimize abnormal voltage rises that might injure personnel or damage equipment.	**Select Status**		
11.2.1.8.4. A discharge path shall be provided between distribution piping and tubing and earth to prevent the buildup of static electricity.	**Select Status**		
11.2.1.8.7. Flanged joints are acceptable if the flanges are stainless steel or the flanged areas in contact with the bolt heads and washers are clean and bright. In addition, the bolts and nuts shall be equipped with serrated or spring washers to maintain tightness.	**Select Status**		
11.2.1.8.8. Tubing sections joined with fittings that seat metal-to-metal are considered adequately bonded.	**Select Status**		
11.2.1.8.9. All mobile equipment shall be equipped for connection to bonding and grounding stations at fixed facility transfer apron areas.	**Select Status**		
11.2.1.8.10. Grounds shall be provided for propellant loading systems (flight propulsion systems or ground propellant tanks) to allow for common grounding and bonding during propellant transfer operations. Loading systems include portable vessels and units.	**Select Status**		
11.2.1.8.11. The use of interconnecting dissimilar ground metals that could lead to increased resistance due to galvanic corrosion over a relatively short time period shall be avoided.	**Select Status**		
11.2.1.8.12. Nonmetallic plumbing installations shall be designed so that the static voltage, generated by fluid flow, will not exceed 350 volts at any point outside the pipes, tubes, or hoses.	**Select Status**		
11.2.1.8.13. The resistance of nonmetallic hoses shall not exceed 1.0 megohm per meter of length so as to dissipate charges developing within the fluid or between fluid and the hose.	**Select Status**		

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11.2.1.9. Generic Ground Support Pressure System Physical Arrangement and Human Factors. Pressure systems shall be designed to provide adequate accessibility, clearance, and operating safety.	Select Status		
MIL-STD-1472 or the equivalent should be used as guidance in designing pressure system operating consoles.	I		
11.2.1.9.1. Hypergolic propellant system design shall take into consideration the limitations imposed on individuals dressed in Self-Contained Atmospheric Protective Ensemble (SCAPE) suits or Propellant Handlers Ensemble (PHE).	Select Status		
11.2.1.9.2. All components and piping shall be located so they are readily accessible for maintenance, inspection, and calibration. All piping shall be located to preclude a hazard to personnel (tripping or head injury).	Select Status		
11.2.1.9.3. Tubing shall be located and protected so that damage cannot occur due to being stepped on, used as handholds, or by manipulation of tools during maintenance.	Select Status		
11.2.1.9.4. Pressure lines shall clear all structures, components, and other lines by not less than 1/4 inch under the most adverse conditions of service to ensure that abrasive chafing does not occur.	Select Status		
11.2.1.9.5. Piping, tubing, and other components shall be routed or located to provide protection from other operational hazards, including moveable equipment. Where such exposure is unavoidable, safeguards that minimize the effects of such exposure shall be incorporated in the design.	Select Status		
11.2.1.9.6. Maximum spacing shall be provided between oxidizer and fuel lines to preclude mixing and combustion. A minimum of 24 inches shall be provided.	Select Status		
11.2.1.9.7. Pipes containing liquids shall not be attached or secured to electrical lines or conduit.	Select Status		
11.2.1.9.8. A two-inch space shall be maintained between electrical conduits and pressure lines.	Select Status		
11.2.1.9.9. Vent outlets shall be located far enough away from incompatible propellant systems and incompatible materials to ensure that no contact is made during vent operations.	Select Status		
11.2.1.9.10. System connections for incompatible propellants shall be keyed, sized, or located so that it is physically impossible to interconnect them.	Select Status		
11.2.1.9.11. Safety relief valves and burst diaphragms shall be located so that their discharge is directed away from personnel and any safety critical equipment to prevent injury to personnel or damage to safety critical equipment. If this requirement cannot be met, safety valves and burst diaphragms shall be equipped with deflection devices. Consideration shall be given to minimizing the noise hazard of high pressure venting.	Select Status		
11.2.1.9.12. Vent lines for flammable and combustible vapors, toxic gases, and gas streams that may be contaminated with toxic vapors shall be extended away from work areas to prevent accidental ignition of vapors and/or injury to personnel.	Select Status		

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11.2.1.9.13. Pipe or flexible hose routing shall not block personnel egress routes.	**Select Status**		
11.2.1.9.14. Pressure systems shall be designed so that the operator is not required to leave the operating control station to monitor the hazard level of that system.	**Select Status**		
11.2.1.9.15. Valves carrying hazardous liquids shall not be located overhead in the area of an operating station.	**Select Status**		
11.2.1.9.16. Manually operated liquid valves shall be located to permit operation from the side or above to prevent spillage of service fluid on the operator due to leak or failure of the valve seals.	**Select Status**		
11.2.1.9.17. For systems with failure modes that could result in a time-critical emergency, provision shall be made for automatic switching to a safe mode of operation. Caution and warning signals shall be provided for these time-critical functions.	**Select Status**		
11.2.1.9.18. Pressure systems shall be designed so that removal and replacement of tubing can be accomplished with minimal removal of other system components.	**Select Status**		
11.2.1.9.19. Systems shall be designed with accessibility to perform end-to-end static ground system checks.	**Select Status**		
11.2.1.9.20. Pipes containing hazardous liquids shall be routed with a continuous downward slope to prevent the accumulation of trapped liquid fluids and allow draining of the lines.	**Select Status**		
11.2.1.9.21. Where possible, pipes carrying hazardous liquids shall be mounted so that the liquid cannot be trapped in internal cavities when it is drained.	**Select Status**		
11.2.1.9.22. High pressure lines and components shall be protected from damage due to leakage, servicing, or other operational hazards created by other systems.	**Select Status**		
11.2.1.9.24. Components shall be located, and lines routed to minimize the risk of ignition should a leak or rupture occur.	**Select Status**		
11.2.1.9.25. Pressure lines shall not be installed inside conduit, large pipe, or tubing for protective support. ***Exception: Lines may be enclosed in protective conduit, pipes, or tubing when routed under roadways, obstructions, and through thick walls.***	**Select Status**		
11.2.1.9.26. System components such as a hand regulator and gauge that are closely related shall be arranged to allow operation and surveillance from a common point.	**Select Status**		
11.2.2. Ground Support Pressure System Hardware Design Requirements	**I**		
11.2.2.1. Ground support pressure systems shall be designed IAW the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, 2, or 3, ASME Code for Pressure Piping, B31, and all other applicable consensus standards and requirements contained in paragraph section 11.2.2. Pressure systems test shall be performed IAW paragraph section 11.2.3. Ground Support Pressure System Testing.	**Select Status**		

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11.2.2.2. Propellant systems shall be designed to ensure separation of fuels and oxidizers to prevent inadvertent mixing during operations.	Select Status		
11.2.2.3. All calibration adjustments shall be designed so that the setting, position, or adjustment cannot be inadvertently altered.	Select Status		
11.2.2.4.12. If DOT vessels are used in portable GSE, maintenance and operating procedures for periodic hydrostatic tests shall be in accordance with DOT regulations.	Select Status		
11.2.2.4.13. All pressure vessels shall be designed to allow for a minimum 10-percent ullage space at full-load conditions.	Select Status		
11.2.2.5. Portable or Mobile Pressure Vessel	I		
11.2.2.5.1. Mobile equipment for public and range highway use shall be designed, fabricated, inspected, tested, and periodically retested and requalified IAW all requirements in 49 CFR. A copy of any DOT-approved exemptions shall be provided to the appropriate local safety authority as identified by the PSWG and Range Safety.	Select Status		
11.2.2.5.2. DOT pressure vessels shall be protected against overpressure in accordance with 49 CFR.	Select Status		
11.2.2.5.3. DOT pressure vessels used and approved for use in a fixed ground-based system shall be provided overpressure protection in accordance with ASME BPVC. DOT specification vessels in permanent or semi-permanent installations that do not strictly comply with 49 CFR 171-180 shall be designated and certified as non-Code PVS and all requirements within NASA-STD-8719.17 Sections 4.7.8 and 4.10.6 apply which includes ASME Equivalent Derating. The original cylinder working pressure shall be de-rated for NASA use, based on equivalent stress ratio between DOT and ASME, to increase the material FS to be FS =4 (or other appropriate FS applicable to the time and material of construction).	Select Status		
11.2.2.6. Ground Support Pressure System Piping. At a minimum, all piping installations shall be designed in accordance with ASME B31.3, Process Piping, in addition to the following:	Select Status		
11.2.2.6.1. Pipe material shall be in accordance with ASTM A312 /A312M, Standard Specifications for Seamless and Welding Austenitic Stainless Steel Pipes, and ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe or B36.19M, Stainless Steel Pipe.	Select Status		
Recommended pipe material is cold-drawn seamless, ASTM A312 grade TP304L or TP316L stainless steel.	I		
11.2.2.6.2. Weld fittings such as tees, crosses, elbows, and reducers shall be of the butt-weld type in accordance with ANSI/ASME B16.9, Factory Made Wrought Steel Butt Welding Fittings.	Select Status		
Butt-weld fittings should be constructed of ASTM A403, grade WP-316L or WP-304Lwrought stainless steel.	I		

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11.2.2.6.3. Mechanical joints shall be made of forged ASTM A182 F340L or F316 butt-weld hubs, ASTM A182 F304 or F316 clamp assemblies, and type 17-4PH Teflon-coated seal rings. Where system design dictates the use of industrial flanged-type mechanical joints, they shall be in accordance with ANSI B16.5, Pipe Flanges and Flanged Fittings. Flange serrations shall be of concentric design. Flange gaskets shall conform to ANSI/ASME B16.21, Nonmetallic Flat Gaskets for Pipe Flange, and be compatible with the media.	**Select Status**		
11.2.2.6.4. Threaded National Pipe (NPT) thread connectors shall not be used in hazardous pressure systems unless approved by PSWG, Range Safety, and the Center Pressure Systems Manager. **Exception**: ***With prior approval from PSWG and Range Safety, NPT connectors may be used for selected supply components in some compressed nitrogen (GN_2) or helium (GHe) gas pipeline metering and letdown stations. The following guidelines will apply:***	**Select Status**		
11.2.2.6.4.1. Maximum Operating Pressure shall not exceed 6,000 psig.	**Select Status**		
11.2.2.6.4.2. NPT connection size shall not exceed 1-inch nominal pipe size.	**Select Status**		
11.2.2.6.4.3. Selected components are sample ports, vent/blowdown valves, pressure indicators, thermowells, and pressure regulation sensors.	**Select Status**		
11.2.2.6.4.4. NPT connectors used for connections that do not require repeated demating/mating shall have effective corrosion control applied to the exposed threads to prevent external corrosion from weakening the high stress points.	**Select Status**		
11.2.2.6.4.5. All of the selected components installed with NPT connections shall face away from high traffic areas and be anchored or shielded to mitigate projectile risk if an NPT connector does fail.	**Select Status**		
11.2.2.6.4.6. Signs shall be placed in the metering and letdown stations warning personnel not to step on or grab the pipe or components protruding from the pipe due to use of NPT connectors in the pressure system.	**Select Status**		
11.2.2.6.4.7. All connections that require periodic demating/mating for periodic maintenance purposes (such as relief valve functional testing) shall use MS or equal straight thread connectors; NPT connectors shall not be used.	**Select Status**		
11.2.2.6.4.8. Pressure reducing regulators and control valves shall not be installed in the pipeline using NPT (tapered thread) fittings. Connections such as hub and seal ring connectors or flanged connections are recommended. Pipe hubs are specifically designed for large, high-pressure connections.	**Select Status**		
11.2.2.6.5. Socket welded flanges shall not be used in hazardous pressure system piping.	**Select Status**		
11.2.2.6.6. All piping welds shall be of the full penetration butt-weld type.	**Select Status**		
11.2.2.6.7. All piping and fitting butt welds used to fabricate hazardous pressure systems shall be 100 percent visually and radiographically inspected. Accept/reject criteria shall be in accordance with ASME B31.3, Table 341.3.2A or Table K341.3.2A for pressure systems equal to or greater than 6,000 psi.	**Select Status**		

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11.2.2.6.8. Cryogenic piping systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.	Select Status		
Offset bends and loops rather than bellows should be used for this purpose wherever possible.	I		
11.2.2.6.10. All piping shall be located so that it is not hazardous to working personnel.	Select Status		
11.2.2.6.11. Cryogenic Pipe Weld Inspection	Select Status		
11.2.2.6.11.1. All inner pipe welds shall be 100 percent radiographically inspected.	Select Status		
11.2.2.6.11.2. The accept/reject criteria shall be in accordance with Table 341.3.2A of ASME B31.3, or Table K341.3.2A for pressures equal to or above 6000 psi.	Select Status		
11.2.2.7. Ground Support Pressure System Tubing. Tubing connections can be of a butt-weld type or by use of precision 37-degree fittings.	Select Status		
If welded, pneumatic distribution tubing should be annealed seamless, stainless steel type 304/316 or 304L/316L.	I		
11.2.2.7.1. If 37-degree flared end fittings are used, they shall be designed in accordance with precision type AN, MS, or KSC-GP-425, Fluid Fitting Engineering Standards, standards.	Select Status		
The material used to join 37-degree flared end fittings should be type 316 stainless steel.	I		
11.2.2.7.2. If butt-weld fittings are used to join tubing, they shall be designed in accordance with KSC-GP-425 or equivalent.	Select Status		
The material should be type 304L or 316L stainless steel.	I		
11.2.2.7.3. All tubing and butt-weld fitting welds shall be 100 percent visually and radiographically inspected. The accept and reject criteria shall be in accordance with Table 341.3.2 of ASME B31.3.	Select Status		
11.2.2.7.4. Tubing used with AN or MS fittings shall be flared per SAE AS4330, Design Standard - Standard Dimensions for Flared Tubing, and tubing used with KSC-GP-425 fittings shall be flared per KSC-GP-425. "Crush" washers are prohibited.	Select Status		
11.2.2.7.5. Since flared tubing is not designed for service above 6,000 psig, PSWG, Range Safety, and the Center Pressure Systems Manager approved super pressure tubing shall be used for service above 6,000 psig.	Select Status		
11.2.2.7.6. Fabrication and installation of tubing using KSC-GP-425 fittings shall be in accordance with KSC-SPEC-Z-0008, Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies.	Select Status		

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11.2.2.7.7. Tube fittings with NPT connectors shall not be used in hazardous pressure systems.	Select Status		
11.2.2.7.8. The number of mechanical joints in tubing systems shall be kept to a minimum.	Select Status		
Table 11.4 Steel Types for Pressure System Tubing ***All pressure gauge material that normally contacts the service fluid should be type 316 stainless steel. Exception: Bourdon-tube bleed screws may be constructed of any 300-series stainless steel.***	I		
11.2.2.7.9. Tubing shall be seamless, stainless steel per ASTM A269, Seamless and Welded Austenitic Stainless Steel Tubing.	Select Status		
11.2.2.8. Ground Support Pressure System Regulators	I		
11.2.2.8.1. Regulators shall be sized to accurately control the pressure to be used in the system.	Select Status		
11.2.2.8.2. Manually operated regulators shall be selected so that over torquing the regulator cannot damage soft seats to the extent that seat failure occurs.	Select Status		
11.2.2.8.3. Regulators shall be designed so that a functional failure cannot create a hazard to personnel.	Select Status		
11.2.2.8.4. Dome loaded pressure regulators shall be designed to withstand a differential pressure across the diaphragm and/or piston equal to the maximum rated inlet pressure without damage. A means of venting the dome loading circuit shall be provided.	Select Status		
11.2.2.8.5. Pressure regulator actuators shall be capable of shutting off the fluid when the system is at the maximum possible flow and pressure.	Select Status		
11.2.2.8.6. A regulator shall not be used as a safety critical component or be required to function to prevent a failure that might injure personnel.	Select Status		
11.2.2.8.7. For each stage of regulation, the ratio of upstream-to-downstream pressure shall not exceed 10:1 for optimum control.	Select Status		
11.2.2.8.8. Regulators shall be selected so their working pressure falls within the center 50 percent of the total pressure range if it is susceptible to inaccuracies or creep at either end of the pressure range.	Select Status		
11.2.2.8.9. Regulator designs using uncontained seats shall not be used.	Select Status		
11.2.2.8.10. The use of a sheathed flexible actuator such as push-pull wires and torque wires for regulator control is prohibited.	Select Status		
11.2.2.8.11. Remote readout pressure transducers are required to monitor hazardous operations from a remote location.	Select Status		

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11.2.2.9. Ground Support Pressure System Valves	I		
11.2.2.9.1. Both manual and automatic valve actuators shall be operable under maximum design flow and pressure for complete opening and closing the respective valve.	Select Status		
11.2.2.9.2. Remotely operated valves shall be designed to be fail-safe if pneumatic or electric control power is lost.	Select Status		
11.2.2.9.3. Designs using uncontained seats shall not be used.	Select Status		
11.2.2.9.4. Use of metal-to-metal seats without prior PSWG, Range Safety, and Center Pressure Systems Manager concurrence is prohibited.	Select Status		
Metal-to-metal seats are not suited for frequent mate/demate activities, as the seats are subject to scratching and damage when demated, which leads to increased leakage. They are suitable for permanent or rarely demated connections.	I		
11.2.2.9.5. Inlet and outlet isolation valves (shutoff valves) and appropriate intermediate vent valves shall be provided for shutdown and maintenance.	Select Status		
11.2.2.9.6. Valve stem travel shall be limited by a positive stop at each extreme position.	Select Status		
11.2.2.9.7. The application or removal of force to the stem positioning device shall not cause disassembly of the pressure containing structure of the valve.	Select Status		
11.2.2.9.8. Manually operated valves shall be designed so that over torquing the valve stem cannot damage soft seats to the extent that seat failure occurs.	Select Status		
11.2.2.9.9. Inlet and outlet isolation valves shall be capable of isolating the maximum allowable working pressure in both directions without seat failure.	Select Status		
11.2.2.9.10. Fast opening valves that can produce high velocity kinetic effects or heating effects due to rapid pressurization shall not be used.	Select Status		
11.2.2.9.11. Systems shall have shutoff valves located as close to the supply vessel as practical and be readily accessible.	Select Status		
11.2.2.9.12. Remotely controlled valves shall provide for remote monitoring of open and closed positions.	Select Status		
11.2.2.9.13. Local or remote stem position indicators shall sense the position of the stem directly, not the position of the actuating device.	Select Status		
11.2.2.9.14. For remotely controlled valves, positive indication of actual valve position shall be displayed at the control station. Indication of valve stem position or flow measurement is an acceptable indication. Indication of a remote command being initiated is not a positive indication of valve position.	Select Status		

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11.2.2.9.15. Valves used in flared tubing system applications shall be designed for panel or other rigid mounting.	Select Status		
11.2.2.9.16. All pressure system valves that are required to be in a closed or open position during system operation shall be protected against inadvertent actuation by physical means.	Select Status		
Examples of physical means to protect against inadvertent actuation are mechanical stops, lock wires, or access control.	I		
11.2.2.9.17. Valves that are not intended to be reversible shall be designed or marked so that they cannot be connected in a reverse mode.	Select Status		
11.2.2.9.17.1. Check valves shall be provided where back flow of fluids would create a hazard.	Select Status		
11.2.2.9.17.2. Check valves shall be the spring-loaded type with soft seats.	Select Status		
11.2.2.9.18. The use of sheathed flexible actuators, such as push/pull wires and cables, for valve control is prohibited.	Select Status		
11.2.2.9.19. All electrical control circuits for remote activation shall be shielded or otherwise protected from hazardous stray energy.	Select Status		
11.2.2.9.20. Balanced manual valves that use external balancing ports or vents open to the atmosphere shall not be used.	Select Status		
11.2.2.9.21. Remotely operated flow control valves shall be operated pneumatically, electrically, or hydraulically and shall be capable of fail-safe operation to either the open or closed position. Determination of fail-safe mode (the open or closed position) shall depend on the system characteristics.	Select Status		
11.2.2.10. Ground Support Pressure System Vents, Drains, Low Points, Bleeds, Test Ports, and Sampling Ports. All pressure and propellant systems shall have a low-point drain capability unless prohibited by the DOT, as well as a high-point bleed capability with easy accessibility.	Select Status		
11.2.2.10.1. Pressure and propellant systems shall be designed so that commodities cannot be trapped in any part of the system without vent capability. ***Exception: Loosening of fittings to vent trapped pressure is allowed when the fluid under pressure is non-hazardous and only for the purpose of calibrating or replacing pressure gauges or transducers that are provided with an upstream isolation valve where the total trapped volume does not exceed 1.5 cubic inches.***	Select Status		
11.2.2.10.2. Vent system outlets shall be in a location normally inaccessible to personnel and shall be conspicuously identified.	Select Status		
11.2.2.10.3. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	Select Status		

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11.2.2.10.4. Oxidizer and fuel vent outlets to the atmosphere shall be separated sufficiently to prevent mixing of vented fluids/gases.	Select Status		
11.2.2.10.5. All vent outlets shall be designed to preclude accumulation of vented fluid in dangerous concentrations in areas frequented by unprotected personnel or motor vehicles.	Select Status		
11.2.2.10.6. Vent line supports shall be designed to withstand reaction loads due to the actuation of safety relief devices in accordance with ASME B31.3, paragraph 322.6.2.	Select Status		
11.2.2.10.7. Each line venting into a multiple-use vent system shall be protected against back pressurization by a check valve if the upstream system cannot withstand the back pressure or where contamination of the upstream system cannot be tolerated.	Select Status		
11.2.2.10.8. Incompatible fluids shall not be discharged into the same vent or drain system.	Select Status		
11.2.2.10.9. Fuel and oxidizer vent systems shall be equipped with a means of purging the system with an inert gas to prevent explosive mixtures.	Select Status		
11.2.2.10.10. Vent systems shall be sized to provide minimum back pressures consistent with required venting flow rates. In no case shall back pressures interfere with proper operation of relief devices. The calculated capacity of any pressure relief system may be determined by analyzing the total system resistance to flow. This analysis shall take into consideration the flow resistance of the piping and piping components including the exit nozzle on the vessels, elbows, tees, reducers, and valves. The calculation shall be made using accepted engineering practices for determining fluid flow through piping systems. This calculated relieving capacity shall be multiplied by a factor of 0.90 or less to allow for uncertainties inherent in this method. The aggregate capacity of the open flow paths, or vents, shall be sufficient to prevent overpressure in excess of those specified in ASME BPVC Division 1, UG-125(c). When the MAWP is 15 psi (105 kPa) or less, in no case shall the pressure be allowed to rise more than 21% above the MAWP.	Select Status		
11.2.2.10.11. Personnel and critical equipment shall be protected from potential venting hazards.	Select Status		
11.2.2.10.12. Bleed ports shall be located so that they can be operated with minimal removal of other components and permit the attachment of a hose to direct the bleed-off material into a container, away from the positions of the operators.	Select Status		
11.2.2.10.13. Test points shall be provided on pressure systems so that disassembly for test is not required.	Select Status		
11.2.2.10.14. Test points shall be easily accessible for attachment of ground test equipment.	Select Status		
11.2.2.10.15. A sampling port shall be provided upstream and downstream of each regulator in any pneumatic branch line that interfaces with a hypergolic propellant system to permit periodic sampling and analysis of the medium for contamination.	Select Status		
11.2.2.10.16. Sample ports shall be provided at cryogenic system low points.	Select Status		
11.2.2.10.17. A single pressure gauge shall be provided at some point downstream either in the pneumatic system or the propellant system to indicate the pressure in the propellant system.	Select Status		

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11.2.2.10.18. Gauge calibration ports shall be designed to limit potential impingement of contaminated gas on personnel.	Select Status		
11.2.2.10.20. Normal discharge of the protective purge gas from a hazard proofed-enclosure outlet shall be to an unclassified location, or to a Division 2 or Zone 2 location if the equipment does not create ignition capable particles during normal operation.	Select Status		
11.2.2.11. Ground Support Pressure System Indicating Devices	Select Status		
11.2.2.11.1. All pressure gauges shall conform to the requirements of ASME B40.1, Gauges, Pressure Indicating Dial Type. ***Exception: Pressure gauges that are part of a cylinder regulator assembly such as those used with cutting, welding, or other industrial equipment are exempt from these requirements as are gauges associated with pneumatic controllers, positioners, and other standard process control equipment.***	Select Status		
11.2.2.11.2. A pressure indicating device shall be connected downstream of each pressure regulator, on each storage system, and on any section of the system where pressure can be trapped.	Select Status		
11.2.2.11.3. Gauges shall be sized to accurately display the pressure to be used in the system.	Select Status		
11.2.2.11.4. All pressure gauges shall be equipped with a full diameter pressure release back that shall be sized for maximum flow without case rupture.	Select Status		
11.2.2.11.5. Gauges shall be securely attached to a panel or other rigid mounting.	Select Status		
11.2.2.11.6. If pressure gauge isolation valves are used, they shall be designed so that they can be secured in the open position.	Select Status		
Lock wiring is an acceptable means of securing pressure gauge isolation valves in the open position.	I		
11.2.2.11.7. Gauge installations shall be designed to have a minimum of one-inch clearance to allow unrestricted venting in the event the gauge vents. Personnel and equipment shall be protected from the vent area.	Select Status		
11.2.2.11.8. Gauges shall be selected so that the normal operating pressure falls between 25 percent and 75 percent of the scale range, except for gauges used in applications that require a wide range of operating pressure, which shall not exceed 95 percent of scale range of the gauge.	Select Status		
11.2.2.11.9. Remote readout pressure transducers shall be used when it is necessary to monitor hazardous operations from a remote location.	Select Status		
11.2.2.11.10. Pressure gauges shall be of one-piece, solid-front, metal-case construction, using an optically clear shatterproof window made of high-impact, non-cracking plastic, heat-treated glass, or laminated glass.	Select Status		

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11.2.2.11.11. Liquid system liquid sensors suitable for indicating the presence or absence of liquid shall be provided.	Select Status		
Metals that could come in contact with the service medium should be compatible, such as type 304 or 316 stainless steel.	I		
11.2.2.11.12. Liquid system liquid level indicators that contain welded portions (typically magnetic float type) shall be constructed of stainless steel.	Select Status		
Low carbon stainless steels such as type 304L or 316L should be used for welded parts.	I		
11.2.2.11.13. For liquid systems, the use of glass-faced or radiation source emitting liquid level indicators is prohibited. Other prohibited types include capacitance, conductive, and pressure/density types due to historical operational failures and continuous maintenance problems.	Select Status		
11.2.2.11.14. Liquid system sight glasses used for liquid level indicators shall be protected from physical damage.	Select Status		
11.2.2.11.15. As required, pressure gauges shall allow for precision cleaning and verification of cleanliness by particle analysis and non-volatile residue analysis; for example, a bourdon tube tip bleeder or equivalent.	Select Status		
11.2.2.11.16. Each pressure-indicating device shall be provided with an isolation valve and a test connection (test port) between the isolation valve and the pressure-indicating device. Trapped volume between the isolation valve and the pressure-indicating device shall not exceed 1 inch^3.	Select Status		
11.2.2.11.17. The operating range-of-pressure transducers used for monitoring pressures during hazardous operations shall not be less than 1.2 and not more than 2.0 times the system MOP.	Select Status		
11.2.2.12. Ground Support Pressure System Flexible Hoses - Flexible hoses shall be used only when required for hookup of portable equipment or to provide for movement between interconnecting fluid lines when no other feasible means is available.	Select Status		
11.2.2.12.1. Unless otherwise specified, each flexible hose assembly shall be hydrostatically tested to a minimum 1.5 times the hose's MAWP at the time of manufacture/fabrication and retested if they are modified or repaired. The hose shall not be damaged or deformed nor leak when subjected to its required pressure.	Select Status		
11.2.2.12.2. Flexible hoses shall consist of a flexible inner pressure carrier tube (compatible with the service fluid) constructed of [typically poly-tetrafluoroethylene (PTFE) for hypergolic fluid] or corrugated metal (typically 300-series stainless steel) material reinforced by one or more layers of 300-series stainless steel wire and/or fabric braid.	Select Status		
In applications where stringent permeability and leakage requirements apply, hoses with a metal inner pressure carrier tube should be used. Where these hoses are used in a highly corrosive environment, consideration should be given to the use of Hastalloy C-22 in accordance with ASTM B575 for the inner pressure carrier tube and C-276 material for the reinforcing braid.	I		

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11.2.2.12.3. Flexible hoses shall be provided with 300-series stainless steel end fittings of the coupling nut, 37-degree flared type or with fittings to mate with the appropriately sized ASME B16.5 flange or KC159 hub. Other end fittings may be used for unique applications, with prior PSWG and Range Safety approval.	Select Status		
11.2.2.12.4. Flexible hoses shall not be interchanged among incompatible service media. Permeation is not totally negated by any cleaning process. Hoses shall be dedicated to a service media.	Select Status		
11.2.2.12.5. Flexible hoses that could subject personnel to injury or cause damage or loss of safety critical or mission essential hardware, to a whipping hazard in the event of end connection failure, shall meet the following restraint requirements:	Select Status		
11.2.2.12.5.1. Flexible hoses shall be restrained at each end by an approved stainless resistant device and securely attached across each union or splice at intervals not to exceed 6 feet. Flexible hose installations that are 6 feet long or longer shall be configured so that restraint is provided on both the hose and adjacent structure at no greater than 6-foot intervals and at each end to prevent personnel injury in the event of a flexible hose rupture or breakaway.	Select Status		
11.2.2.12.5.2. Hose end restraints shall be securely attached to the structure in a manner that does not interfere with the hose flexibility.	Select Status		
11.2.2.12.5.3. Flexible hose restraint devices shall be capable of withstanding not less than 1.5 times the open line pressure force. See Table 11.2 below.	Select Status		
11.2.2.12.5.4. The design safety factor for restraint devices shall not be less than 3 on material yield strength.	Select Status		
11.2.2.12.5.5. Temporary flexible hose installations may be weighted with 50-pound sandbags, lead ingots, or other suitable weights at intervals not to exceed 6 feet.	Select Status		
11.2.2.12.5.6. Hose clamp-type restraining devices shall not be used.	Select Status		
11.2.2.12.6. Flexible hose installation shall be designed to avoid abrasive contact with adjacent structures or moving parts.	Select Status		
11.2.2.12.7. Flexible hose assemblies shall not be installed in a manner that will place a mechanical load on the hose or hose fittings to an extent that will degrade hose strength or cause the hose fitting to loosen.	Select Status		
11.2.2.12.8. Flexible hose shall not be supported by rigid lines or components if excessive loads from flexible hose motion can occur.	Select Status		
11.2.2.12.9. Flexible hose between two components may have excessive motion restrained where necessary but shall never be rigidly supported by a tight rigid clamp around the flexible hose.	Select Status		
11.2.2.12.10. Flexible hoses shall not be exposed to temperatures that exceed the rated temperature of the hose.	Select Status		

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Table 11.2 Open Line Force Calculation Factor

Diameter Opening (inch)	Calculated Force Factor for Each psi of Source Pressure (psi)
1/8	0.18506
1/4	0.28320
3/8	0.38140
1/2	0.47960
5/8	0.57770
3/4	0.67590
7/8	0.77410
1.0	0.87230
To calculate the force acting on line opening, select the applicable diameter opening and multiply the right-hand column by the source pressure (psi).	

11.2.2.12.8. Flexible hose shall not be supported by rigid lines or components if excessive loads from flexible hose motion can occur.	Select Status		
11.2.2.12.9. Flexible hose between two components may have excessive motion restrained where necessary but shall never be rigidly supported by a tight rigid clamp around the flexible hose.	Select Status		
11.2.2.12.10. Flexible hoses shall not be exposed to temperatures that exceed the rated temperature of the hose.	Select Status		
11.2.2.12.11. Flexible hoses that are permitted to pass close to a heat source shall be protected with a fireproof boot metal baffle.	Select Status		
11.2.2.12.12. Designs using convoluted, unlined bellows, or flexible metal hoses shall be analyzed to verify premature failure caused by flow-induced vibration is precluded.	Select Status		
11.2.2.12.13. Acoustic coupling that can intensify the stresses caused by flow-induced vibration shall be avoided by ensuring that normal fluid flow requirements do not exceed a velocity of Mach 0.2.	Select Status		
A guidance document for performing the flow-induced vibration analysis is MSFC-SPEC-3746, Flow-Induced Vibration Assessment Requirements for Metal Bellows and Flex hoses.	I		
11.2.2.12.14. The bend radius of flexible hoses shall be designed to be no less than the safe minimum bend radius recommended in authoritative specifications for the particular hose and in no case less than five times the outside diameter of the hose.	Select Status		

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11.2.2.12.15. A means of plugging or capping flexible hoses shall be provided when the hose is not in use.	Select Status		
11.2.2.12.16. Ground Support Cryogenic System Flexible Hoses:	Select Status		
11.2.2.12.16.1. Flexible hoses shall be used only when required to isolate vibration and piping movement and for hookup of portable and mobile equipment.	Select Status		
11.2.2.12.16.2. Flexible hoses shall be of the single-wall, double-wall, or double-wall vacuum-jacketed type.	Select Status		
11.2.2.12.16.3. All convoluted portions of flexible hoses shall be covered with stainless steel wire braid.	Select Status		
11.2.2.12.17 Flexible hoses whose rupture would cause unacceptable hazard to personnel or risk to mission shall be retested at the flexible hose MAWP no less frequently than every 5 years. A flexible hose that is permanently installed by welding or brazing does not require retesting IAW NASA STD-8719.17 section 4.10.4	Select Status		
11.2.2.12.18 A flexible hose exhibiting major defects as classified in SAE ARP 1658B, shall be removed from service IAW NASA STD-8719.17 section 4.10.4.7	Select Status		
11.2.2.13. Ground Support Pressure System Relief Devices	I		
11.2.2.13.1. All fixed pressure vessels shall be protected against overpressure by means of at least one conventional safety relief valve or pilot-operated pressure relief valve in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Rupture disks alone shall not be used to protect against overpressure.	Select Status		
11.2.2.13.2. A rupture disc may be installed between the pressure relief valve and the vessel provided that the limitations of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Paragraphs UG-127(a)(3)(b) and UG 127(a)(3)(c) are met.	Select Status		
11.2.2.13.3. Particular care shall be taken to monitor and/or vent the space between the rupture disc and the relief valve as required. The space between a rupture disc and a relief valve shall be designed to allow annual testing for leakage and/or contamination.	Select Status		
11.2.2.13.4. All rupture discs installed in hazardous fluid systems shall be replaced every two years.	Select Status		
A non-fragmenting rupture disc should be used when a rupture disc is used between a pressure vessel and a relief valve to prevent contamination or damage to the relief valve.	I		
11.2.2.13.5. Installation of the pressure relief devices shall be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.	Select Status		
1.2.2.13.6. The flow capacity for all relief devices shall be certified in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Paragraphs UG-130 through UG-134.	Select Status		

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11.2.2.13.7. The total required relieving capacity of pressure relief devices shall be determined in accordance with ASME BPVC, Section VIII, Division 1, API 520, API 521, and/or CGA (S-1.1, S-1.2, S-1.3, 341, E-4 etc.) requirements as applicable for all relevant failure scenarios. The required relieving capacity shall be provided by a single valve where possible.	Select Status		
11.2.2.13.8. Pressure relief devices shall be set to operate at a pressure not to exceed the MAWP of the vessel or the design pressure of a system. See ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Paragraph UG-134. If multiple relief devices are required see UG-134 for the requirements.	Select Status		
11.2.2.13.9. The relieving capacity of the safety relief valve shall be equal to or greater than the maximum calculated required flow capacity to prevent PVS overpressure 10% above MAWP (or piping system design pressure) for normal operating contingency failure scenarios (i.e. full open failure of upstream pressure reducing devices, heat exchanger/vessel block outlets, cooling water failure, overfilling, loss of automated controls, power failure, etc...), and no more than 21% above MAWP for fire scenarios. See ASME BPVC Div. 1, UG-125 and API 520. If multiple relief devices are required see UG-125 for the requirements.	Select Status		
11.2.2.13.10. Pressure relief valves shall be set to operate at a pressure not to exceed 110 percent of the system MOP or that allowed by ASME B31.3, whichever is less.	Select Status		
11.2.2.13.11. Negative pressure protection shall be provided for vessels not designed to withstand pressures below one atmosphere if the pressure vessel feed system or operational use renders it susceptible to negative gauge pressure.	Select Status		
Negative pressure protection may be accomplished by the use of check valves or negative pressure relief devices.	I		
11.2.2.13.12. Pressure vessel relief devices shall be located so that other components cannot render them inoperative except as specified in ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Paragraphs UG-135(d)(1), UG-135(d)(2), and Appendix M, Installation and Operations, Paragraphs M-5, and M-6. When a full-area stop valve is allowed in accordance with ASME Boiler and Pressure Vessel Code, the valve type shall have provisions for being locked in the open or closed position.	Select Status		
Safety wiring is an acceptable means of locking shutoff valves in the open or closed position.	I		
11.2.2.13.13. The shutoff valve associated with the relief device shall have permanent marking clearly identifying its position (OPEN or CLOSED).	Select Status		
The body and other pressure containing parts for pressure relief devices should be 300-series stainless steel. Exception: DOT cylinders or trailer relief devices may contain parts of brass or bronze.	I		
11.2.2.13.14. A pressure relief valve shall be installed downstream of the last GSE regulator before flight hardware interface and before entering a container and/or black box purge system.	Select Status		

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11.2.2.13.15. All relief valves and piping shall be structurally restrained to eliminate any thrust effects from transferring moment forces to the vessel nozzles or lines.	Select Status		
11.2.2.13.16. The effects of the discharge from relief devices shall be assessed and analyzed to ensure that operation of the device cannot be hazardous to personnel or equipment. Items to be analyzed are thrust loads, noise, impingement of high velocity gas or entrained particles, toxicity, oxygen enrichment, flammability, and oxygen deprivation.	Select Status		
11.2.2.13.17. All relief devices shall be vented separately unless the following can be positively demonstrated:	Select Status		
11.2.2.13.17.1. The creation of a hazardous mixture of gases in the vent system and the migration of hazardous gases into an unplanned environment is impossible.	Select Status		
11.2.2.13.17.2. The capacity of the vent system is adequate to prevent a pressure rise more than 20 percent above MOP or exceed 10 percent of the set pressure of the valve in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix M, Paragraph M-8. The analysis shall assume that all relief valves connected to the vent system are open and flowing full capacity.	Select Status		
11.2.2.13.17.3. Relief devices vented to a common header shall be pressure balanced bellows type or appropriate pilot operated type relief valves for which set pressure is unaffected by the vent header superimposed back pressure. Conventional relief valves shall only be used if an analysis of failure scenarios confirm that multiple devices are not needed for any failure scenario.	Select Status		
11.2.2.13.18. Both the inlet and discharge sides of a relief valve shall be hydrostatically or pneumatically tested. When the discharge side has a lower pressure rating than the inlet side, they are to be hydrostatically or pneumatically tested independently. Prior approval of the plan for pneumatic testing shall be obtained from the PSWG, Range Safety, and Center Pressure Systems Manager.	Select Status		
11.2.2.13.19. Pressure relief valves shall be tested for proper setting before installation and annually thereafter.	Select Status		
11.2.2.13.20. Pressure relief devices shall be marked in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Paragraphs UG-129, UG-130, UG-131, and UG-132 as applicable.	Select Status		
11.2.2.13.21. A pressure relief valve shall be installed as close as is practical downstream of each pressure reducing device (regulator, orifice) or downstream of any source of pressure such as compressors, gas rechargers, and tube bank trailer whenever any portion of the downstream system cannot withstand the full upstream pressure. The criteria for “withstand” is that the upstream pressure shall not exceed the MAWP of any pressure vessel or component downstream of the regulator or pressure source.	Select Status		
11.2.2.13.22. A three-way valve with dual relief valve is required where continuous operation of the system is needed during relief valve calibration.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.13.23. Pressure system relief devices shall have no intervening stop valves between piping being protected and the relief devices or between the relief device and the point of discharge except as allowed by ASME B31.3, Paragraph 322.6.1. When a full-area stop valve is allowed in accordance with the ASME code, the valve shall have provisions for being locked in the open or closed position. The valve shall have permanent marking clearly identifying its position (OPEN or CLOSED).	Select Status		
11.2.2.13.24. Pressure relief valve set point testing shall be performed in accordance with NASA-STD-8719.17 and NBIC NB-23. Set point testing shall only be performed by organizations that possess current National Board Certificate of Authorization for the repair of pressure relief valves (VR Stamp) or Test Only Certificate (T/O Stamp).	Select Status		**Mandatory**
Safety wiring is an acceptable means of locking shutoff valves in the open or closed position.	I		
11.2.2.14. Ground Support Pressure System Supports, Anchors, Clamps, and Other Restraints	I		
11.2.2.14.1. All piping supports, anchors, hangers, and other restraints shall conform to the requirements of ASME B31.3, Paragraph 321.	Select Status		
11.2.2.14.2. Line Restraints.	I		
11.2.2.14.2.1. Where line restraint is required, anchors, guides, pivots, or restraints shall be fabricated or purchased and assembled in such a form as to secure the desired points of piping in relatively fixed positions.	Select Status		
11.2.2.14.2.2. Line restraints shall permit the line to expand and contract freely in opposite directions away from the anchored or guided point.	Select Status		
11.2.2.14.2.3. Line restraints shall be designed to withstand the thrust, torsional forces, and load conditions of operation.	Select Status		
11.2.2.14.2.4. Line restraints shall contain the line in case of line failure.	Select Status		
11.2.2.14.2.5. The support shall be capable of withstanding no less than two times the available force as a result of thrust generated from component failure under pressure.	Select Status		
11.2.2.14.3. All relief valves and attached vent piping shall be designed to withstand any thrust caused by venting fluids.	Select Status		
11.2.2.14.4. All rigid tubing assemblies shall be supported by rigid structures using cushioned steel clamps or suitable multiple tube, block-type clamps.	Select Status		
11.2.2.14.5. Tubing supports within consoles or modules shall be spaced according to the maximum spacing listed in Table 11.3.	Select Status		
11.2.2.14.6. Tubing supports between consoles and modules shall be spaced according to the maximum spacing listed in Table 11.4.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.14.7. Components within a system shall be supported by a firm structure and not the connecting tubing or piping unless it can be shown by analysis that the tubing or piping can safely support the component with a safety factor of 3 against yield.	Select Status		
11.2.2.14.8. Hazardous pressure system piping shall be installed with sufficient flexibility to prevent static or dynamic flow-induced loads and thermal expansion or contraction from causing excessive stresses to be induced in the system, excessive bending moments at joints, or undesirable forces or moments at points of connection to equipment or at anchorage or guide points.	Select Status		

Table 11.3. Spacing for Tubing Supports Within Consoles or Modules.

Nominal Tubing Diameter (inches)	Maximum Distance Between Tubing Support (inches)
1/8 through 3/8	18
1/2 through 3/4	25
1 and over	30

Table 11.4. Spacing for Tubing Supports between Consoles or Modules.

Nominal Tubing Diameter (inches)	Maximum Distance Between Tubing Support (feet)
1/8 through 3/8	4
1/2 through 3/4	6
1 through 2	9

11.2.2.14.7. Components within a system shall be supported by a firm structure and not the connecting tubing or piping unless it can be shown by analysis that the tubing or piping can safely support the component with a safety factor of 3 against yield.	Select Status		
11.2.2.14.8. Hazardous pressure system piping shall be installed with sufficient flexibility to prevent static or dynamic flow-induced loads and thermal expansion or contraction from causing excessive stresses to be induced in the system, excessive bending moments at joints, or undesirable forces or moments at points of connection to equipment or at anchorage or guide points.	Select Status		

11.2.2.15. Reserved	I		
11.2.2.16. Ground Support Pressure System Pumps	I		

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11.2.2.16.1. The Standards of the Hydraulic Institute should be used as a guide in selecting a safe pump.	Select Status		
11.2.2.16.2. Gear pumps shall not be used for high pressure applications involving flammable and/or hazardous fluids.	Select Status		
11.2.2.16.3. The inlet pressure of hydraulic pumps shall be controlled to prevent cavitation effects in the pump passage or outlets.	Select Status		
11.2.2.16.4. Hydraulic pumps required to provide emergency power shall not be used for any other function.	Select Status		
11.2.2.16.5. Hydraulic pressure systems shall have regulators with a pressure relieving or self-bleeding feature.	Select Status		
11.2.2.16.6. Pumps used in hypergolic propellant systems shall be of the centrifugal type specifically designed for pumping hypergolic propellants.	Select Status		
11.2.2.17. Ground Support Hydraulic System Hardware	I		
11.2.2.17.1. General Ground Support Hydraulic System Design	I		
11.2.2.17.1.1. For all power-generating components, pump pulsations shall be controlled to a level that does not adversely affect system tubing, components, and support installation.	Select Status		
11.2.2.17.1.2. When two or more hydraulic actuators are mechanically tied together, only one lock valve shall be used to hydraulically lock all the actuators.	Select Status		
11.2.2.17.1.3. The ambient operating temperature for hydraulic systems shall not exceed 275ºF for systems using petroleum-based fluids.	Select Status		
11.2.2.17.1.4. Fluids for systems operating at temperatures higher than 275ºF shall be fire resistant or fireproof for the intended service.	Select Status		
11.2.2.17.1.5. Where system leakage can expose hydraulic fluid to potential ignition sources, fire resistant or flameproof hydraulic fluid shall be used.	Select Status		
11.2.2.17.1.6. All hydraulic piping installations shall be designed, installed, and tested in accordance with ASME B31.3.	Select Status		
11.2.2.17.1.7. Pressure snubbers shall be used with all hydraulic pressure transmitters, hydraulic pressure switches, and hydraulic pressure gauges. **Exception:** Pneumatic pressure gauges are excluded from this requirement.	Select Status		
11.2.2.17.1.8. A gauge indicating accumulator gas pressure shall never be used to indicate equivalent hydraulic pressure.	Select Status		
11.2.2.17.1.9. Pressure system relief devices shall have no intervening stop valves between piping being protected and the relief devices or between the relief device and the point of discharge, except as allowed per ASME B31.3.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.17.1.10. When a full-area stop valve is allowed in accordance with the ASME Boiler and Pressure Vessel Code, the valve type shall have provisions for being secured in the open or closed position.	Select Status		
11.2.2.17.1.11. The shutoff valve shall have permanent marking clearly identifying its position (OPEN or CLOSED).	Select Status		
11.2.2.17.1.12. Thermal expansion relief valves shall be installed as necessary to prevent system damage from thermal expansion of hydraulic fluid.	Select Status		
11.2.2.17.1.13. The liquid thermal expansion relief valve setting shall not exceed 120 percent of the system design pressure in accordance with ASME B31.3 paragraph 322.6.3 (b).	Select Status		
11.2.2.17.2. Ground Support Hydraulic System Accumulators and Reservoirs	Select Status		
11.2.2.17.2.1. Accumulators and reservoirs that are pressurized with gas (within the scope of ASME BPVC VIII Div. 1 U-1) shall be designed, constructed, tested, certified, and code stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or Division 2 and registered with the National Board.	Select Status		
11.2.2.17.2.2. Hydraulic system reservoirs shall be provided with a fluid level indicator. If a sight glass is used for a liquid level indicator, it shall be properly protected from physical damage.	Select Status		
11.2.2.17.2.3. Only inert gases shall be used in pressurization accumulators in systems operating at pressures in excess of 200 psig or temperatures over 160ºF unless adequate fire and explosion resistance is demonstrated.	Select Status		
11.2.2.17.2.4. For a gas-pressurized reservoir, the gas pressure shall be controlled by an externally nonadjustable pressure regulating device to control the gas pressure in the reservoir.	Select Status		
11.2.2.17.2.5. Hydraulic systems having reservoir filling caps shall include design provisions that will automatically vent the reservoir opening.	Select Status		
11.2.2.18. Ground Support Hypergolic Propellant System Hardware. The minimum design requirements for all mobile, or portable equipment used to handle hypergolic propellants (Nitrogen Tetroxide [N_2O_4], Hydrazine [N_2H_4,] Unsymmetrical Dimethylhydrazine [UDMH], Aerozine 50 [A-50], Monomethyl hydrazine [MMH]) shall comply with NASA-STD-5005 Standard for The Design and Fabrication of Ground Support Equipment and the requirements described below.	Select Status		
11.2.2.18.3. Components used in any fuel or oxidizer system shall not be interchanged after exposure to the respective media.	Select Status		
11.2.2.18.5. Bi-propellant propellant systems shall have the capability of loading and off-loading fuel and oxidizer systems one at a time.	Select Status		
11.2.2.18.6. The minimum design requirements for controlling the migration of liquid or gas hypergolic propellant into an associated pneumatic system are as follows:	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.18.6.1. Each pneumatic branch line that interfaces with a hypergolic propellant system shall be single failure tolerant to permit positive shutoff of the pneumatic supply and prevent back flow through the branch. A pressure gauge shall be provided at some point downstream either in the pneumatic system or the hypergols system of each check valve to indicate the pressure in the hypergolic propellant system.	Select Status		
A hand-operated, shutoff valve upstream of a regulator and a spring-loaded, poppet-type check valve to permit positive shutoff of the pneumatic supply and prevent back flow through the branch is an acceptable solution.	I		
11.2.2.18.6.2. Each pneumatic branch supply shall interface with only one type of hypergolic propellant (fuel or oxidizer).	Select Status		
11.2.2.18.6.3. Downstream of the pneumatic pressure regulator, the pneumatic system shall be identified and marked as a hypergolic propellant system.	Select Status		
11.2.2.18.6.4. Hypergolic propellant system GSE shall be designed to interface with facility scrubber or incinerator.	Select Status		
11.2.2.18.6.5. Interfaces with scrubber and incinerator designs and qualification tests shall be reviewed and approved by the appropriate local safety authorities as identified by the PSWG and Range Safety.	Select Status		
11.2.2.18.6.6. Each line venting into a multiple-use vent system shall be protected against back pressurization by means of a check valve if the upstream system cannot withstand the back pressure or where contamination of the upstream system cannot be tolerated.	Select Status		
11.2.2.18.7. Copper, bronze, or other alloys that might form copper oxides shall be avoided in hydrazine areas. If used, they shall be positively protected by distance, sealing in a compatible material, or use of a splash guard.	Select Status		
11.2.2.18.8. GSE used to handle propellant systems shall be designed to ensure that all incompatible fuels and oxidizers are separated so that operations during the prelaunch phase cannot cause inadvertent mixing of the propellants.	Select Status		
11.2.2.18.9. Downstream of the pneumatic pressure regulator, including the regulator seat, the pneumatic system shall be constructed of materials that are compatible with all of the hypergolic propellants serviced by the pneumatic supply.	Select Status		
11.2.2.18.10. The area in close proximity to the hardware containing and/or transporting hydrazine-based fuels shall be maintained free of surface corrosion and its associated oxidation byproducts.	Select Status		
11.2.2.18.11. All hypergolic fuel and oxidizer transportation and storage containers shall have the capability to be grounded.	Select Status		
11.2.2.18.12. Flexible non-metallic Carbon-filled, Teflon-lined flexible hoses blister when used for N_2H_4, MMH, for N_2O_4 service shall be replaced after 2 years of cumulative exposure to any of these fluids. For guidance, see KSC-STD-Z-0006, Design of Hypergolic Propellants Ground Support Equipment.	Select Status		

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11.2.2.19. Ground Support Cryogenic System Hardware. The minimum design requirements for all mobile, and portable equipment used to handle liquid oxygen (LO_2 or LOX), or liquid hydrogen (LH_2), liquid helium (LHe), liquid nitrogen (LN_2), liquefied natural gas (LNG) and their respective vent gases are as follows:	Select Status		
The inner shell and piping in the annular space should be type 304 or 316 (304L or 316L, if welded) stainless steel. The outer shell and supports may be stainless steel or carbon steel.	I		
11.2.2.19.1. Cryogenic systems shall be insulated with compatible material or be vacuum-jacketed to avoid liquefaction of air. Drip pans or other equivalent means shall be provided under flanges when there exists the possibility of leaking liquefied air.	Select Status		
11.2.2.19.2. Cryogenic fuel and oxidizer systems shall have the capability of loading and off-loading one commodity at a time.	Select Status		
11.2.2.19.3. Vacuum-jacketed systems shall be capable of having the vacuum verified.	Select Status		
11.2.2.19.4. Purge gas for LH_2 and cold gaseous hydrogen (GH_2) lines shall be gaseous helium (GHe). Neither GN_2 nor LN_2 shall be introduced into any LH_2 line that interfaces with a liquid storage tank cold port.	Select Status		
11.2.2.19.5. Cryogenic systems shall be designed to ensure the separation of fuels and oxidizers and to prevent inadvertent mixing.	Select Status		
11.2.2.19.6. Precautions shall be taken to prevent cross mixing of media through common purge lines by use of check valves to prevent back flow from a system into a purge distribution manifold.	Select Status		
11.2.2.19.7. Cross connection of GN_2 and GH_e systems is prohibited.	Select Status		
11.2.2.19.8. All permanently installed cryogenic vessels shall consist of an inner and an outer shell.	Select Status		
11.2.2.19.9. The annular space between the inner and outer shell shall be insulated and may be vacuum-jacketed or purged. ***Exception: LH_2 and LHe vessels shall be vacuum-jacketed.***	Select Status		
11.2.2.19.10. The inner pressure vessel shall be designed, constructed, examined, tested, certified, registered with the National Board, and code stamped on the exterior of the vessel in compliance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or Division 2.	Select Status		
An additional nameplate marked "DUPLICATE" may be attached to the support structure.	I		
11.2.2.19.12. The outer vessel shall be designed for 15.0 psia external pressure.	Select Status		
11.2.2.19.13. For nonvacuum-jacketed vessels, the annular space shall be protected by means of a vacuum breaker.	Select Status		

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11.2.2.19.14. Local and remote readout liquid level indicators shall be provided for LH_2 and storage vessels.	Select Status		
11.2.2.19.15. At a minimum, local readout capability shall be provided for all other cryogenic storage vessels.	Select Status		
11.2.2.19.16. Cryogenic piping systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.	Select Status		
11.2.2.19.17. Cryogenic systems shall be designed to ensure icing does not render any valve or system component inoperable.	Select Status		
11.2.2.19.18. Cryogenic valves with extended stems shall be installed with the actuator approximately vertical above the valve.	Select Status		
11.2.2.19.19. GH_2 and liquefied natural gas (LNG) shall be vented to the atmosphere through a burner system.	Select Status		
11.2.2.19.20. GH_2 and liquefied natural gas (LNG) burner design and testing requirements shall be approved by the appropriate local safety authority as identified by the PSWG and Range Safety.	Select Status		
11.2.2.19.21. Pressure vessels shall be designed with an opening for inspection purposes.	Select Status		
11.2.2.19.22. All inner vessel pressure retaining welds including shell, head nozzle, and nozzle-to-head and shell welds shall be 100 percent inspected by radiographic and/or ultrasonic volumetric NDE.	Select Status		
11.2.2.19.23. All inner vessel attachment welds for items such as supports, lugs, and pads shall be 100 percent inspected by liquid penetrant, ultrasonic, magnetic particle, eddy current, and/or radiographic surface NDE.	Select Status		
11.2.2.19.24. Welded attachments to the inner vessel such as stiffening rings or supports shall be continuously welded.	Select Status		
11.2.2.19.25. All attachments to the inner shell shall be positioned so that no attachment weld overlaps any Category A or B weld as defined in ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Paragraph UW-3.	Select Status		
11.2.2.19.26. Cryogenic systems shall be provided with readily accessible low-point drain capability to allow draining of tanks and piping systems. Small volumes contained in valves, filters, and other containers that will boil-off in a short period of time do not require low-point drain capability.	Select Status		
11.2.2.19.27. Vacuum-jacketed or other types of thermal insulation shall be based on system heat leak rate and failure mode and effect determination.	Select Status		
11.2.2.19.28. Guidelines for oxygen systems design, material selection, operations, storage, and transportation can be found in ASTM Manual MNL36, Safe Use of Oxygen and Oxygen Systems: Handbook for Design, Operation, and Maintenance.	Select Status		
11.2.2.19.29. For failure modes that could result in a time-critical emergency condition, provisions shall be made for automatic switching to a safe mode of operation. Caution and warning signals shall be provided for these time-critical functions.	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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11.2.2.19.30. Flight propulsion systems and/or propellant tanks and their associated propellant loading system (including portable vessels and units) shall be designed such that propellant transfer operations are commonly bonded and grounded.	**Select Status**		
11.2.2.19.31. Titanium and titanium alloys shall not be used where there is possible exposure to gaseous oxygen (cryogenic boil-off) or liquid oxygen.	**Select Status**		
11.2.2.20. Ground Support Cryogenic Piping System Joints, Connections, and Fittings	**I**		
11.2.2.20.1. Cryogenic piping design shall be in accordance with ASME B31.3, Process Piping.	**Select Status**		
11.2.2.20.2. Joints in piping systems shall be of the butt-weld, flanged, bayonet, or hub type in accordance with KSC-GP-425, KC159/KC163, or the commercial equivalent.	**Select Status**		
11.2.2.20.3. Butt-welded joint designs shall meet the requirements of ASME B31.3.	**Select Status**		
11.2.2.20.4. Flanged joints shall be either weld neck or lap joint, raised face type conforming to ASME B16.5 and shall be constructed of forged ASTM A182 304L or 316L material. The use of slip-on flanges shall be avoided.	**Select Status**		
The preferred materials for welded pipe fittings are 304L or 316L stainless steel.	**I**		
11.2.2.20.5. Flange faces or lap-joint stub end faces shall be concentrically serrated conforming to Manufacturers Standardization Society of the Valve and Fittings Industry Standard Practice, MSS-SP-6, Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings.	**Select Status**		
11.2.2.20.6. LH_2 vent system flanged joints shall be metal-to-metal and welded in accordance with applicable ASME B31.3, Process Piping requirements.	**Select Status**		
11.2.2.20.7. Flange bolting and studs shall conform to ASME B18.2.1, Square and Hex Bolts and Screw Inch Series recommended dimensions with rolled threads conforming to ASME B1.1, Unified Inch Screw Threads.	**Select Status**		
11.2.2.20.8. Bolt materials shall be per ASTM A193 or ASTM A320.	**Select Status**		
11.2.2.20.9. Nuts for flange bolting and studs shall be ASTM A194, conforming to ASME B18.2.2, Square and Hex Nuts (Inch Series), heavy hex type and shall use ASME B1.1 thread.	**Select Status**		
Type 304 or 316 stainless steel are the preferred materials for nuts, bolts, and studs used for flange bolting.	**I**		
11.2.2.20.10. Pipe fittings such as tees, elbows, crosses, reducers, and lap joint stub ends shall be full penetration butt weld type only, conforming to ASME B16.9 and ASTM A403.	**Select Status**		
ASTM A403 grade WP304L or WP316L wrought stainless steel is the preferred materials for pipe fittings.	**I**		

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11.2.2.20.11. Bayonet fittings shall be used on vacuum-jacketed lines where butt welding is not practical, and a mechanical joint is required.	Select Status		
11.2.2.20.12. Metal-to-metal couplings shall be the butt-welded types. The gaskets (not reusable) shall be constructed of stainless steel only. The V-band clamps shall be constructed of stress-corrosion-resistant material.	Select Status		
11.2.2.20.13. Vacuum-jacketed pipe shall not use bellows in the inner pipe. Allowance for differential expansion between inner and outer pipe shall be provided by bellows in the outer pipe.	Select Status		
11.2.3. Ground Support Pressure System Testing	I		
11.2.3.1. Testing Ground Support Pressure Systems Before Assembly	I		
11.2.3.1.2. Fluid system components such as piping, tubing, flexible hoses, valves, filters, fittings, and pressure regulators (not including pressure gauges, transducers, and pressure relief devices) shall be pressure tested in accordance with methods and criteria contained in ASME B31.3.	Select Status		
11.2.3.1.3. Pressure vessels designed to meet DOT specifications shall undergo qualification and hydrostatic testing in accordance with 49 CFR and DOT requirements.	Select Status		
11.2.3.1.4. Hydrostatic or pneumatic testing shall demonstrate that there is no distortion, damage, or leakage of components at the appropriate test level pressure.	Select Status		
11.2.3.1.5. The following inspections shall be performed after hydrostatic testing:	Select Status		
11.2.3.1.5.1. Mechanical components such as valves, regulators, piping, and fittings shall be inspected for distortion or other evidence of physical damage. Damaged components shall be rejected.	Select Status		
11.2.3.1.5.2. A component functional and leak test shall be performed at the MAWP of the component.	Select Status		
11.2.3.1.6. Pressure relief devices, gauges and transducers shall be calibrated before installation and yearly thereafter.	Select Status		
11.2.3.1.7. For pressure gauges, transducers, or rupture discs and other components not covered by ASME B31.3, pneumatic testing to 1.25 times maximum operating pressure (MOP/MEOP) (not to exceed MAWP), in lieu of hydrostatic testing, is permissible if hydrostatic testing is impractical, impossible, or jeopardizes the integrity of the component or system. Pneumatic testing to 1.1 times design pressure for components covered by ASME B31.3 in lieu of hydrostatic testing, is permissible if hydrostatic testing is impractical, impossible, or jeopardizes the integrity of the component or system. Prior approval for pneumatic proof testing at the ranges shall be obtained from SLD 30/SE and SLD 45/SE.	Select Status		
11.2.3.1.8. Certain critical system components may require further testing (helium mass spectrometer) in accordance with ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination, Article 10, Leak Testing.	Select Status		

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11.2.3.1.9. All valves used for hypergolic propellant systems shall be tested for both external and internal leakage at MAWP using an inert gas (helium/nitrogen) consisting of at least 10 percent helium. The use of argon as a testing medium is prohibited.	Select Status		
11.2.3.1.9.1. No external leakage is allowed (bubble-tight).	Select Status		
11.2.3.1.9.2. Internal leakage of valves shall not exceed limits specified in the valve performance specification.	Select Status		
11.2.3.1.9.3. Where no valve specification exists, the leak rate shall not exceed 1x10-6 cc/sec at standard temperature and pressure.	Select Status		
11.2.3.2. Testing Ground Support Pressure Systems After Assembly	I		
11.2.3.2.1. Ground Support Pressure System Hydrostatic Tests	I		
11.2.3.2.1.1. All newly assembled pressure systems shall be hydrostatically tested to 1.5 times system design pressure before use. When the design temperature is greater than the test temperature the minimum test pressure shall be adjusted in accordance with ASME B31.3 par. 345.4.2(b). Where this is not possible adequate rational and data supporting the adequacy of component testing and alternate means of testing the assembled system shall be submitted for review and approval by the PSWG, Range Safety, and the Center Pressure Systems Manager. Pneumatic testing at 1.1 times the system design pressure is acceptable in lieu of hydrostatic testing at 1.5 times the design pressure. Prior approval of the plan for pneumatic testing shall be obtained from the PSWG, Range Safety, and the Center Pressure Systems Manager.	Select Status		
11.2.3.2.1.2. All cryogenic systems shall be hydrostatically tested to at least 1.25 times system MOP using an inert cryogenic fluid at or below the expected lowest temperature.	Select Status		
11.2.3.2.1.3. Cryogenic systems that cannot be chilled and hydrostatically tested with an inert fluid at or below the lowest expected temperature shall require a cold shock demonstration test, a hazard analysis, and a fracture mechanics safe-life analysis. The test and analysis methodology is subject to review and approval by the PSWG, Range Safety, and the Center Pressure Systems Manager.	Select Status		
11.2.3.2.1.4. The hydrostatic test or cold shock/soak test (for at least 1 hour) shall demonstrate that the system or components shall sustain test pressure level and temperature gradient without distortion, damage, or leakage.	Select Status		
11.2.3.2.1.5. The following inspections shall be performed on vacuum-jacketed systems:	Select Status		
11.2.3.2.1.5.1. An examination for cold spots on vacuum jackets. Cold spots in the outer line shall not be more than 5ºC colder than the surrounding area, except in cases where system heat-leak requirements permit colder temperatures, such as around low-point drain valves, relief valves, or other areas where a direct thermal path is available.	Select Status		
11.2.3.2.1.5.2. Vacuum readings for all vacuum volumes shall be taken and recorded. These readings shall be taken before, during, and after the test.	Select Status		

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11.2.3.2.1.5.3. The vacuum readings after the hydrostatic or cold shock/soak using a cryogenic fluid shall be taken when the system returns to ambient temperature.	**Select Status**		
11.2.3.2.2. Ground Support Pressure System Leak Tests	**I**		
11.2.3.2.2.1. For systems with a hazardous fluid, after hydrostatic testing and before the introduction of propellant, a pneumatic leak test of completely assembled systems shall be conducted at the system MOP using an inert gas (helium/nitrogen) consisting of at least 10 percent helium. The use of argon as a testing medium is prohibited.	**Select Status**		
11.2.3.2.2.2. After successful completion of the hydrostatic test using a cryogenic fluid, a pneumatic leak test of the complete system shall be performed at the system MOP using helium or a mixture of nitrogen with a minimum of 25 percent helium. There shall be no leakage into the vacuum volume in excess of 1.0E-06 cc/sec. The sensitivity of the instrumentation used to measure leak rate shall be a minimum of 1.0E-09 std cm3/sec/div in accordance with Article 10 of the ASME Boiler and Pressure Vessel Code.	**Select Status**		
11.2.3.2.2.3. All newly assembled pressure systems, except systems designed, fabricated, inspected, and tested in accordance with DOT requirements, shall be leak tested at the system MOP before first use at the payload processing facility and launch site area.	**Select Status**		
11.2.3.2.2.4. This test shall be conducted at the payload processing facility and launch site area unless prior approval from the PSWG and Range Safety has been obtained.	**Select Status**		
11.2.3.2.2.5. Minimum test requirements:	**I**		
11.2.3.2.2.5.1. The gas used during the leak test shall be the same as the system fluid media except that for hazardous gas systems, a system compatible, non-hazardous gas may be used that has a density as near as possible to the system fluid; for example, helium should be used to leak test a gaseous hydrogen system.	**Select Status**		
11.2.3.2.2.5.2. Mechanical connections, gasketed joints, seals, valve bonnets, and weld seams shall pass a mass spectrometer helium leak check or shall be visually bubble tight for a minimum of 1 minute when leak tested with MIL-PRF-25567, Leak Detection Compound, Oxygen Systems, Type 1 or equivalent leak test solution.	**Select Status**		
Alternate methods of leak testing may be approved on a case-by-case basis.	**I**		
11.2.3.2.2.5.3. Non-hazardous liquid systems may be leak tested using the normal system service.	**Select Status**		
11.2.3.2.3. Ground Support Pressure System Validation and Functional Tests	**I**		
11.2.3.2.3.1. All newly assembled pressure systems shall have a system validation test and a functional test of each component at system MOP before first operational use at the payload processing facility and launch site area.	**Select Status**		
11.2.3.2.3.2. These tests shall be conducted at the payload processing facility and launch site area unless prior approval from the PSWG and Range Safety has been obtained.	**Select Status**		

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11.2.3.2.3.3. Minimum test requirements:	**I**		
11.2.3.2.3.3.1. Tests shall demonstrate the functional capability of all components such as valves, regulators, orifices, pumps, flexible hose connections, and gauges.	**Select Status**		
11.2.3.2.3.3.2. All operational sequences for the system shall be executed including emergency shutdown and safing procedures.	**Select Status**		
11.2.3.2.3.3.3. All shutoff and block valves shall be leak checked downstream to verify their shutoff capability in the closed position.	**Select Status**		
11.2.3.2.3.3.4. The intended service fluid shall be used as the test fluid where practical. PSWG and Range Safety approved inert service fluid may be used in place of the service fluid if the intent of the test (equivalent effect on the system) is demonstrated.	**Select Status**		
11.2.3.2.3.3.5. Systems shall be tested to verify bonding and grounding.	**Select Status**		
11.2.3.3. Ground Support Pressure System Periodic Testing and Maintenance	**I**		
11.2.3.3.1. Uninstalled flexible hoses shall be hydrostatically proof tested to 1.5 times their MAWP within one year before use, or pneumatically tested to 1.1 times MAWP once every two years unless otherwise approved by the PSWG or Range Safety. Installed flexible hoses in functional use shall be hydrostatically tested to 1.5 times their MAWP once a year. ***Exception: This requirement does not apply to flexible hoses that are permanently installed, located, and operated in an environment that does not exceed the rated temperature, pressure, and shelf life of the hose.***	**Select Status**		
11.2.3.3.2. Prior to project use and at least annually, all flexible hoses shall be visually inspected over their entire length. Those with damaged fittings, broken braid, kinks, flattened areas, or other evidence of degradation shall be removed from service. A flexible hose exhibiting major defects as classified in SAE ARP 1658, shall be removed from service.	**Select Status**		
11.2.3.3.3. Pressure gauges and transducers shall be calibrated within one year before use. Pressure gauges and transducers in functional use shall be calibrated once a year.	**Select Status**		
11.2.3.3.4. Pressure relief valves shall be tested for proper setting and operation once a year. Pressure relief valve set point testing shall be performed in accordance with NASA-STD-8719.17 and NBIC NB-23. Set point testing shall only be performed by organizations that poses current National Board Certificate of Authorization for the repair of pressure relief valves (VR Stamp) or Test Only Certificate (T/O Stamp).	**Select Status**		
11.2.3.4. Testing Modified and Repaired Ground Support Pressure Systems	**I**		
11.2.3.4.1. After repairs and/or modifications to existing tankage, piping, and other system components, tests shall be performed to the same standards, codes, and requirements for which a new system would be designed, fabricated, and tested. Minor refurbishment, such as replacement of gaskets, seals, and valve seats that does not affect structural integrity, does not require a requalification test.	**Select Status**		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.3.4.2. Any pressure system component covered by ASME B31.3, including piping, tubing, fittings, or welds, that has been repaired, modified, or possibly damaged, having been hydrostatically or pneumatically tested, shall be retested hydrostatically to 1.5 time MAWP or pneumatically to 1.1 times MAWP before reuse. Any pressure system component that may be damaged during testing, including pressure gauges, transducers, or rupture discs and other components shall be retested hydrostatically to 1.5 times MOP (not to exceed MAWP) before reuse. Pneumatic testing requires prior approval by the PSWG, Range Safety, and the Center Pressure Systems Manager.	Select Status		
11.2.3.4.3. After hydrostatic testing, modified or repaired systems shall be leak tested at the system MOP before placing them back in service. This test shall be conducted at the payload processing facility and launch site area unless prior approval has been obtained from the PSWG and Range Safety.	Select Status		
11.2.3.4.4. After hydrostatic testing, modified or repaired systems shall be functionally tested at the system MOP before reuse.	Select Status		
11.2.3.4.5. All system mechanical joints affected in the disconnection, connection, or replacement of components shall be leak tested at the system MOP before being placed back in service.	Select Status		
11.2.3.4.6. Gaskets shall not be reused.	Select Status		
11.2.4. Ground Support Pressure System Analysis and Documentation Requirements	Select Status		
11.2.4.1. Ground Support Pressure System Hazard Analysis	Select Status		
11.2.4.1.1. As applicable, a hazard analysis shall be performed on all hazardous systems hardware and software in accordance with a jointly tailored SSP. (See Volume 1, Attachment 2.)	Select Status		
11.2.4.1.2. At a minimum, the hazard analysis shall include the analysis requirements in AFI 10-2501, Air Force Emergency Management Program, and DAFMAN 91-203, Air Force Occupational Safety, Fire and Health Standards, for toxic, reactive, flammable, and explosive fluids and 29 CFR 1910.119 for highly hazardous chemicals, as applicable. Additional hazard analysis may be required by the PSWG and Range Safety regarding emergency planning and response of hazardous materials.	Select Status		
11.2.4.2. Engineering Assessment, Data, and Analysis Requirements	I		
11.2.4.2.1. An engineering assessment and analysis IAW NASA STD 8719.17 shall be performed before the start of the first recertification period.	Select Status		
11.2.4.2.2. The engineering assessment of the design, fabrication, material, service, inspection, and testing shall be evaluated against the latest codes, standards, regulations, and requirements identified in this volume.	Select Status		
11.2.4.2.3. Discrepancies with the latest requirements shall be resolved by repair, modification, analysis, inspection, or test.	Select Status		
11.2.4.2.4. Design, Fabrication, and Installation Deficiencies. At a minimum, the following potential design, fabrication, and installation type deficiencies shall be assessed:	Select Status		

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11.2.4.2.4.1. Design deficiencies such as design notches, weld joint design, and reinforcements.	Select Status		
11.2.4.2.4.2. Material deficiencies such as laminations, laps, seams, cracks, hardness variations, and notch brittleness.	Select Status		
11.2.4.2.4.3. Welding deficiencies such as cracks, incomplete fusion, lack of penetration, overlap, undercut, arc strikes, porosity, slag inclusions, weld spatter, residual stresses, and distortion.	Select Status		
11.2.4.2.4.4. Installation deficiencies such as fit up, alignment, attachments, and supports.	Select Status		
11.2.4.2.4.5. Operation and Maintenance Deficiencies. At a minimum, the following potential operation and maintenance deficiencies shall be assessed:	Select Status		
11.2.4.2.4.5.1. Refurbishment damage.	Select Status		
11.2.4.2.4.5.2. Modification and/or repair deficiencies.	Select Status		
11.2.4.2.4.5.3. Operation beyond allowable limits or improper sequence.	Select Status		
11.2.4.2.4.5.4. Maintenance deficiencies.	Select Status		
11.2.4.3. Inservice Operating, Maintenance, and Inspection Plan. The payload project responsible for the design of hazardous pressure systems shall prepare an in-service operating, maintenance, and inspection plan. This plan shall be referred to as the Inservice Inspection (ISI) Plan. The ISI Plan shall be IAW NASA-STD-8719.17 section 4.8.3 and shall address and provide the following:	Select Status		
Table 11.9. In-service Operating, Maintenance, and Inspection Plan Guidance. Guidance for preparing an ISI Plan can be found in ASME Post Construction Committee (PCC)-3, Inspection Planning Using Risk-Based Methods. Petroleum storage systems designed, operated, and maintained in accordance with OSHA and/or other identified standards are not generally considered hazardous and thus do not require ISI plans. Compressed air (shop air) systems designed, operated, and maintained in accordance with 29 CFR.169 also do not require an ISI Plan.	I		
11.2.4.3.1. Credible damage mechanisms that may cause service-related failures of the system during its service life shall be analyzed.	Select Status		
11.2.4.3.2. Methods such as “eliminated,” “controlled by design,” “controlled by procedure,” or “controlled by corrosion protection” used to eliminate and control these failure mechanisms shall be identified.	Select Status		
Failure mechanisms to be evaluated include corrosion, stress, fatigue, creep, design fabrication, installation, operation, and maintenance deficiencies.	I		
11.2.4.3.3. Using the results of the above failure mechanism analysis, the following minimum requirements for an operating, maintenance, and inspection plan shall be defined:	Select Status		

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11.2.4.3.3.1. Operating plans shall address operating constraints such as maximum pressure, MAWP, MOP, minimum and maximum temperature, vibration, and maximum cycles.	Select Status		
11.2.4.3.3.2. Maintenance plans shall address corrosion protection, maintenance schedule, soft-good replacement program, refurbishment, calibration, and other maintenance requirements.	Select Status		
Hazardous pressure systems intended for one-time use can usually be exempted from the cited maintenance plan requirements. Typically, a Launch Site Requirements Relief Request (LSRRR) provides the basis for this exemption.	I		
11.2.4.3.3.3. Inspection plans shall identify the type and frequency of inspections such as visual, surface, and volumetric NDE required for each vessel and system to detect the types of failure mechanisms identified in 11.2.4.3.1 above.	Select Status		
11.2.4.3.3.4. Hazardous pressure systems shall be maintained and periodically inspected in accordance with the ISI Plan.	Select Status		
11.2.4.3.3.5. Unacceptable findings from the performance of periodic inspections shall be resolved with the PSWG, Range Safety, and the Center Pressure Systems Manager participation.	Select Status		
11.2.4.4. Ground Support Pressure System Data Requirements. The minimum data required to certify compliance with the design, analysis, and test requirements of ground support pressure systems are listed below. The data required shall be incorporated into the Safety Data Package (MSPSP) or submitted as a separate package when appropriate. Certification data shall be placed in a certification file to be maintained by the hazardous pressure system operator. The PSWG, Range Safety, and the Center Pressure Systems Manager shall review and approve this data before first operational use of new, modified, or repaired hazardous pressure systems at the payload processing facility and launch site area.	Select Status		
11.2.4.4.1. Ground Support Pressure System General Data Requirements. The following general ground support equipment data shall be submitted as part of the MSPSP.	Select Status		
11.2.4.4.1.1. Hazard analysis of hazardous pressure systems in accordance with the SSP (Volume 1, Attachment 2).	Select Status		
11.2.4.4.1.2. A compliance checklist of all design, test, analysis, and data submittal requirements in this volume.	Select Status		
11.2.4.4.1.3. The material compatibility analysis in accordance with the 11.2.1.4 of this chapter.	Select Status		
11.2.4.4.1.4. Inservice operating, maintenance, and inspection plan in accordance with 11.2.4.3 of this chapter.	Select Status		
11.2.4.4.1.5. Physical and chemical properties and general characteristics of propellants, test fluids, and gases data.	Select Status		
11.2.4.4.1.6. For hazardous propellants, fluids, and gases, data shall be submitted in accordance with 3.10.4 and Attachment 1, A1.2.4.7.1.3 of this volume.	Select Status		

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11.2.4.4.2. Ground Support Pressure System Design Data Requirements. Ground support pressure systems design data shall be submitted in accordance with Attachment 1, A1.2.5.9 of this volume.	Select Status		
11.2.4.4.3. Ground Support Pressure System Component Design Data Requirements. Ground support pressure systems component design data shall be submitted in accordance with Attachment 1, A1.2.5.9.3 of this volume.	Select Status		
11.2.4.4.4. Ground Support Pressure System Test Procedures and Reports	Select Status		
11.2.4.4.4.1. All test plans, test procedures and test reports required in Chapter 11 of this volume shall be submitted to the PSWG, in conjunction with Range Safety and the Center Pressure Systems Manager for review and approval.	Select Status		
11.2.4.4.4.2. A list and synopsis of all hazardous pressure system operational procedures to be performed at the payload processing facility and launch site areas shall be provided to the appropriate local safety authority responsible for the procedure review at the location where the operations are to take place.	Select Status		
11.3. Ground Support Pressure Systems Certification and Recertification	I		
11.3.1. Ground Support Pressure Systems Recertification Test Requirements. Testing requirements for recertification of components and systems are as follows:	Select Status		
11.3.1.1. Vessels and packaging designed to 49 CFR specifications shall be retested to DOT requirements.	Select Status		
11.3.1.2. All ground support pressure systems, except DOT vessels shall be pressure tested in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, or Division 2, as applicable to the year of construction of the vessel.	Select Status		
11.3.1.3. All piping and tubing system components shall be pressure tested in accordance with methods and criteria contained in ASME B31.3.	Select Status		
11.3.1.4. Cryogenic systems shall be retested in accordance with 11.2.3.2 of this volume.	Select Status		
11.3.1.5. 100 percent visual inspection of all joints and connections shall be performed before and after hydrostatic or pneumatic pressure tests. Parts that indicate a change in volume, permanent deformation, leakages, or cracks shall be rejected.	Select Status		
11.3.1.6. 100 percent visual inspection of the external surfaces of a vessel and system and 100 percent of the internal surfaces for vessels shall be performed before and after hydrostatic or pneumatic pressure tests.	Select Status		
11.3.1.6.1. Any sign of corrosion, dents, or other damages shall be identified and annotated on permanently maintained recertification documents.	Select Status		
11.3.1.6.2. For corroded areas, the corrosion shall be removed.	Select Status		
11.3.1.6.3. Using ultrasonic testing (UT), the entire surface area affected by corrosion shall be measured and the remaining wall thickness determined.	Select Status		

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11.3.1.6.4. Wall areas that are below the minimum required thickness and other unacceptable findings shall be fixed before placing the system back into service.	Select Status		
11.3.1.6.5. The susceptibility effects of corrosion such as cracking, delamination, or intergranular attack should be addressed.	Select Status		
11.3.1.7. All weld joints on vessels and systems with pressure greater than 500 psig or containing a hazardous fluid shall be 100 percent volumetrically and surface NDE inspected.	Select Status		
11.3.1.7.1. Radiographic examination shall be used to the maximum extent possible.	Select Status		
11.3.1.7.2. UT shall be used if radiographic testing (RT) is determined to be ineffective.	Select Status		
11.3.1.7.3. NDE surface and volumetric testing shall be performed after the hydrostatic/pneumatic pressure test.	Select Status		
11.3.1.8. All components and systems shall be leak checked in accordance with paragraph 11.2.3.2.2., Ground Support Pressure System Leak Tests and functionally tested in accordance with 11.2.3.2.3., Ground Support Pressure System Validation and Functional Tests.	Select Status		
11.3.1.9. Leaks shall be repaired and components that do not function properly shall be repaired or replaced before starting the subsequent recertification period.	Select Status		
11.3.2. Ground Support Pressure Systems General Recertification Requirements. Requirements for performing recertification are found in NASA-STD-8719.17 and the following:	I		
11.3.2.1. The recertification period for vessels and systems shall comply with local requirements and shall not exceed the shortest period resulting from or determined by the following criteria:	Select Status		
11.3.2.1.1. The shortest service life shall be determined based on the system and components design performance parameters, operational requirements, and inspection and test results. PVS shall be recertified on or before one-half the documented initial service life or one-half the recertified remaining life and not to exceed 20 years IAW NASA STD 8719.17, 4.11.2.3 and 4.8.2.7.	Select Status		
11.3.2.1.2. Twenty years for systems and for vessels that can be 100 percent inspected both internally and externally.	Select Status		
11.3.2.1.3. Ten years for systems and for vessels that cannot be 100 percent inspected internally but can be 100 percent inspected externally.	Select Status		
11.3.2.1.4. Five years for systems and for vessels that cannot be 100 percent inspected either internally or externally.	Select Status		
11.3.2.1.5. Manufacturer recommendations.	Select Status		
11.3.2.1.6. Recertification of cryogenic vessels shall be accomplished at a minimum of every 20 years with an internal inspection every 10 years.	Select Status		

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11.3.2.3. Portable or mobile vessels used for transportation and/or storage of pressurized or hazardous commodities shall be designed, maintained, and recertified in accordance with 49 CFR or applicable codes.	Select Status		
11.3.2.4. Inspections and maintenance shall be performed on hazardous pressure systems and integrated portable or mobile vessels in accordance with local requirements and a system inspection and maintenance plan developed by the system operator approved by the PSWG, Range Safety and the Center Pressure Systems Manager.	Select Status		
11.3.2.5. The hazardous pressure system operator shall retain all documentation generated as a result of the recertification effort and place a copy of this documentation in the system certification and recertification file located at the ranges.	Select Status		
11.3.3. Ground Support Pressure Systems Certification	I		
11.3.3.1. Ground Support Pressure Systems Certification Files General Requirements	I		
11.3.3.1.1. Certification files shall be maintained and updated in an appropriate configuration management system acceptable to the responsible pressure systems manager. These files shall be available at the payload processing facility and launch site area and accessible for PSWG and Range Safety review. Vessels and systems, including mobile and portable systems, that do not have current certification files shall be deactivated and removed from service.	Select Status		
11.3.3.1.2. Certification files shall be updated within 90 calendar days of completion of periodic inspections and tests.	Select Status		
11.3.3.1.3. Updated information shall include any changes to the current certification files and the following:	Select Status		
11.3.3.1.3.1. Temperature, pressurization history, and pressurizing fluid for both the tests and operations.	Select Status		
11.3.3.1.3.2. Results of any inspection conducted, including the name of the inspector, inspection dates, inspection techniques used, location and character of defects, defect origin, and defect cause.	Select Status		
11.3.3.1.3.3. Maintenance and corrective actions performed from the time of manufacture throughout operational life, including refurbishment.	Select Status		
11.3.3.1.3.4. Sketches and photographs to show areas of structural damage and extent of repairs.	Select Status		
11.3.3.1.3.5. Certification and recertification tests performed, including test conditions and results.	Select Status		
11.3.3.2. Ground Support Pressure System Certification Data	I		
11.3.3.2.1. The certification file for each hazardous pressure system shall contain all the data required to justify system certification IAW NASA-STD-8719.17.	Select Status		
11.3.3.2.2. The data shall include, but not be limited to, the following:	Select Status		
11.3.3.2.2.1. Design calculations for stress, fatigue, and other items that verify compliance with applicable code requirements such as ASME, ANSI, and DOT.	Select Status		

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11.3.3.2.2.3. In-process fabrication and construction inspection plans and results.	Select Status		
11.3.3.2.2.4. Pressure vessel manufacturer data reports (ASME Form U-1 or Form U-1A).	Select Status		
11.3.3.2.2.5. Specification drawings and documents for all components.	Select Status		
11.3.3.2.2.6. If available, maintenance manuals for all components.	Select Status		
11.3.3.2.2.7. If available, component operating manual.	Select Status		
11.3.3.2.2.8. As required, a cross-sectional assembly drawing of the component to assess the safety aspects of the internal elements.	Select Status		
11.3.3.2.2.9. System operating and maintenance plans and procedures.	Select Status		
11.3.3.2.2.10. Welding Procedure Specifications (WPS), Procedure Qualification Records (PQR), and Welder Performance Qualifications (WPQ) in accordance with ASME BPVC, B31 piping codes and Section IX.	Select Status		
11.3.3.2.2.11. Unique qualification and acceptance test plans and test reports.	Select Status		
11.3.3.2.2.12. Certification documentation showing that vessels are designed, fabricated, and tested in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1/Division 2 or 49 CFR.	Select Status		
11.3.3.2.2.13. Certification that all components, including pipe and tube fittings have successfully passed a hydrostatic or pneumatic pressure test.	Select Status		
11.3.3.2.2.14. A controlled pressure system drawing (Piping and Instrumentation Diagram or a schematic) and component sheets that reflect the current system configuration.	Select Status		
11.3.3.2.2.15. All system Non-Destructive Examination reports.	Select Status		
11.3.4. Ground Support Pressure System Analyses. An engineering analysis shall be performed as follows:	Select Status		
11.3.4.1. A stress analysis of all vessels and piping shall be available for evaluation or performed to verify that stresses are within allowable limits of current codes, standards, and regulations as identified in this volume and NASA-STD-8719.17.	Select Status		
11.3.4.2. The number of stress cycles experienced by the vessel during the certification period shall be determined.	Select Status		
11.3.4.3. Using fracture mechanics analysis, the cyclic limits for vessels with pressures greater than 2,500 psig, burst-before-leak failure mode, or corrosive and/or toxic fluids shall be determined.	Select Status		
11.3.4.4. The safe-life analysis shall be performed under the assumption of pre-existing cracks. This does not imply that cracks are allowed. All unacceptable indications shall be repaired. The safe-life analysis shall be conducted in accordance with the following requirements:	Select Status		

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11.3.4.4.1. The analysis shall show that the vessel will service at least 4 times the cycles expected during the recertification period.	Select Status		
11.3.4.4.2. The analysis shall calculate and evaluate the results from the worst combination of crack sizes (for guidance refer to NASA-STD-5009 Nondestructive Evaluation Requirements for Fracture-Critical Metallic Components and locations such as boss transition area, heat affected area, weld joint, and membrane section within the vessel.	Select Status		
11.3.4.4.3. The appropriate stress component in the vessel shall be used in the analysis.	Select Status		
11.3.4.4.4. The initial flaw size used in the safe-life analysis shall be based on either the hydrostatic test pressure or the detection limits of the appropriate NDE techniques. Flaw shapes (a/2c) ranging from 0.1 to 0.5 shall be considered.	Select Status		
Refer to NASA-STD-5009 and ASME Section VIII for guidance.	I		
11.3.4.4.5. Calculated cycles to failure shall be based on the maximum and minimum operating pressure.	Select Status		
11.3.4.4.6. A linear elastic fracture mechanic parameter (stress-intensity factors) shall be used to determine critical crack sizes. The most conservative deformation mode shall be used to determine the appropriate stress-intensity factors (fracture toughness) as appropriate for the parent, weld, and joint materials.	Select Status		
11.3.4.4.7. Fracture mechanics shall only be used to predict the subcritical crack propagation life before unstable crack growth.	Select Status		
11.3.4.4.8. The safe-life analysis results shall be reduced by a factor of 4 in conjunction with assuming the most conservative bounds on material properties and crack growth data for the vessel environment.	Select Status		
11.3.4.4.9. Failure mode determination shall be in accordance with API-579/ASME-FFS-1, Fitness for Service, or equivalent standard and shall consider operations in hazardous area classification zones as defined by Volume 6, Chapter 14, Section 14.1.2.	Select Status		
11.3.4.4.10. Vessels subject to stress corrosion (sustained stress) shall show that the corresponding applied stress intensity during operation is less than the threshold stress intensity in the intended environment.	Select Status		
11.3.4.4.11. Corrosion allowance and the remaining wall shall be determined based on MIL-HDBK-729, Corrosion and Corrosion Prevention Metals.	Select Status		

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CHAPTER 12 FLIGHT HARDWARE PRESSURE SYSTEMS AND PRESSURIZED STRUCTURES	I		
This chapter establishes minimum design, fabrication, installation, testing, inspection, certification, and data requirements for flight aerospace vehicle equipment (AVE) and pressurized systems, pressure vessels, and pressurized structures.	I		
12.1. Flight Hardware Pressure System and Pressurized Structure General Requirements.	I		
Hazardous flight hardware pressure systems are defined as follows: ***(1) Flight systems containing hazardous fluids such as cryogens, flammables, combustibles, and toxics.*** ***(2) Systems used to transfer hazardous fluids such as cryogens, flammables, combustibles, and hypergols.*** ***(3) Systems with operating pressures that exceed 100 psig.*** ***(4) Systems with stored energy levels exceeding 14,240 foot pounds; and*** *(5)* ***Systems that are identified by Payload Safety Working Group (PSWG) as safety critical.***	I		
12.1.1. Flight Hardware Pressure System and Pressurized Structure General Design Requirements	I		
12.1.1.1. The structural design of all pressure vessels and pressurized structures shall use industry or government standard processes and procedures for manufacture and repair.	Select Status		
12.1.1.2. The design shall provide for access, inspection, service, repair, refurbishment, and pre-launch servicing as required.	Select Status		
The Payload Project System Safety Engineer must ensure that all of the requirements in this chapter and document are well understood and incorporated by the spacecraft design engineers or tailored appropriately.	I		
12.1.1.3. For all reusable pressure vessels and pressurized structures, the design shall permit hardware to be maintained in and refurbished to a flightworthy condition. To be considered flightworthy, repaired, or refurbished hardware items shall pass all the applicable acceptance tests and inspections required for new flight hardware.	Select Status		
12.1.1.4. Repaired, refurbished, or hardware transferred from another payload project shall meet the same conditions of flightworthiness as new hardware. To be considered flight worthy, repaired, refurbished, or hardware transferred from another payload project, items shall pass all the applicable qualification, acceptance tests and inspections required for new flight hardware.	Select Status		
12.1.2. Flight Hardware Pressure System and Pressurized Structure Failure Tolerance	I		

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12.1.2.1. Payload/Spacecraft hazardous pressure systems shall be designed to be single fault tolerant against inadvertent actuations (including leakage) or component failure that could result in a critical hazard during prelaunch operations.	Select Status		
12.1.2.2. Payload/Spacecraft hazardous pressure systems shall be designed to be dual fault tolerant against inadvertent actuations (including leakage) or component failure that could result in a catastrophic hazard during prelaunch operations. **Exception:** Structural failure (i.e., rupture or leakage) of tubing, piping, vessels, components featuring machined parent metal or all-welded construction (e.g. valves, regulators, transducers, heat exchangers, etc.), and normally closed pyrovalves with machined parent metal shear sections shall not be considered credible single-barrier failures provided they meet the applicable requirements of this volume. Normally closed pyrovalves used in propellant/pressurization systems without additional barriers to leakage shall be considered hazardous ordnance devices per Chapter 13 of this volume and shall meet the tubing and fitting requirements of this volume.	Select Status		
12.1.3. Flight Hardware Pressure System Offloading	I		
12.1.3.1. For contingency safing operations, hazardous pressure systems shall be designed so that depressurization and drain fittings are accessible and do not create a personnel or equipment hazard for offloading hazardous fluids at the launch complex.	Select Status		
12.1.3.2. System design and accessibility shall permit the offload of propellant and pressure systems at any point after pressurization or loading, including the ability to offload all systems at the launch pad and/or vehicle integration facilities. This shall occur without de-mating of the spacecraft from the launch vehicle or any other disassembly of vehicle systems unless approved by the appropriate authorities as identified by the PSWG and Range Safety.	Select Status		
System design and contingency planning shall permit for safe movement of the payload. Planning shall address the worst-case scenario. ***Accessibility through payload fairing door(s) is the desired approach. Verification/validation of the design for accessibility is best achieved through a high fidelity modeling or mock-up of hardware, including required GSE, tooling, PPE, etc., or by demonstrating similarity to accepted design and processes.*** ***Early coordination with the launch vehicle supplier is necessary to establish required payload fairing door size and placement, operational support, and ability to perform contingency support in hazardous and/or explosive environments. Also, see 12.1.10.1.***	I		
12.1.3.3. If the payload project and the local safety authority decide that depressurizing and/or offloading the pressure systems of a spacecraft is necessary, spacecraft offload procedures shall be approved by the local safety authority prior to use, in accordance with Volume 6 section 4.4 and attachment 2 of this publication or as required by the local safety authority.	Select Status		
12.1.3.4. Flight hardware propellant systems shall be designed to permit propellant loading or offloading without the need for internal or external power to re-configure propulsion system components.	Select Status		

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12.1.4. Flight Hardware Pressure System Operations. The requirements for operating hazardous pressure systems found in Volume 6 of this publication shall be taken into consideration in the design and testing of these systems in addition to the general requirements identified in 12.5 of this chapter.	Select Status		
12.1.5. Flight Hardware Pressure System and Pressurized Structure Analyses	I		
12.1.5.1. Flight Hardware Pressure System and Pressurized Structure Hazard Analysis	I		
12.1.5.1.1. A hazard analysis shall be performed on all hazardous systems hardware and software (if applicable) in accordance with a PSWG approved SSP (Volume 1, Attachment 2).	Select Status		
12.1.5.1.2. Hazards related to the test, integration, and planned and contingency operations of these systems in payload processing facility and launch site area shall be analyzed.	Select Status		
12.1.5.2. Flight Hardware Pressure System and Pressurized Structure Functional Analysis	I		
12.1.5.2.1. A detailed system functional analysis shall be performed to determine that the operation, interaction, or sequencing of components shall not lead to damage to the launch vehicle, payload, or associated ground support equipment.	Select Status		
This requirement is generally satisfied in the subsystem/system hazard analysis.	I		
12.1.5.2.2. The analysis shall identify all possible malfunctions or personnel errors in the operation of any component that may create conditions leading to an unacceptable risk to personnel or equipment.	Select Status		
12.1.5.2.3. The analysis shall also evaluate any credible secondary or subsequent occurrence, failure, or component malfunction that, initiated by a primary failure, could result in personnel injury.	Select Status		
12.1.5.2.4. Items identified by the hazard analyses shall be designated safety critical and shall require the following considerations:	Select Status		
12.1.5.2.4.1. Hazard identification and proposed corrective action.	Select Status		
12.1.5.2.4.2. Design action.	Select Status		
12.1.5.2.4.3. Safety procedures and operating requirements.	Select Status		
12.1.5.2.4.4. Safety supervision.	Select Status		
12.1.5.2.5. Systems analysis data shall show that:	Select Status		
12.1.5.2.5.1. The system provides the capability of maintaining all pressure levels in a safe condition in the event of the interruption of any process or control sequence at any time during test or countdown.	Select Status		
12.1.5.2.5.2. Redundant pressure relief devices have mutually independent pressure escape routes.	Select Status		

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12.1.5.2.5.3. In systems where pressure regulator failure may result in a critical hazard to personnel or hardware safety systems, regulation is redundant and, where passive redundant systems are specified, includes automatic switchover.	Select Status		
12.1.5.2.5.4. When the hazardous effects of safety critical failures or malfunctions are prevented through the use of redundant components or systems, all such redundant components or systems shall be operational before the initiation of irreversible portions of safety critical operations or events.	Select Status		
12.1.5.3. Flight Hardware Pressure System and Pressurized Structure Stress Analysis	I		
12.1.5.3.1. General Requirements	I		
12.1.5.3.1.1. A detailed and comprehensive stress analysis of each pressure vessel and pressurized structure shall be conducted under the assumption of no crack-like flaws in the structure.	Select Status		
12.1.5.3.1.2. The analysis shall determine stresses resulting from the combined effects of internal pressure, ground or flight loads, and thermal gradients.	Select Status		
12.1.5.3.1.3. Both membrane stresses and bending stresses resulting from internal pressure and external loads shall be calculated to account for the effects of geometrical discontinuities, design configuration, and structural support attachments.	Select Status		
12.1.5.3.1.4. Loads shall be combined by using the appropriate design limit or ultimate safety factors on the individual loads and comparing the results to material allowable loads.	Select Status		
12.1.5.3.1.5. Safety factors shall be as determined in 12.2.	Select Status		
12.1.5.3.1.6. Safety factors on external (support) loads shall be as assigned to the primary structure supporting the pressurized system.	Select Status		
12.1.5.3.2. Metallic Pressure Vessels and Pressurized Structures Stress Analysis	Select Status		
12.1.5.3.2.1. For metallic pressure vessels and pressurized structures, classical solutions are acceptable if the design geometries and loading conditions are simple and the results are sufficiently accurate (as determined by PSWG and Range Safety) to warrant their application.	Select Status		
12.1.5.3.2.2. Finite element or other equivalent structural analysis techniques shall be used to calculate the stresses, strains, and displacements for complex geometries and loading conditions.	Select Status		
12.1.5.3.2.3. As necessary, local structural models shall be constructed to augment the overall structural model in areas of rapidly varying stresses.	Select Status		
12.1.5.3.2.4. Minimum material gauge as specified in the design drawings shall be used in calculating stresses.	Select Status		
12.1.5.3.2.5. The allowable material strengths shall reflect the effects of temperature, thermal cycling and gradients, processing variables, and time associated with the design environments.	Select Status		

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12.1.5.3.2.6. Minimum margins of safety associated with the parent materials, weldments, and heat-affected zones shall be calculated and tabulated for all pressure vessels and pressurized structures along with their locations and stress levels.	Select Status		
12.1.5.3.2.7. The margins of safety shall be positive against the strength and stiffness requirements of 12.1.7 and 12.1.8.	Select Status		
12.1.5.3.3. Composite Hardware Stress Analysis	I		
12.1.5.3.3.1. Composite overwrapped pressure vessels (COPVs) constructed with a metallic liner and a carbon fiber polymer overwrap material, shall be analyzed in accordance with ANSI/American Institute of Aeronautics and Astronautics (AIAA) S-081B-2018, Space Systems - Composite Overwrapped Pressure Vessels (COPVs). All other metallic lined COPV's using a composite overwrap material or a non-metallic lined pressure vessel manufactured of a composite material shall be analyzed in accordance with BPVC-X-2019 ASME Boiler and Pressure Vessel Code Section X Fiber-Reinforced Plastic Pressure.	Select Status		
12.1.5.3.3.2. Interlamination normal and shear stresses as well as in-plane stress components shall be calculated.	Select Status		
12.1.5.3.3.3. Effects of ply orientation, stacking sequence, and geometrical discontinuities shall be accounted for.	Select Status		
12.1.5.4. Flight Hardware Pressure System and Pressurized Structure Fatigue Analysis. When conventional fatigue analysis is used to demonstrate the fatigue-life of an unflawed pressure vessel or pressurized structure, nominal values of fatigue-life characteristics including stress-life (S-N) and strain-life (Se - N) data of the structural materials shall be used.	Select Status		
12.1.5.4.1. These data shall be taken from reliable sources or other sources approved by the payload project and the PSWG.	Select Status		
Fatigue-life characteristics data are available from reliable sources such as MIL-HDBK-5.	I		
12.1.5.4.2. The analysis shall account for the spectra of expected operating loads, pressure, and environments.	Select Status		
12.1.5.4.3. Fatigue damage cumulative technique (such as Miner's rule) is an acceptable method for handling variable amplitude fatigue cyclic loadings.	Select Status		
12.1.5.5. Flight Hardware Pressure System and Pressurized Structure Safe-Life Analysis	I		
12.1.5.5.1. When crack growth safe-life analysis is used to demonstrate the safe-life of a pressure vessel or a pressurized structure, undetected flaws shall be assumed to be in the critical locations and in the most unfavorable orientation with respect to the applied stress and material properties.	Select Status		
12.1.5.5.2. The size of the flaws (cracks) shall be based on the appropriate NDE techniques and flaw detection capabilities. Proof test logic shall not be used to determine the initial flaw size for fracture analysis.	Select Status		

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12.1.5.5.3. The crack growth safe-life analysis shall be based on fracture mechanics methodology that has been submitted to the PSWG for PSWG and Range Safety review and approval.	Select Status		
12.1.5.5.4. Nominal values of fracture toughness and fatigue crack growth rate data associated with each alloy, temper, product form, and thermal and chemical environments shall be used in the safe-life analysis.	Select Status		
12.1.5.5.5. Pressure vessels or pressurized structures that experience sustained stresses shall also show that the corresponding maximum stress intensity factor (K_{max}) during sustained load in operation is less than the stress-corrosion cracking threshold (K_{ISCC}) data in the appropriate environment, $K_{max} < K_{ISCC}$.	Select Status		
12.1.5.5.6. A crack growth software package accepted by the PSWG and Range Safety shall be used to conduct the safe-life analysis.	Select Status		
12.1.5.5.7. Aspect ratio (a/2c) changes shall be accounted for in the analysis.	Select Status		
12.1.5.5.8. Retardation effects on crack growth rates from variable amplitude loading shall not be considered without approval by the payload project.	Select Status		
12.1.5.5.9. Tensile residual stresses shall be included in the analysis.	Select Status		
12.1.5.5.10. The safe-life analysis shall be included in the stress analysis report. In particular, loading spectra, environments, assumed initial flaw sizes, crack-growth models, fatigue crack growth rate, and fracture data shall be delineated. A summary of significant results shall be clearly presented.	Select Status		
12.1.6. Flight Hardware Pressure Vessel and Pressurized Structure Loads, Pressures, and Environments	**I**		
12.1.6.1. The entire anticipated load-pressure-temperature history and associated environments throughout the service life shall be determined in accordance with specified mission requirements.	Select Status		
12.1.6.2. At a minimum, the following factors and their statistical variations shall be considered:	Select Status		
12.1.6.2.1. The environmentally induced loads and pressures.	Select Status		
12.1.6.2.2. The environments acting simultaneously with these loads and pressures with their proper relationships.	Select Status		
12.1.6.2.3. The frequency of application of these loads, pressures, environments, and their levels and duration.	Select Status		
12.1.7. Flight Hardware Pressure Vessel and Pressurized Structure Strength Requirements	**I**		
12.1.7.1. All pressure vessels and pressurized structures shall possess sufficient strength to withstand limit loads and maximum operating pressure (MOP) in the expected operating environments throughout their respective service lives without experiencing detrimental deformation.	Select Status		
12.1.7.2. All pressure vessels and pressurized structures shall also withstand ultimate loads and design burst pressure in the expected operating environments without experiencing rupture or collapse.	Select Status		

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12.1.7.3. Pressure vessels and pressurized structures shall be capable of withstanding ultimate external loads and ultimate external pressure (destabilizing) without collapse or rupture when internally pressurized to the minimum anticipated operating pressure.	Select Status		
12.1.7.4. All pressure vessels and pressurized structures shall sustain proof pressure without incurring gross yielding or detrimental deformation and shall sustain design burst pressure without rupture.	Select Status		
12.1.7.5. When proof tests are conducted at temperatures other than design temperatures, the change in material properties at the proof temperature shall be accounted for in determining proof pressure.	Select Status		
12.1.7.6. Pressurized structures subject to instability modes of failure shall not collapse under ultimate loads nor degrade the functioning of any system due to elastic buckling deformation under limit loads.	Select Status		
12.1.7.7. Evaluation of buckling strength shall consider the combined action of primary and secondary stresses and their effects on general instability, local or panel instability, and crippling.	Select Status		
12.1.7.8. Design loads for buckling shall be ultimate loads, except that any load component that tends to alleviate buckling shall not be increased by the ultimate design safety factor.	Select Status		
12.1.7.9. Destabilizing pressures shall be increased by the ultimate design factor, but internal stabilizing pressures shall not be increased unless they reduce structural capability.	Select Status		
12.1.7.10. The margin of safety shall be positive and shall be determined by analysis or test at design ultimate and design limit levels, when appropriate, at the temperatures expected for all critical conditions.	Select Status		
12.1.8. Flight Hardware Pressure Vessel and Pressurized Structure Stiffness Requirements	I		
12.1.8.1. Pressure vessels and pressurized structures shall possess adequate stiffness to preclude detrimental deformation at limit loads and pressures in the expected operating environments throughout their respective service lives.	Select Status		
12.1.8.2. The stiffness properties of pressure vessels and pressurized structures shall be such as to prevent all detrimental instabilities of coupled vibration modes, minimize detrimental effects of the loads and dynamics response that are associated with structural flexibility, and avoid adverse contact with other vehicle systems.	Select Status		
12.1.9. Flight Hardware Pressure Vessel and Pressurized Structure Thermal Requirements	Select Status		
12.1.9.1. Thermal effects, including heating rates, temperatures, thermal gradient, thermal stresses and deformations, and changes in the physical and mechanical properties of the material of construction shall be considered in the design of all pressure vessels and pressurized structures.	Select Status		
12.1.9.2. These effects shall be based on temperature extremes that simulate those predicted for the operating environment plus a design margin as specified in NASA-STD-7002 Payload Test Requirements, Space and Missile Systems Center (SMC) Standard, SMC-S-016, Test Requirements for Launch, Upper-stage, and Space Vehicles, or equivalent.	Select Status		

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12.1.10. Physical Arrangement of Flight Hardware Pressure Systems and System Components	I		
12.1.10.1. Flight Hardware Pressure System and System Component General Requirements	I		
12.1.10.1.1. The design of hypergolic propellant systems shall take into consideration limitations imposed on individuals dressed in SCAPE or other approved propellant handling ensembles during fill and drain operations.	Select Status		
12.1.10.1.2. Sufficient clearances are needed for the insertion of assembly tools.	Select Status		
12.1.10.1.3. Redundant pressure components and systems shall be separated from main systems to decrease the chance of total system failure in case of damage, fire, or malfunction.	Select Status		
12.1.10.1.4. Pressure systems shall be shielded from other systems to protect against hazards caused by proximity to combustible gases, heat sources, and electrical equipment.	Select Status		
12.1.10.1.5. Any failure in any such adjacent system shall not result in combustion, explosion, or release of pressure fluids.	Select Status		
12.1.10.1.6. Safety critical pressure systems shall be designed so that special tools are not required for removal and replacement of components unless it can be shown that the use of special tools does not create additional hazards and the special tools will be made available throughout testing, ground processing and launch.	Select Status		
12.1.10.2. Flight Hardware Pressure System Components and Fittings	I		
12.1.10.2.1. Components shall be designed so that, during the assembly of parts, sufficient clearance exists to permit assembly of the components without damage to seals, O-rings, or backup rings where they pass over threaded parts or sharp corners.	Select Status		
12.1.10.2.2. All incompatible propellant system connections shall be designed to be physically impossible to interconnect.	Select Status		
Incompatible propellant system connections should be keyed, sized, or located so that it is physically impossible to interconnect them.	I		
12.1.10.2.3. Quick Disconnect Couplings	Select Status		
The quick disconnect assembly consists of both the ground-half and air-half couplings.	I		
12.1.10.2.3.1. All quick disconnect couplings shall be designed with a factor of safety of not less than 2.5.	Select Status		
12.1.10.2.3.2. Quick disconnect coupling bodies and appropriate parts shall be constructed of 304, 304L, 316, or 316L series stainless steel. All parts that contact the fluid shall be compatible with the fluid.	Select Status		

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12.1.10.2.3.3. The quick disconnect ground-half coupling shall withstand being dropped from a height of six feet on to a metal deck/grating or concrete floor without leaking or becoming disassembled.	Select Status		
12.1.10.2.3.4. When uncoupled, the quick disconnect shall seal the air-half and ground-half couplings and shall not permit external leakage. Both halves of the coupling shall seal under both low and high pressure. In cryogenic systems only, quick disconnects used in vent coupling assemblies shall allow gaseous cryogenic flow through the coupling whether connected or disconnected.	Select Status		
12.1.10.2.3.5. When coupled, the quick disconnect shall permit fluid flow in either direction.	Select Status		
12.1.10.2.3.6. The quick disconnect shall not permit external leakage during any phase of coupling or uncoupling.	Select Status		
12.1.10.2.3.7. The quick disconnect shall be designed so that coupling and uncoupling can be performed with simple motions.	Select Status		
12.1.10.2.3.8. The quick disconnect coupling shall contain a positive locking device that will automatically lock the connection of the coupling halves. It shall be possible by visual inspection to determine that the quick disconnect is completely coupled and locked. The quick disconnect shall not have any partially coupled unlocked position in which the coupling can remain stable and permit fluid flow.	Select Status		
12.1.10.2.3.9. Special care shall be taken in the quick disconnect design to ensure that the possibility of inadvertent uncoupling and/or coupling external leakage due to side and axial loads is minimized.	Select Status		
12.1.10.2.3.10. The quick disconnect shall be designed to couple/uncouple without imparting adverse loads on fluid lines that could cause flight hardware damage.	Select Status		
12.1.10.2.3.11. Quick disconnects shall be designed to ensure that all incompatible fuel and oxidizer couplings cannot be inadvertently connected, causing mixing of propellants.	Select Status		
12.1.10.2.3.12. All quick disconnect ground half couplings shall be identified in accordance with the requirements of 11.2.1.7.6 of this volume.	Select Status		
12.1.10.2.4. Pressure fluid tanks shall be shielded or isolated from combustion apparatus or other heat sources.	Select Status		
12.1.10.3. Flight Hardware Pressure System Tubing and Piping	I		
12.1.10.3.1. In general, tubing and piping shall be located so that damage cannot occur due to being stepped on, used as handholds, or by manipulation of tools during installation.	Select Status		
12.1.10.3.2. Straight tubing and piping runs shall be avoided between two rigid connection points.	Select Status		
12.1.10.3.3. Where such straight runs are necessary, provisions shall be made for expansion joints, motion of the units, or similar compensation to ensure that no excessive strain is applied to the tubing and fittings.	Select Status		
12.1.10.3.4. Line bends shall be used to ease stresses induced in tubing by alignment tolerances and vibration.	Select Status		

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12.1.10.4. Flight Hardware Pressure System Flexible Hose Requirements	I		
12.1.10.4.1. Flight pressure system Flexible hose shall be designed, qualified and acceptance tested in accordance with ANSI/AIAA S-080-2018 Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components.	Select Status		
12.1.10.4.2. Flexible hoses shall be used only when required to provide movement between interconnecting fluid lines when no other means are available.	Select Status		
12.1.10.4.3. Flexible hose systems shall be designed to prevent kinking, avoid abrasive chafing from the restraining device, and avoid abrasive contact with adjacent structure or moving parts that may cause reduction in strength.	Select Status		
12.1.10.4.4. Flexible hoses shall not be supported by rigid lines or components if excessive loads from flexible hose motion can occur.	Select Status		
12.1.10.4.5. Flexible hose assemblies shall not be installed in a manner that will place a mechanical load on the hose or hose fittings to an extent that will degrade hose strength or cause the hose fitting to loosen.	Select Status		
12.1.10.4.6. Flexible hoses shall be designed such that the bend radius is not less than the minimum bend radius recommended in authoritative specifications for the particular hose.	Select Status		
12.1.10.4.7. Flexible hoses shall not be exposed to internal temperatures that exceed the rated temperature of the hose.	Select Status		
12.1.10.4.8. Flexible hoses shall not be permitted to pass close to a heat source unless approved by the PSWG and Range Safety and sufficiently protected from the heat source.	Select Status		
12.1.10.4.9. All flexible hoses that are not lined shall be subjected to a flow-induced vibration analysis, performed in accordance with MSFC-SPEC-3746, Flow-Induced Vibration Assessment Requirements for Metal Bellows and Flexible hoses.	Select Status		
MSFC-SPEC-3746 provides guidance for performing flow-induced vibration analysis.	I		
12.1.10.4.10. Flexible hoses shall consist of a flexible inner pressure carrier tube (compatible with the service fluid) constructed of elastomeric (typically polytetrafluoroethylene [PTFE]) for hypergolic fluid) or corrugated metal (typically 300 series stainless steel) material reinforced by one or more layers of 300 series stainless steel wire and/or fabric braid.	Select Status		
In applications where stringent permeability and leakage requirements apply, hoses with a metal inner pressure carrier tube should be used. If these hoses will be used in a highly corrosive environment, consideration should be given to the use of Hastalloy C-22 in accordance with ASTM B575 for the inner pressure carrier tube and C-276 material for the reinforcing braid.	I		

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12.1.10.4.11. Flexible hose restraining devices shall be designed and demonstrated to contain a force not less than 1.5 times the open line pressure force (see Table 12.1).	Select Status		
12.1.10.4.11.1. The restraint design safety factor shall not be less than 3 on material yield strength.	Select Status		
12.1.10.4.11.2. Hose clamp-type restraining devices shall not be used.	Select Status		
12.1.10.4.12. Flexible hose installations shall be designed to produce no stress or strain in the hard lines or components. Stresses induced because of dimensional changes caused by pressure or temperature variations or torque forces induced in the flexible hose shall be included in the analysis.	Select Status		
12.1.10.4.13. Flexible hose assemblies that exhibit operational use anomalies conditions shall be identified, documented, and tracked IAW paragraph 12.1.18.3. Flight Hardware Pressure System and Pressurized Structure Inspection and Maintenance. Flexible hoses exhibiting major defects as classified in SAE ARP 1658, shall be removed from service.	Select Status		

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Table 12.1. Open Line Force Calculation Factor

Diameter Opening (inch)	Calculated Force Factor for Each psi of Source Pressure (psi)
1/8	0.18506
1/4	0.28320
3/8	0.38140
1/2	0.47960
5/8	0.57770
3/4	0.67590
7/8	0.77410
1	0.87230
To calculate the force acting on line opening, select the applicable diameter opening and multiply he right-hand column by the source pressure (psi)	

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12.1.10.5. Flight Hardware Pressure System Valves, Vents, Vent Lines, and Drains	I		
12.1.10.5.1. Manually operated valves shall be located to permit operation from the side or above to prevent spillage of “hazardous” service fluid on the operator due to leak or failure of the valve seals.	Select Status		
12.1.10.5.2. For remotely controlled non-pyrotechnically actuated valves, positive indication of actual valve position shall be displayed at the control station.	Select Status		
Indication of valve stem position or flow measurement is an acceptable indication. Indication of an electrical control circuit actuation is not a positive indication of valve position.	I		

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12.1.10.5.3. Vent lines for flammable and combustible vapors shall be extended away from work areas to prevent accidental ignition of vapors and/or injury to personnel.	Select Status		
12.1.10.5.4. Vent outlets shall be located far enough away from incompatible propellants systems and incompatible materials to ensure no contact is made during vent operations.	Select Status		
12.1.10.5.5. Safety valves and burst diaphragms shall be located so that their operation cannot cause injury to personnel standing close by or damage to the installation or equipment, or they shall be equipped with deflection devices to protect personnel and equipment.	Select Status		
12.1.10.5.6. Lines, drains, and vents shall be separated or shielded from other high-energy systems; for example, heat, high voltage, combustible gases, and chemicals.	Select Status		
12.1.10.5.7. Drain and vent lines shall not be connected to any other lines in any way that could generate a hazardous mixture in the drain/vent line or allow feedback of hazardous substances to the components being drained or vented.	Select Status		
12.1.10.5.8. Systems containing liquid explosives, flammable liquids, or explosive waste shall be designed so that a complete offload/drainage of the system is achievable by gravity or pneumatics.	Select Status		
12.1.10.5.9. For systems designed for gravity drainage, the pipe/tube slope shall be not less than 1/4 inch per foot at any point. Drain lines designed for positive pressure purges do not have a slope requirement.	Select Status		
12.1.10.5.10. The drain system shall include a sump or basin where the fluid can safely collect. This sump or basin shall be designed so that it can be easily cleaned, and drainage easily removed.	Select Status		
12.1.10.6. Flight Hardware Pressure System Test Points	I		
12.1.10.6.1. If required, test points shall be provided so that disassembly for test is not required.	Select Status		
12.1.10.6.2. The test points shall be easily accessible for attachment of ground test equipment.	Select Status		
12.1.10.6.3. Common-plug test connectors for pressure and return sections shall be designed to require positive removal of the pressure connection before unsealing the return connections.	Select Status		
12.1.10.6.4. Individual pressure and return test connectors shall be designed to positively prevent inadvertent cross-connections.	Select Status		
12.1.11. Flight Hardware Pressure System and Pressurized Structure Supports and Clamps	I		

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12.1.11.1. All rigid pipe and tubing assemblies shall be supported by a firm structure to restrain destructive vibration, shock, and acceleration.	Select Status		
12.1.11.2. Components within a system shall be supported by a firm structure and not the connecting tubing or piping unless it can be shown by analysis that the tubing or piping can safely support the component.	Select Status		
12.1.11.3. Pipe and tube accessories such as supports, anchors, and braces shall be compatible with hypergolic propellant vapors when installed in a hypergolic propellant system.	Select Status		
12.1.11.4. All threaded parts in safety critical components shall be securely locked to resist uncoupling forces by acceptable safe design methods.	Select Status		
Safety wiring and self-locking nuts are examples of acceptable safe design.	I		

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12.1.11.5. Torque for threaded parts in safety critical components shall be specified and documented.	Select Status		
12.1.11.6. Friction-type locking devices shall be avoided in safety critical applications.	Select Status		
12.1.11.7. Star washers and jam nuts shall not be used as locking devices.	Select Status		
12.1.11.8. The design of internally threaded bosses shall preclude the possibility of damage to the component or the boss threads because of screwing universal fittings to excessive depths in the bosses.	Select Status		
12.1.11.9. Retainers or snap rings shall not be used in pressure systems where failure of the ring would allow connection failures or blow-outs caused by internal pressure.	Select Status		
12.1.11.10. Snubbers shall be used with all bourdon-type pressure transmitters, pressure switches, and pressure gauges, except air pressure gauges.	Select Status		
12.1.12. Flight Hardware Pressure System Bonding and Grounding	I		
12.1.12.1. Hazardous pressure systems shall be designed so that the flight system being loaded or unloaded, and the ground support loading system can be commonly grounded and bonded during transfer operations. When the flight system and the ground system are connected, maximum DC resistance from any flight system tubing or tanks to the nearest earth electrode plate shall be 1.0 ohm or less. See 11.2.1.8.	Select Status		
12.1.12.2. Propellant system components and lines shall be grounded to metallic structures.	Select Status		
12.1.12.3. All hazardous pressure systems shall be electrically bonded to the flight vehicle to minimize the DC resistance between the hazardous pressure system and the flight vehicle.	Select Status		
12.1.13. Flight Hardware Pressure System and Pressurized Structure Material Compatibility and Selection	I		
12.1.13.1. Material Compatibility	I		
12.1.13.1.1. Materials shall be compatible throughout their intended service life with the service fluids and the materials used in the construction and installation of tankage, piping, and components as well as with nonmetallic items such as gaskets, seals, packing, seats, and lubricants.	Select Status		
12.1.13.1.2. At a minimum, material compatibility shall be determined in regard to flammability, ignition and combustion, toxicity, and corrosion.	Select Status		
12.1.13.1.3. Materials that could come in contact with fluid from a ruptured or leaky tank, pipe, or other components that contain hazardous fluids shall be nonflammable and non-combustible.	Select Status		
12.1.13.1.4. Compatible materials selection shall be obtained from one of the following sources:	Select Status		
12.1.13.1.4.1. T.O. 00-25-223.	Select Status		
12.1.13.1.4.2. CPIA (Chemical Propulsion Information Agency) 394.	Select Status		

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12.1.13.1.4.3. NASA-STD-6016, Standard Materials and Processes Requirements for Spacecraft.	Select Status		
12.1.13.1.4.4. NASA-STD-6001, Flammability, Offgassing, and Compatibility Requirements and Test Procedures	Select Status		
12.1.13.1.4.5. The NASA Material and Process Technical Information System (MAPTIS). MAPTIS is accessible via the Internet at http://maptis.nasa.gov	Select Status		
12.1.13.1.4.6. KTI-5212, NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes.	Select Status		
12.1.13.1.4.7. MSFC-STD-3029, NASA/MSFC Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments.	Select Status		
12.1.13.1.4.8. Other sources and documents approved by the PSWG and Range Safety.	Select Status		
12.1.13.1.5. Compatibility Testing. When compatibility data cannot be obtained from a PSWG and Range Safety approved source, compatibility tests shall be performed. Test procedures, pass/fail criteria, and test results shall be submitted to the PSWG for PSWG and Range Safety review and approval.	Select Status		
12.1.13.1.6. Compatibility Analysis. The payload project shall prepare a compatibility analysis containing the following information:	Select Status		
12.1.13.1.6.1. List of all materials used in system.	Select Status		
12.1.13.1.6.2. Service fluid in contact with each material.4	Select Status		
12.1.13.1.6.3. Source document or test results showing material compatibility in regard to flammability, toxicity, corrosion, and ignition and combustion.	Select Status		
12.1.13.2. Material Selection	**I**		
12.1.13.2.1. Material "A" allowable values shall be used for pressure vessels and pressurized structures where failure of a single load path would result in loss of structural integrity.	Select Status		
12.1.13.2.2. For redundant pressurized structures where failure of a structural element would result in a safe redistribution of applied loads to other load-carrying members, material "B" allowables may be used.	Select Status		
12.1.13.2.3. The fracture toughness shall be as high as practical within the context of structural efficiency and fracture resistance.	Select Status		
12.1.13.2.4. For pressure vessels and pressurized structures to be analyzed with linear elastic fracture mechanics, fracture properties shall be accounted for in material selection. These properties include fracture toughness; threshold values of stress intensity under sustained loading; sub-critical crack-growth characteristics under sustained and cyclic loadings; the effects of fabrication and joining processes; the effects of cleaning agents, dye penetrants, coatings, and proof test fluids; and the effects of inspection couplants or materials, temperature, load spectra, and other environmental conditions.	Select Status		
12.1.13.2.5. Materials that have a low KISCC in the expected operating environments shall not be used in pressure vessels and pressurized structures unless adequate protection from the operating environments can be demonstrated by tests and reviewed and approved by the PSWG and Range Safety.	Select Status		
12.1.13.2.6. If the material has a KISCC less than 60 percent of the plane-strain fracture toughness, KIC under the conditions of its application, it shall be mandatory to show, by a “worst case” fracture mechanics analysis, that the low KISCC factor will not precipitate premature structural failure.	Select Status		

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12.1.14. Flight Hardware Pressure System Contamination and Cleanliness Requirements	I		
12.1.14.1. Adequate levels of contamination control shall be established by relating the cleanliness requirements to the actual needs and nature of the system and components.	Select Status		
12.1.14.2. General contamination control requirements are as follows:	Select Status		
12.1.14.2.1. Components and systems shall be protected from contaminants by filtration, sealed modules, clean fluids, and clean environment during assembly, storage installation, and use.	Select Status		
12.1.14.2.2. Systems shall be designed to allow verification that the lines and components are clean after flushing and purging the system.	Select Status		
12.1.14.2.3. Systems shall be designed to ensure that contaminants or waste fluids can be flushed and purged after fill and drain operations.	Select Status		
12.1.15. Flight Hardware Pressure System Components Service Life and Safe-Life	I		
12.1.15.1. All hazardous pressure system components shall be designed for safe endurance against hazardous failure modes for not less than 400 percent of the total number of expected prelaunch cycles.	Select Status		
12.1.15.2. The safe-life for pressure vessels and pressurized structures shall be established assuming the existence of pre-existing initial flaws or cracks in the vessel and shall cover the maximum expected operating loads and environments. The safe-life shall be at least four times the specified life for those pressure vessels not accessible for periodic inspection and repair.	Select Status		
12.1.15.3. For those pressure vessels and pressurized structures that are readily accessible for periodic inspection and repair, the safe-life, as determined by analysis and test, shall be at least four times the interval between scheduled inspection and/or refurbishment.	Select Status		
12.1.15.4. All pressure vessels and pressurized structures that require periodic refurbishment to meet safe-life requirements shall be recertified after each refurbishment by the same techniques and procedures used in the initial certification, unless an alternative recertification plan has been approved by the payload project and the PSWG and Range Safety.	Select Status		
12.1.16. Flight Hardware Metallic Materials	I		
12.1.16.1. Selection. Metallic materials shall be selected on the basis of proven environmental compatibility, material strengths, fracture properties, fatigue-life, and crack growth characteristics consistent with the overall program requirements.	Select Status		
12.1.16.2. Evaluation. Metallic material evaluation shall be conducted based on the following considerations:	Select Status		
12.1.16.2.1. The metallic materials selected for design shall be evaluated with respect to material processing, fabrication methods, manufacturing operations, refurbishment procedures and processes, and other pertinent factors that affect the resulting strength and fracture properties of the material in the fabricated as well as the refurbished configurations.	Select Status		
12.1.16.2.2. The evaluation shall ascertain that the mechanical properties, strengths, and fracture properties used in design and analyses shall be realized in the actual hardware and that these properties are compatible with the fluid contents and the expected operating environments.	Select Status		

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12.1.16.2.3. Materials that are susceptible to stress-corrosion cracking or hydrogen embrittlement shall be evaluated by performing sustained threshold stress intensity tests when applicable data are not available	Select Status		
12.1.16.3. Characterization. Metallic material characterization shall be based on the following considerations:	Select Status		
12.1.16.3.1. The allowable mechanical properties, strength and fracture properties of all metallic materials selected for pressure vessels and pressurized structures shall be characterized in sufficient detail to permit reliable and high confidence predictions of their structural performance in the expected operating environments unless these properties are available from reliable or other sources approved by the payload project, PSWG and Range Safety.	Select Status		
Strength and fracture properties of metallic materials selected for pressure vessels and pressurized structures are available from references such as DOT/FAA/AR-MMPDS, ASTM Standards, the Air Force Damage Tolerant Design Handbook, military specifications, and the Aerospace Structural Metals Handbook.	I		
12.1.16.3.2. Where material properties are not available, they shall be determined by test methods approved by the payload project, and the PSWG and Range Safety.	Select Status		
12.1.16.3.3. The characterization shall produce the following strength and fracture properties for the parent metals, weldments, and heat-affected zones as a function of the fluid contents, loading spectra, and the expected operating environments, including proof test environments, as appropriate:	Select Status		
12.1.16.3.3.1. Tensile yield strength, Fy, and ultimate tensile strength, Fu.	Select Status		
12.1.16.3.3.2. Fracture toughness, KIc, KIe, Kc, KISCC.	Select Status		
12.1.16.3.3.3. Sustained-stress crack-growth data, da/dt versus Kmax.	Select Status		
12.1.16.3.3.4. Fatigue crack growth data, da/dn versus KI and load ratio, R.	Select Status		
12.1.16.3.4. Proven test procedures shall be used for determining material fracture properties as required. These procedures shall conform to recognized standards.	Select Status		
Recognized standards include those developed by the ASTM.	I		
12.1.16.3.5. The test specimens and procedures used shall provide valid test data for the intended application.	Select Status		
12.1.16.3.6. Sufficient tests shall be conducted so that meaningful nominal values of fracture toughness, fatigue data and crack growth rate data corresponding to each alloy system, temper, product form, thermal and chemical environments, and loading spectra can be established to evaluate compliance with safe-life requirements.	Select Status		
12.1.16.3.7. If the conventional fatigue analysis is to be performed, the stress-life (S-N) or the strain-life (Se-N) fatigue data shall be generated in accordance with the standard test methods developed by ASTM.	Select Status		
12.1.16.4. Fabrication and Process Control	I		
12.1.16.4.1. Proven processes and procedures for fabrication and repair shall be used to preclude damage or material degradation during material processing, manufacturing operations, and refurbishment.	Select Status		

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12.1.16.4.2. In particular, the melt process, thermal treatment, welding process, forming, joining, machining, drilling, grinding, repair and rewelding operations, and other operations shall be within the state-of-the-art and have been used on currently approved hardware.	Select Status		
12.1.16.4.3. The fracture toughness, mechanical and physical properties of the parent materials, weldments and heat-affected zones shall be within established design limits after exposure to the intended fabrication processes.	Select Status		
12.1.16.4.4. The machining, forming, joining, welding, dimensional stability during thermal treatments, and through-thickness hardening characteristics of the material shall be compatible with the fabrication processes to be encountered.	Select Status		
12.1.16.4.5. Fracture control requirements and precautions shall be defined in applicable drawings and process specifications.	Select Status		
12.1.16.4.6. Detailed fabrication instructions and controls shall be provided to ensure proper implementation of the fracture control requirements.	Select Status		
12.1.16.4.7. Special precautions shall be exercised throughout the manufacturing operations to guard against processing damage or other structural degradation. In addition, procurement requirements and controls shall be implemented to ensure that suppliers and subcontractors use fracture control procedures and precautions consistent with the fabrication and inspection processes intended for use during actual hardware fabrication.	Select Status		
12.1.17. Flight Hardware Pressure Vessel and Pressurized Structure Quality Assurance Program Requirements	I		
12.1.17.1. A quality assurance (QA) program shall be established to ensure that the necessary NDE and acceptance tests are effectively performed to verify that the product meets the requirements of this publication. The QA program shall be based on a comprehensive study of the product and engineering requirements, drawings, material specifications, process specifications, workmanship standards, design review records, stress analysis, failure mode analysis, safe-life analysis, and the results from development and qualification tests.	Select Status		
12.1.17.2. The program shall ensure that materials, parts, subassemblies, assemblies, and all completed and refurbished hardware conform to applicable drawings and process specifications; that no damage or degradation has occurred during material processing, fabrication, inspection, acceptance tests, shipping, storage, operational use and refurbishment; and that defects that could cause failure are detected or evaluated and corrected.	Select Status		
12.1.17.3. QA program Inspection Plan. At a minimum, the following considerations shall be included in structuring the quality assurance program:	Select Status		
12.1.17.3.1. An inspection master plan shall be established before the start of fabrication.	Select Status		
12.1.17.3.2. The plan shall specify appropriate inspection points and inspection techniques for use throughout the program, beginning with material procurement and continuing through fabrication, assembly, acceptance proof test, operation, and refurbishment, as appropriate.	Select Status		
12.1.17.3.3. In establishing inspection points and inspection techniques, consideration shall be given to the material characteristics, fabrication processes, design concepts, structural configuration, and accessibility for inspection and detection of discontinuities or flaws.	Select Status		
12.1.17.3.4. For metallic hardware, the flaw geometries shall encompass defects commonly encountered, including surface crack at the open surface, corner crack, or through-the-thickness crack at the edge of fastener hole, and surface crack at the root of intersecting prismatic structural elements.	Select Status		
12.1.17.3.5. Acceptance and rejection standards shall be established for each phase of inspection and for each type of inspection technique.	Select Status		

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12.1.17.3.6. For COPVs and other composite hardware, laminate defects, such as delamination, fiber breakage, surface cuts, porosity, air bubbles, cracks, dents, and abrasions, shall be considered.	Select Status		
12.1.17.3.7. All inspections shall be performed by inspectors qualified and certified in inspection techniques according to the American Society for Nondestructive Testing recommended practices (SNT-TC-1A) or PSWG and Range Safety approved equivalent.	Select Status		
12.1.17.3.8. For COPVs, inspectors shall also be certified to American Society for Nondestructive Testing (ASNT) Level II (or PSWG and Range Safety approved equivalent) and shall be familiar with laminate production processes and composite shell defects. Inspectors shall be certified to inspect specific types of COPVs using specific inspection techniques in accordance with ASNT standards.	Select Status		
12.1.17.4. Inspection Techniques. At a minimum, the following considerations shall be included in determining the appropriate inspection techniques:	Select Status		
12.1.17.4.1. The selected NDE inspection techniques shall have the capability to determine the size, geometry, location, and orientation of suspect discontinuities; a flaw or defect; to obtain, where multiple flaws exist, the location of each with respect to the other and the distance between them; and to differentiate among defect shapes, from tight cracks to spherical voids.	Select Status		
12.1.17.4.2. Two or more NDE methods shall be used for a part or assembly that cannot be adequately examined by only one method.	Select Status		
12.1.17.4.3. The flaw detection capability of each selected NDE technique shall be based on past experience on similar hardware.	Select Status		
12.1.17.4.4. Where this experience is not available or is not sufficiently extensive to provide reliable results, the capability, under production or operational inspection conditions, shall be determined experimentally and demonstrated by tests approved by the payload project on representative material product form, thickness, and design configuration.	Select Status		
12.1.17.4.5. The flaw detection capability shall be expressed in terms of detectable crack length, crack depth, and crack area. For COPVs, the detection of laminate defects, such as delamination, fiber breakage, and air bubbles, shall also be addressed.	Select Status		
12.1.17.4.6. The selected NDE should be capable of detecting allowable initial flaw size corresponding to a 90 percent probability of detection at a 95 percent confidence level.	Select Status		
12.1.17.4.7. The most appropriate NDE technique(s) for detecting commonly encountered flaw types shall be used for all metallic pressure vessels, COPVs, pressurized structures, and other hardware based on their flaw detection capabilities.	Select Status		
12.1.17.5. Inspection Data. At a minimum, inspection data shall be dispositioned as follows:	Select Status		
12.1.17.5.1. Inspection data in the form of flaw histories shall be maintained throughout the life of the pressure vessel or pressurized structure. The inspection data shall be stored in the system certification file.	Select Status		
12.1.17.5.2. These data shall be periodically reviewed and assessed to evaluate trends and anomalies associated with the inspection procedures, equipment and personnel, material characteristics, fabrication processes, design concept, and structural configuration.	Select Status		
12.1.17.5.3. The result of this assessment shall form the basis of any required corrective action.	Select Status		

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12.1.17.5.4. For suspect COPVs, the payload project shall ensure a Material Review Board (MRB) is initiated to evaluate the NDE results and recommend disposition. The MRB shall consist of the procuring agency (Range User), the COPV manufacturer, and Range Safety. Findings of the MRB shall be briefed to the payload project and the PSWG and Range Safety. The MRB shall use NDE comparison, past experience, additional NDE, and other qualitative and quantitative methods to recommend the acceptability of a suspect vessel. Data collected from the MRB process shall be input into the inspection database and system certification file.	Select Status		
12.1.17.6. Acceptance Proof Test	Select Status		
12.1.17.6.1. All pressure vessels, pressurized structures, and pressure components shall be proof pressure tested in accordance with the requirements of 12.2 through 12.5, as applicable, to verify that the hardware has sufficient structural integrity to sustain the subsequent service loads, pressure, temperatures, and environments.	Select Status		
12.1.17.6.2. For pressure vessels, pressurized structures, and other pressurized components, the temperature shall be consistent with the critical use temperature; or, as an alternative, tests may be conducted at an alternate temperature if the test pressures are suitably adjusted to account for temperature effects on strength and fracture toughness.	Select Status		
12.1.17.6.3. Proof test fluids shall be compatible with the structural materials in the pressure vessels and pressurized structures.	Select Status		
12.1.17.6.4. Proof test fluids shall not pose a hazard to test personnel.	Select Status		
12.1.17.6.5. If such compatibility data is not available, required testing shall be conducted to demonstrate that the proposed test fluid does not deteriorate the test article.	Select Status		
12.1.17.6.6. Accept/reject criteria shall be formulated before the acceptance proof test.	Select Status		
12.1.17.6.7. Every pressure vessel and pressurized structure shall not leak, rupture, or experience gross yielding during acceptance testing.	Select Status		
12.1.18. Flight Hardware Pressure System and Pressurized Structure Operations and Maintenance	I		
12.1.18.1. Flight Hardware Pressure System and Pressurized Structure Safe Operating Limits	I		
12.1.18.1.1. Safe operating limits shall be established for each pressure vessel and each pressurized structure based on the appropriate analysis and testing used in its design and qualification in accordance with 12.2, 12.3, and 12.4.	Select Status		
12.1.18.1.2. These safe operating limits shall be summarized in a format that provides rapid visibility of the important structural characteristics and capability.	Select Status		
12.1.18.2. Flight Hardware Pressure System and Pressurized Structure Operating Procedures	I		
12.1.18.2.1. Operating procedures shall be established for each pressure vessel and pressurized structure.	Select Status		
12.1.18.2.2. These procedures shall be compatible with the safety requirements and personnel control requirements at the facility where the operations are conducted.	Select Status		
12.1.18.2.3. Step-by-step directions shall be written with sufficient detail to allow a qualified technician or mechanic to accomplish the operations.	Select Status		
12.1.18.2.4. Schematics that identify the location and pressure limits of relief valves and burst discs shall be provided when applicable, and procedures to ensure compatibility of the pressurizing system with the structural capability of the pressurized hardware shall be established.	Select Status		

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12.1.18.2.5. Before initiating or performing a procedure involving hazardous operations with pressure systems, practice runs shall be conducted on non-pressurized systems until the operating procedures are well rehearsed.	Select Status		
12.1.18.2.6. Initial tests shall then be conducted at pressure levels not to exceed 50 percent of the normal operating pressures until operating characteristics can be established and stabilized.	Select Status		
12.1.18.2.7. Only qualified and trained personnel shall be assigned to work on or with high pressure systems.	Select Status		
12.1.18.2.8. Warning signs with the hazard(s) identified shall be posted at the operations facility before pressurization.	Select Status		
12.1.18.3. Flight Hardware Pressure System and Pressurized Structure Inspection and Maintenance	I		
12.1.18.3.1. The results of the appropriate stress and safe-life analyses shall be used in conjunction with the appropriate results from the structural development and qualification tests to develop a quantitative approach to inspection and repair.	Select Status		
12.1.18.3.2. Allowable damage limits shall be established for each pressure vessel and pressurized structure so that the required inspection interval and repair schedule can be established to maintain hardware to the requirements of this volume.	Select Status		
12.1.18.3.3. NDE technique(s) and inspection procedures to reliably detect characteristic discontinuities, defects and determine flaw size under the condition of use shall be developed for use in the field and at payload processing facilities.	Select Status		
12.1.18.3.4. Procedures shall be established for recording, tracking, and analyzing operational data as it is accumulated to identify critical areas requiring corrective actions.	Select Status		
12.1.18.3.5. Analyses shall include prediction of remaining life and reassessment of required inspection intervals.	Select Status		
12.1.18.4. Flight Hardware Pressure System and Pressurized Structure Repair and Refurbishment	I		
12.1.18.4.1. When inspections reveal structural damage or defects exceeding the permissible levels, the damaged hardware shall be repaired, refurbished, or replaced, as appropriate.	Select Status		
12.1.18.4.2. All repaired or refurbished hardware shall be recertified after each repair and refurbishment by the applicable acceptance test procedure for new hardware to verify their structural integrity and to establish their suitability for continued service.	Select Status		
12.1.18.5. Flight Hardware Pressure System and Pressurized Structure Storage Requirements	I		
12.1.18.5.1. When pressure vessels and pressurized structures are prepared for transportation or storage, they shall be protected against exposure to adverse environments that could cause corrosion or other forms of material degradation.	Select Status		
12.1.18.5.2. Pressure vessels and pressurized structures shall be protected against mechanical degradation resulting from scratches, dents, or accidental dropping of the hardware.	Select Status		
12.1.18.5.3. Induced stresses due to storage fixture constraints shall be minimized by suitable storage fixture design.	Select Status		
12.1.18.5.4. In the event storage requirements are violated, recertification shall be required before acceptance for use.	Select Status		
12.1.18.6. Flight Hardware Pressure System and Pressurized Structure Reactivation	I		

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12.1.18.6.1. Pressure vessels and pressurized structures that are reactivated for use after an extensive period in either an unknown, unprotected, or unregulated storage environment shall be recertified to ascertain their structural integrity and suitability for continued service before commitment to flight.	Select Status		
12.1.18.6.2. Recertification tests for pressurized hardware shall be in accordance with the appropriate Recertification Test Requirement. (See 12.2.2.8.)	Select Status		
12.1.19. Flight Hardware Pressure System and Pressurized Structure Documentation Requirements	I		
12.1.19.1. Inspection, maintenance, and operation records shall be kept and maintained throughout the life of each pressure vessel and each pressurized structure.	Select Status		
12.1.19.2. At a minimum, the records shall contain the following information:	Select Status		
12.1.19.2.1. Temperature, pressurization history, and pressurizing fluid for both tests and operations.	Select Status		
12.1.19.2.2. Number of pressurizations experienced as well as number allowed in safe-life analysis.	Select Status		
12.1.19.2.3. Results of any inspection conducted, including the inspector, inspection dates, inspection techniques employed, location and character of defects, defect origin, and cause.	Select Status		
12.1.19.2.4. Storage condition.	Select Status		
12.1.19.2.5. Maintenance and corrective actions performed from manufacturing to operational use, including refurbishment.	Select Status		
12.1.19.2.6. Sketches and photographs to show areas of structural damage and extent of repairs.	Select Status		
12.1.19.2.7. Acceptance and recertification tests performed, including test conditions and results.	Select Status		
12.1.19.2.8. Analyses supporting the repair or modification that may influence future use capability.	Select Status		
12.2. Flight Hardware Pressure Vessel Design, Analysis, and Test Requirements	I		
12.2.1. Flight Hardware Metallic Pressure Vessel General Design, Analysis, and Verification Requirements. Three approaches for the design, analysis and verification of metallic pressure vessels can be selected as shown in Figure 12.1. Selection of the approach to be used depends on the desired efficiency of design coupled with the level of analysis and verification testing required.	Select Status		
12.2.1.1. Approach A. Approach A in Figure 12.1 shows the steps required for verification of a metallic pressure vessel designed with a burst factor equal to 1.5 or greater.	Select Status		
12.2.1.1.1. Based on the results of the failure mode determination, one of two distinct verification paths shall be satisfied: (Path 1) Leak-before-burst (LBB) with leakage of the contents not creating a condition that could lead to a mishap (such as toxic gas venting or pressurization of a compartment not capable of the pressure increase) or (Path 2) Brittle fracture failure mode or hazardous LBB in which, if allowed to leak, the leak would cause a hazard.	Select Status		
12.2.1.1.2. The verification requirements for Path 1 are delineated in 12.2.2 and the verification requirements for Path 2 in 12.2.3.	I		

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12.2.1.2. Approach B. Approach B, Figure 12.1 shows the steps required for verification of flight hardware metallic pressure vessels designed using the ASME Boiler and Pressure Vessel Code in accordance with paragraph 12.2.4., or with 49 CFR DOT Pressure Vessel Codes.	**Select Status**		
12.2.1.3. Approach C. Approach C, Figure 12.1 – Approach C specifies the design, qualification, and acceptance test requirements of flight hardware metallic PVS shall be in accordance with ANSI/AIAA S-080A-2018, Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components.	**Select Status**		

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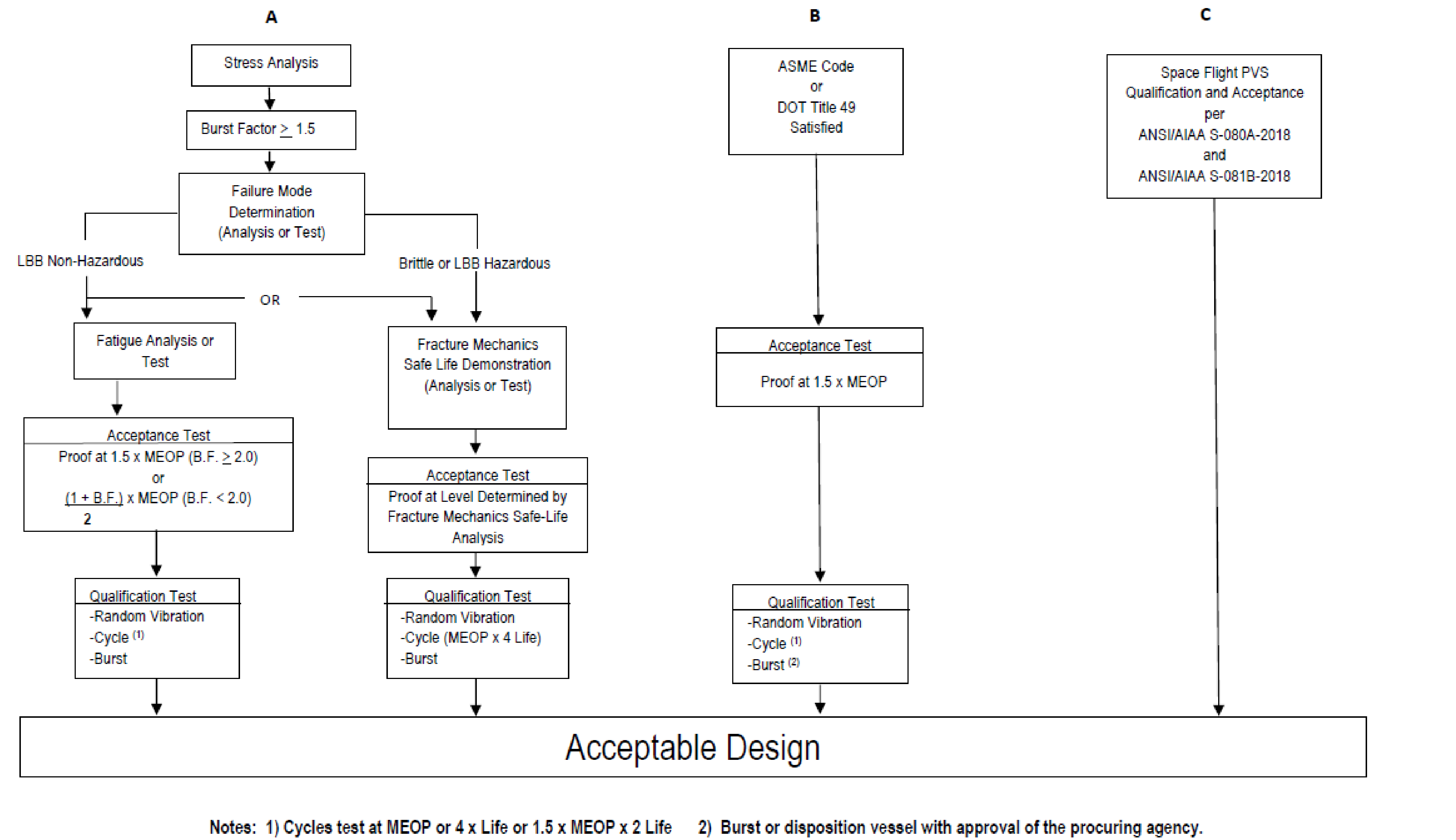

Figure 12.1. Pressure Vessel Design Verification Approach

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12.2.2. Path 1. Flight Hardware Metallic Pressure Vessels with Non-Hazardous LBB Failure Mode	I		
12.2.2.1. The LBB failure mode shall be demonstrated analytically or by test showing that an initial surface flaw with a shape (a/2c) ranging from 0.1 to 0.5 will propagate through the vessel thickness to become a through-the-thickness crack with a length less than or equal to 10 times the vessel thickness and still be stable at MOP/MEOP.	Select Status		
12.2.2.2. Fracture mechanics shall be used if the failure mode is determined by analysis.	Select Status		
12.2.2.3. A pressure vessel that contains non-hazardous fluid and exhibits LBB failure mode is considered a non-hazardous LBB pressure vessel.	Select Status		
12.2.2.4. Flight Hardware Metallic Pressure Vessels with Non-Hazardous LBB Failure Mode Factor of Safety Requirements	I		
12.2.2.4.1. Metallic pressure vessels that satisfy the non-hazardous LBB failure mode criterion may be designed conventionally, wherein the design factors of safety and proof test factors are selected on the basis of successful past experience.	Select Status		
12.2.2.4.2. Unless otherwise specified, the minimum burst factor shall be 1.5.	Select Status		
12.2.2.5. Flight Hardware Metallic Pressure Vessels with Non-Hazardous LBB Failure Mode Fatigue-Life Demonstration	I		
12.2.2.5.1. After completion of the stress analysis conducted in accordance with the requirements of 12.1.5.3, conventional fatigue-life analysis shall be performed, as appropriate, on the unflawed structure to ascertain that the pressure vessel, acted upon by the spectra of operating loads, pressures, and environments meets the life requirements.	Select Status		
12.2.2.5.2. A life factor of 4 shall be used in the analysis.	Select Status		
12.2.2.5.3. Testing of unflawed specimens to demonstrate fatigue-life of a specific pressure vessel together with stress analysis is an acceptable alternative to fatigue test of the vessel.	Select Status		
12.2.2.5.4. Fatigue-life requirements are considered demonstrated when the unflawed specimens that represent critical areas such as membrane section, weld joints, heat-affected zone, and boss transition section successfully sustain the limit loads and MEOP/MOP in the expected operating environments for the specified test duration without rupture.	Select Status		
12.2.2.5.5. The required test duration is 4 times the specified service life.	Select Status		
12.2.2.6. Flight Hardware Metallic Pressure Vessels with Non-Hazardous LBB Failure Mode Qualification Test Requirements	I		
12.2.2.6.1. Qualification tests shall be conducted on flight quality hardware to demonstrate structural adequacy of the design.	Select Status		

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12.2.2.6.2. The test fixtures, support structures, and methods of environmental application shall not induce erroneous test conditions.	Select Status		
12.2.2.6.3. The types of instrumentation and their locations in qualification tests shall be based on the results of the stress analysis of 12.1.5.3.	Select Status		
12.2.2.6.4. The instrumentation shall provide sufficient data to ensure proper application of the accept/reject criteria, which shall be established before test.	Select Status		
12.2.2.6.5. The sequences, combinations, levels, and duration of loads, pressure, and environments shall demonstrate that design requirements have been met.	Select Status		
12.2.2.6.6. Qualification testing shall include random vibration testing and pressure testing. The following delineates the required tests:	Select Status		
12.2.2.6.6.1. Random Vibration Testing. Random vibration qualification testing shall be performed in accordance with the requirements of NASA-STD-7001, Payload Vibroacoustic Test Criteria, SMC-S-016 or equivalent unless it can be shown that the vibration requirement is enveloped by other qualification testing performed.	Select Status		
12.2.2.6.6.2. Pressure Testing. Required qualification pressure testing levels are shown in Table 12.2. Requirements for application of external loads in combination with internal pressures during testing shall be evaluated based on the relative magnitude and/or destabilizing effect of stresses due to the external load. If limit-combined tensile stresses are enveloped by test pressure stresses, the application of external loads shall not be required. If the application of external loads is required, the load shall be cycled to limit for 4 times the predicted number of operating cycles of the most severe design condition (for example, destabilizing load with constant minimum internal pressure or maximum additive load with a constant maximum expected operating pressure). Qualification test procedures shall be approved by the payload project, the PSWG, the appropriate launch or test range approval authority, and other necessary approval authorities as identified by the PSWG and Range Safety.	Select Status		

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Table 12.2. Qualification Pressure Test Requirements.

Test Item	No Yield After	No Burst at (1)
Vessel # 1(2)		Burst Factor x MOP
Vessel # 2	Cycle at 1.5 x MOP for 2x predicted number of service life. (50 cycles minimum) Or Cycle at 1.0 x MOP for 4x predicted number of service life. (50 cycles minimum)	Burst Factor x MOP

(1) Unless otherwise specified, after demonstrating no burst at the design burst pressure test level, increase pressure to actual burst of vessel. Record actual burst pressure.

(2) Test may be deleted at discretion of the payload project.

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12.2.2.7. Flight Hardware Metallic Pressure Vessels with Non-Hazardous LBB Failure Mode Acceptance Test Requirements. Every pressurized system element shall be proof tested to verify that the materials, manufacturing processes, and workmanship meet design specifications and that the hardware is suitable for flight.	Select Status		
12.2.2.7.1. Acceptance tests shall be conducted on every pressure system element before commitment to flight. Accept/reject criteria shall be formulated before tests.	Select Status		
12.2.2.7.2. The test fixtures and support structures shall be designed to permit application of all test loads without jeopardizing the flightworthiness of the test article.	Select Status		
12.2.2.7.3. At a minimum, the following are required as part of the acceptance process:	I		
12.2.2.7.3.1. Nondestructive Inspection. A complete inspection by the selected nondestructive inspection (NDE) technique(s) shall be performed before the proof pressure test to establish the initial condition of the hardware.	Select Status		
12.2.2.7.3.2. Proof Pressure Test. Every pressure vessel shall be proof pressure tested to verify that the item has sufficient structural integrity to sustain the subsequent service loads, pressure, temperatures, and environments. The proof test fixture shall simulate the structural response or reaction loads of the flight mounting configuration when vessel mounting induces axial or radial restrictions on the pressure driven expansion of the vessel. Test temperature shall be consistent with the critical use temperature, or the test pressure shall be adjusted to account for temperature effects on material properties. The minimum proof pressure shall be: P = ((1 + Burst Factor)/2) x MOP for a burst factor less than 2.0, or P = 1.5 x MOP for a burst factor equal or greater than 2.0. The minimum hold time at proof pressure shall be 5 minutes.	Select Status		

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12.2.2.8. Flight Hardware Metallic Pressure Vessels with Non-Hazardous LBB Failure Mode Recertification Test Requirements. All refurbished pressure system elements shall be recertified after each refurbishment by the acceptance test requirements for new hardware to verify their structural integrity and to establish their suitability for continued service before commitment to flight. Pressure vessels that have exceeded the approved storage environment (temperature, humidity, time, and others) shall also be recertified by the acceptance test requirements for new hardware.	Select Status		
12.2.2.9. Special Provisions. For one-of-a-kind applications, a proof test of each flight unit to a minimum of 1.5 times MOP and a conventional fatigue analysis showing a minimum of 10 design lifetimes may be used in lieu of the required pressure testing as defined in 12.2.2.6. The implementation of this option needs prior approval by the payload project, the PSWG, and any other necessary approval authorities identified by the PSWG and Range Safety.	Select Status		
12.2.3. Path 2. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode	I		
12.2.3.1. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode Factor of Safety Requirements	I		
12.2.3.1.1. Safe-life design methodology based on fracture mechanics techniques shall be used to establish the appropriate design factor of safety and the associated proof factor for metallic pressure vessels that exhibit brittle fracture or hazardous LBB failure mode.	Select Status		
12.2.3.1.2. The loading spectra, material strengths, fracture toughness, and flaw growth rates of the parent material and weldments, test program requirements, stress levels, and the compatibility of the structural materials with the thermal and chemical environments expected in service shall be taken into consideration.	Select Status		
12.2.3.1.3. Nominal values of fracture toughness and flaw growth rate data corresponding to each alloy system, temper, and product form shall be used along with a life factor of 4 on specified service life in establishing the design factor of safety and the associated proof factor.	Select Status		
12.2.3.1.4. Unless otherwise specified, the minimum burst factor shall be 1.5.	Select Status		
12.2.3.2. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode Safe-Life Demonstration Requirements	I		
12.2.3.2.1. After completion of the stress analysis conducted in accordance with the requirements of 12.1.5.3, a safe-life analysis of each pressure vessel covering the maximum expected operating loads and environments shall be performed under the assumption of preexisting initial flaws or cracks in the vessel.	Select Status		
12.2.3.2.2. The analysis shall show that the metallic pressure vessel with flaws placed in the most unfavorable orientation with respect to the applied stress and material properties, of sizes defined by the acceptance proof test or NDE and acted upon by the spectra of expected operating loads and environments, meets the safe-life requirements of 12.1.15.	Select Status		

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12.2.3.2.3. Nominal values of fracture toughness and flaw growth rate data associated with each alloy system, temper, product form, thermal and chemical environments, and loading spectra shall be used along with a life factor of 4 on specified service life in all safe-life analyses.	Select Status		
12.2.3.2.4. Pressure vessels that experience sustained stress shall also show that the corresponding applied stress intensity (K_I) during operation is less than K_{ISCC} in the appropriate environment.	Select Status		
12.2.3.2.5. Testing of metallic pressure vessels under fracture control in lieu of safe-life analysis is an acceptable alternative, provided that, in addition to following a quality assurance program (12.1.17) for each flight article, a qualification test program is implemented on pre-flawed specimen's representative of the structure design.	Select Status		
12.2.3.2.6. These flaws shall not be less than the minimum detectable flaw sizes established by the selected NDE method(s). Proof test logic shall not be used to determine minimum flaw size.	Select Status		
12.2.3.2.7. Safe-life requirements of 12.1.15 are considered demonstrated when the pre-flawed test specimens successfully sustain the limit loads and pressure cycles in the expected operating environments without rupture.	Select Status		
12.2.3.2.8. A life factor of 4 on specified service life shall be applied in the safe-life demonstration testing.	Select Status		
12.2.3.2.9. A report that documents the fracture mechanics safe-life analysis or safe-life testing shall be prepared to delineate the following:	Select Status		
12.2.3.2.9.1. Fracture mechanics data (fracture toughness and fatigue crack growth rates).	Select Status		
12.2.3.2.9.2. Loading spectrum and environments.	Select Status		
12.2.3.2.9.3. Initial flaw sizes.	Select Status		
12.2.3.2.9.4. Analysis assumptions and rationales.	Select Status		
12.2.3.2.9.5. Calculation methodology.	Select Status		
12.2.3.2.9.6. Summary of significant results.	Select Status		
12.2.3.2.9.7. References.	Select Status		
12.2.3.2.10. This report shall be closely coordinated with the stress analysis report and shall be periodically revised and updated during the life of the program.	Select Status		
12.2.3.3. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode Qualification Test Requirements. Qualification testing shall meet requirements of 12.2.2.6.	Select Status		

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12.2.3.4. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode Acceptance Test Requirements. Acceptance test requirements for pressure vessels that exhibit brittle fracture, or hazardous LBB failure mode are identical to those with ductile fracture failure mode as defined in 12.2.2.7 except that the test level shall be that defined by the fracture mechanics analysis. Surface and volume NDE shall be performed before and after proof test on the weld joints as a minimum. Cryo-proof acceptance test procedures may be required to adequately verify initial flaw size. The pressure vessel shall not rupture or leak at the acceptance test pressure.	Select Status		
12.2.3.5. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	Select Status		
12.2.3.6. Flight Hardware Metallic Pressure Vessels with Brittle Fracture or Hazardous LBB Failure Mode Special Provisions. For one-of-a-kind applications, a proof test of each flight unit to a minimum of 1.5 times MOP and a conventional fatigue analysis showing a minimum of 10 design lifetimes may be used in lieu of the required pressure testing as defined in 12.2.2.6 for qualification. The implementation of this option needs prior approval by the PSWG and Range Safety.	Select Status		
12.2.4. Approach B, Flight Hardware Metallic Pressure Vessels Designed Using ASME Boiler and Pressure Vessel Code. Metallic pressure vessels may be designed and manufactured per the rules of the ASME Boiler and Pressure Vessel Code, Section VIII, Divisions 1 or 2.	Select Status		
12.2.4.1. Flight Hardware Metallic Pressure Vessels Designed Using ASME Boiler and Pressure Vessel Code Qualification Test Requirements. Qualification testing shall meet the requirements of 12.2.2.6.	Select Status		
12.2.4.2. Flight Hardware Metallic Pressure Vessels Designed Using ASME Boiler and Pressure Vessel Code Acceptance Test Requirements	Select Status		
12.2.4.2.1. A proof test shall be performed as specified in ASME Boiler and Pressure Vessel Code.	Select Status		
12.2.4.2.2. NDE shall be performed in accordance with the ASME Code and RT and/or UT as appropriate to quantify defects in all full penetration welds after the proof test.	Select Status		
12.2.5. Flight Hardware Composite Overwrapped Pressure Vessels. Flight Hardware Composite Overwrapped Pressure Vessels (COPV). Flight Hardware COPV's shall be designed, qualified, and acceptance tested using Approach A, Approach B, or Approach C as shown in Figure 12.1.	Select Status		
12.2.5.1. Approach A. Flight COPVs designed using Approach A in Figure 12.1 shall have a design burst pressure equal to 1.5 or greater. The COPV failure mode shall be demonstrated by applicable fracture mechanics analysis, test, or similarity, as approved by the PSWG and Range Safety.	Select Status		
12.2.5.1.1. Manufacturers of COPVs using non-metallic liners or new composite over wrap materials (other than carbon, aramid, or glass fibers in epoxy resins) and their customers shall conduct the necessary development test program that is acceptable to the PSWG and Range Safety to substantiate a level of safety that is comparable to conventional metal-lined COPVs.	Select Status		

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12.2.5.1.2. Based on the results of the failure mode determination, one of two distinct Paths shall be satisfied: 1) (Path 1) LBB, in which leakage of the contents will not create a hazard, or 2) (Path 2) Brittle fracture failure mode or hazardous LBB, in which, if allowed to leak, the leak would cause a hazard (such as release of toxic gas, damage to nearby safety critical components, or over-pressurization of a closed compartment).	Select Status		
12.2.5.1.3. The verification requirements for path 1 (LBB) are delineated in 12.2.6 and the verification requirements for path 2 (brittle fracture/hazardous LBB) are delineated in 12.2.7.	Select Status		
12.2.5.1.4. Failure mode and safe-life testing using coupons or subscale vessels shall not be used unless approved by the PSWG and Range Safety.	Select Status		
12.2.5.1.5. COPVs with metal liners, evaluated by similarity (in other words, comparison with a vessel that has already been tested and documented having similar fiber, epoxy, matrix design, and geometry) may not require a demonstration test, if approved by the PSWG and Range Safety.	Select Status		
12.2.5.1.6. For COPVs subjected to sustained load conditions, stress rupture life shall be considered. The operating strain in the fiber shall be below 50 percent of the ultimate fiber strain at burst during ground pressurization, storage, integration, and flight operations. Operating strain may exceed 50 percent of the ultimate fiber strain during transportation proof or other proof testing when personnel are not present.	Select Status		
12.2.5.2. Approach B. Approach B, in Figure 12-1, shows the steps required for verification of a COPV designed using ASME Boiler and Pressure Vessel Code, Section X, or DOT Title 49 Exemptions with a burst factor equal to 3.0 or greater.	Select Status		
12.2.5.3. Approach C. Approach C specifies that COPV's, constructed with a metal liner and a carbon fiber/polymer matrix overwrap, shall be designed, qualified and acceptance tested in accordance with ANSI/AIAA S-081B-2018.	Select Status		
12.2.5.4. Damage Control Plan (DCP). Damage control plan(s) shall be developed to identify and mitigate credible sources of mechanical and other forms of damage to the COPV during manufacturing and throughout service life. The DCP shall be developed in accordance with ANSI/AIAA S-081B-2018, section 5.3, and shall include the use of protective covers. The DCP may include additional protections, as necessary, such as damage indicators.	Select Status		
12.2.5.4.1. Damage Control Test (DCT). The ability of the DCP to mitigate credible sources of damage to the COPV during manufacturing and throughout the service life shall be verified by test. DCT procedures shall be developed and performed in accordance with ANSI/AIAA S-081B-2018, section 10.3.	Select Status		
12.2.5.4.2. The DCP and DCT procedures shall be submitted to Range Safety for review and approval prior to implementation	Select Status		
12.2.5.5. COPV Prelaunch Inspection and Pressure Test Requirements	I		

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12.2.5.5.1. Before the first pressurization of a COPV at a NASA facility, a NASA contracted commercial payload processing facility, or at the launch site, compliance with the Mechanical Damage Control Plan (DCP) shall be verified. A trained COPV inspector certified in accordance with ANSI/AIAA S-081B requirements and Section 12.1.17.3 shall perform the inspection. If this inspection is not possible at the launch base (in other words, the COPV is not accessible), then it shall be conducted the last time the vessel is accessible for inspection.	Select Status		
12.2.5.5.2. An inspection of the vessel shall be conducted to determine if there is any evidence of visible damage or evidence of damage to the composite shell.	Select Status		
12.2.5.4.3. After arrival at the prelaunch processing facility and completion of the inspection with no evidence of damage to the COPV, but prior to propellant loading or pressurization, COPVs shall be pressure tested to 100% of the maximum ground operating pressure. The minimum hold time for this pressure test shall be 5 minutes. This pressurization shall be conducted remotely, or a blast shield shall be used to protect personnel. Personnel will not approach the COPV for a minimum of 10 minutes following the pressurization.	Select Status		
12.2.6. COPVs with Non-Hazardous LBB Failure Mode	I		
12.2.6.1. General	I		
12.2.6.1.1. The failure mode designation for COPVs shall be based on the liner and the composite overwrap.	Select Status		
12.2.6.1.2. For metal-lined COPVs, the LBB failure mode shall be demonstrated by applicable fracture mechanics analysis and/or test or similarity, as approved by the PSWG and Range Safety. The effects of the liner sizing operation on the fracture mechanics characteristics of the metal liner shall be accounted for in the LBB evaluation. For non-metallic lined COPVs, the LBB failure mode shall be demonstrated by test.	Select Status		
12.2.6.1.3. The demonstration of the LBB failure mode by test of a COPV shall include a pre-flawed liner (flaw size determined by analysis of the liner material and flaw detection capabilities of the selected NDE techniques). Surface cracks shall be put into the liner at locations and orientations that are most critical to the LBB response. An inert fluid shall be used to pressurize the COPV. Pressure cycles shall be applied to the COPV with the upper pressure limit equal to the MOP. The LBB failure mode shall be demonstrated if one or more of the cracks leak pressure from the COPV at MOP before catastrophic failure occurs.	Select Status		
12.2.6.2. COPVs with Non-Hazardous LBB Failure Mode Factor of Safety Requirements. Nonmetallic pressure vessels that satisfy the non-hazardous LBB failure mode criterion may be designed conventionally, wherein the design factors of safety and proof test factors are selected on the basis of successful past experience. The minimum burst factor shall be 1.5.	Select Status		
12.2.6.3. COPVs with Non-Hazardous LBB Failure Mode Fatigue-Life Demonstration	I		
12.2.6.3.1. After completion of the stress analysis, a fatigue-life demonstration shall be performed for the liner, bosses, and composite shell of an unflawed COPV. Fatigue-life shall be demonstrated either by test or analysis, as approved by the PSWG and Range Safety. The test or analysis shall account for the spectra of expected loads, pressures, and environments.	Select Status		

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12.2.6.3.2. The minimum fatigue life for COPVs shall be 4 times the service life. The planned number of cycles for the COPV service life shall account for any cycles to be performed at the payload processing facility and launch site area, a launch base pressure test at 1.0 times the ground MOP, in addition to cycles at the manufacturer's facility.	Select Status		
12.2.6.4. COPVs with Non-Hazardous LBB Failure Mode Qualification Test Requirements. Qualification testing shall meet the requirements of 12.2.2.6.	Select Status		
12.2.6.5. COPVs with Non-Hazardous LBB Failure Mode Acceptance Test Requirements. Acceptance testing shall be in accordance with 12.2.2.7 and the additional requirements of 12.2.6.5.1 through 12.2.6.5.3 below.	Select Status		
12.2.6.5.1. Nondestructive Inspection. In accordance with 12.2.2.7.3.1, every COPV shall be subjected to visual and other nondestructive inspection before and after proof testing. All inspections shall be conducted by specially trained COPV inspectors certified in accordance with ANSI/AIAA S-081B requirement and Section 12.1.17.3.	Select Status		
12.2.6.5.2. Proof Pressure Test. Every COPV shall be proof pressure tested in accordance with 12.2.2.7.3.2.	Select Status		
12.2.6.5.3. Liner Inspection. Following completion of the autofrettage cycle and the proof pressure test, every COPV shall be inspected internally for liner buckling, debonding, or other gross internal defects.	Select Status		
12.2.6.5.4. Prelaunch Inspection and Pressure Test. Before a COPV is used in operations an inspection and pressure test shall be conducted in accordance with 12.2.5.3.	Select Status		
12.2.6.6. COPVs with Non-Hazardous LBB Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	Select Status		
12.2.7. Flight Hardware COPVs with Brittle Fracture or Hazardous LBB Failure Mode. The requirements described below are applicable only to flight hardware COPVs that exhibit brittle fracture or hazardous LBB failure modes.	Select Status		
12.2.7.1. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Factor of Safety Requirements. The minimum burst factor shall be 1.5.	Select Status		
12.2.7.2. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Safe-Life Demonstration Requirements	I		
12.2.7.2.1. In addition to performing a stress analysis as specified in 12.1.5.3, a safe-life demonstration of each pressure vessel, covering the maximum expected operating loads and environments, shall be performed assuming pre-existing initial flaws or cracks in the vessel. For metal-lined COPVs, safe-life shall be demonstrated either by test, analysis, similarity, or any combination thereof. For non-metallic lined COPVs, the safe-life shall be demonstrated by test, similarity, or both.	Select Status		
12.2.7.2.2. Specifically, the analysis shall show that the metal-lined COPV (with liner flaws placed in the most unfavorable orientation with respect to the applied stress and material properties, of sizes defined by the NDE flaw detection capabilities, and acted upon by the spectra of expected operating loads) shall meet the safe-life requirements specified by 12.1.15.	Select Status		

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12.2.7.2.3. For metallic liners, the nominal values of fracture toughness and flaw growth rate data associated with each alloy system, temper, product form, thermal and chemical environments, and loading spectra shall be used in all safe-life analyses.	Select Status		
12.2.7.2.4. Metal-lined COPVs that experience sustained stress shall also show that the corresponding stress intensity factor (K_I) applied to the metal liner during the operation is less than K_{ISCC} in the appropriate environment. For all liner materials for which data do not exist, the sustained load crack behavior of the liner material shall be determined by test for all fluids that are introduced into the COPV under pressure.	Select Status		
12.2.7.2.5. Testing of metal-lined COPVs under fracture control is an acceptable alternative to safe-life analysis, provided that, in addition to following a quality assurance program (12.1.17) for each flight article, a qualification test program is implemented on pre-flawed specimen's representative of the structure design. For non-metallic lined COPVs, safe-life demonstrations shall be performed by test.	Select Status		
12.2.7.2.6. These flaws shall not be less than the minimum detectable flaw sizes established by the selected NDE method(s). Proof test logic shall not be used to determine minimum flaw size.	Select Status		
12.2.7.2.7. Safe-life requirements of 12.1.15 are considered demonstrated when the pre-flawed test specimens successfully sustain the limit loads and pressure cycles in the expected operating environments without rupture.	Select Status		
12.2.7.2.8. The safe-life shall be 4 times the service life for all safe-life demonstrations. The planned number of cycles for the COPV service life shall account for any cycles to be performed at the payload processing facility and launch site area in addition to a launch base pressure test at 1.1 times the ground MOP and cycles at the manufacturer's facility.	Select Status		
12.2.7.2.9. A report that documents the fracture mechanics safe-life analysis (for metal liners only) or safe-life testing shall be prepared to delineate the following:	Select Status		
12.2.7.2.9.1. Fracture mechanics data for metal liners, including fracture toughness and fatigue crack growth on launch vehicles.	Select Status		
12.2.7.2.9.2. Loading spectrum and environments.	Select Status		
12.2.7.2.9.3. Initial flaw sizes.	Select Status		
12.2.7.2.9.4. Analysis assumptions and rationales.	Select Status		
12.2.7.2.9.5. Calculation methodology.	Select Status		
12.2.7.2.9.6. Summary of significant results.	Select Status		
12.2.7.2.9.7. References.	Select Status		
12.2.7.2.10. This report shall be closely coordinated with the stress analysis report and shall be periodically revised and updated during the life of the program.	Select Status		

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12.2.7.3. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Fatigue-Life Demonstration. For fatigue-life demonstration requirements, see 12.2.2.6.	Select Status		
12.2.7.4. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Qualification Test Requirements. Qualification testing shall meet the requirements of 12.2.2.6.	Select Status		
12.2.7.5. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Acceptance Test Requirements. Acceptance testing shall be in accordance with 12.2.2.7 and the additional requirements of 12.2.7.5.1 through 12.2.7.5.3 below.	Select Status		
12.2.7.5.1. Nondestructive Inspection. In accordance with 12.2.2.7.3.1, every COPV shall be subjected to visual and other nondestructive inspection prior to proof testing. In addition, following completion of the proof test, every COPV shall be inspected internally for liner buckling, debonding, or other gross internal defects. All inspections shall be conducted by specially trained COPV inspectors certified in accordance with ANSI/AIAA S-081B requirement and Section 12.1.17.3. If this inspection is not possible at the payload processing launch site area (i.e., the COPV is not accessible), then it shall be conducted the last time the COPV is accessible for inspection.	Select Status		
12.2.7.5.2. Proof Pressure Test. Every COPV shall be proof pressure tested in accordance with 12.2.2.7.3.2.	Select Status		
12.2.7.5.3. Prelaunch Inspection and Pressure Test. Before a COPV is used in prelaunch operations at the payload processing facility or launch area, a prelaunch inspection and pressure test shall be conducted in accordance with 12.2.5.3.	Select Status		
12.2.7.6. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	Select Status		
12.2.8. COPV Data Requirements. The following data and documentation shall be provided for flight COPVs in addition to the data required in section 12.10 for all flight pressure systems and vessels.	Select Status		
12.2.8.1. COPV Design Data.	Select Status		
12.2.8.1.1. Design specifications.	Select Status		
12.2.8.1.2. Design drawings.	Select Status		
12.2.8.1.3. Design calculations.	Select Status		
12.2.8.1.4. Material manufacturer's specification sheets for resin, fiber reinforcement, promoters, catalyst, and other components used in laminate construction.	Select Status		
12.2.8.1.5. Properly certified documentation for parts of the vessel fabricated by other fabricators.	Select Status		
12.2.8.1.6. Process specifications, giving the fabrication procedures used to fabricate both the prototype vessel(s) and all production vessels.	Select Status		

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12.2.8.2. COPV Validation Data. A summary of the design, analysis, and development test data that validates the design burst pressure, failure mode (LBB or brittle fracture), and material (liner and over wrap) compatibility with propellants and other service fluids.	Select Status		
12.2.8.3. COPV Test Data	I		
12.2.8.3.1. Qualification test report.	Select Status		
12.2.8.3.2. Quality control and production test reports.	Select Status		
12.2.8.3.3. Acceptance test report.	Select Status		
12.2.8.3.4. Prelaunch inspection and pressure test reports.	Select Status		
12.2.8.3.5. In-service inspection and recertification test reports for reusable flight COPVs.	Select Status		
12.2.8.4. Other Required COPV Documentation	I		
12.2.8.4.1. Ground processing plans and procedures for the launch sites, including all operations and activities involving to the COPV.	Select Status		
12.2.8.4.2. A risk assessment of the COPV during ground processing.	Select Status		
12.2.8.4.3. A description and the analysis of the protection system(s) used to prevent impact damage.	Select Status		
12.2.8.4.4. Description of the protective coating/covers or splash shields used to guard against contact with incompatible commodities.	Select Status		
12.2.8.4.5. History of pressure cycles (rate, magnitude, and duration) along with the design limitations.	Select Status		
12.2.8.4.6. Data to verify design limits have not been exceeded for specified storage and transport environmental conditions.	Select Status		
12.2.8.4.7. Reports of inspections or observations that identified COPV exposure to abnormal conditions, such as impacts, chemical exposure, excessive environmental loads (such as vibration, acceleration, temperature).	Select Status		
12.2.8.4.8. Mechanical Damage Control Plan (MDCP) shall be created and implemented that assures the COPV will not fail due to mechanical damage during manufacturing, testing, shipping, installation, or flight.	Select Status		
12.2.8.4.8.1. MDCP shall identify all credible mechanical damage threats starting from the point of manufacture to the end-of-service life.	Select Status		
12.2.8.4.8.2. Mechanical damage mitigation plans and procedures, and inspection points, shall be defined.	Select Status		
12.2.8.4.8.3. Comprehensive operating/handling/shipping procedures shall be prepared and included in the MDCP to ensure the COPV does not receive critical mechanical damage.	Select Status		

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12.2.8.4.8.4. One or more of the following approaches shall be selected to satisfy the appropriate safety authorities that a mechanically damaged COPV will meet the minimum burst factor requirement.	Select Status		
12.2.8.4.8.4.1. Protective Covers. Covers may be used to isolate and protect the COPV. This approach requires that the cover be tested to demonstrate that the worst-case credible mechanical damage threat results in 5 ft-lb or less energy imparted to the COPV. If the energy imparted to the COPV is greater than 5 ft-lbs., then an impacted dedicated test article vessel must be pressure tested to demonstrate that the burst factor requirement of Section 12.2.2.6 of this chapter.	Select Status		
12.2.8.4.8.4.2. Damage Indicators. Indicators may be used to clearly show whether a COPV has received critical damage. This approach requires that the indicators be tested to demonstrate that they can sense and indicate a mechanical damage event over the range of 5 ft-lbs. to the maximum credible threat level. If the indicator's minimum sensing energy is above 5 ft-lbs., then a dedicated test article COPV must be impacted at that energy level and pressure tested to demonstrate that the burst factor requirement of Section 12.2.2.6 of this chapter is met.	Select Status		
12.2.8.4.8.4.3. Worst-Case Threat Damage Tolerance Testing. A dedicated test article COPV may be tested to demonstrate it can withstand 1.25 x the worst-case credible mechanical damage and still meet the burst factor requirement of Section 12.2.2.6 of this chapter.	Select Status		
12.2.8.4.8.4.4. Visual Mechanical Damage Threshold Testing. A dedicated test article COPV may be tested to demonstrate that the mechanical damage threshold energy creates a visually detectable damage indication that will survive the pressure test for the burst factor requirement of Section 12.2.2.6 of this chapter. This approach requires the COPV to be accessible for 100% visual inspection after the threat exposure and prior to pressurization.	Select Status		
12.3. Flight Hardware Metallic Pressurized Structure Analysis and Test Requirements.	I		
12.3.1. Flight Hardware Metallic Pressurized Structure General Requirements. For pressurized structures made of metallic materials such as the fuel tanks of a launch or an upper-stage vehicle, the design approach may be based on successful past experience when appropriate. However, the analysis and verification requirements specified in this part shall be met.	Select Status		
12.3.2. Flight Hardware Metallic Pressurized Structures with Non-Hazardous LBB Failure Mode.	Select Status		
12.3.2.1. Flight Hardware Metallic Pressurized Structure Factor of Safety Requirements. Unless otherwise specified, metallic pressurized structures that satisfy the LBB failure mode may be designed with a minimum ultimate safety factor of 1.25 for unmanned systems and 1.40 for manned systems.	Select Status		
12.3.2.2. Flight Hardware Metallic Pressurized Structure Fatigue-Life Demonstration. In addition to the stress analysis conducted IAW section 12.1.5.3, a conventional fatigue-life analysis shall be performed, as appropriate, on the unflawed structure to ascertain that the pressure vessel, acted upon by the spectra of operating loads, pressures, and environments meet the life requirements. A life factor of 4 shall be used in the analysis.	Select Status		
12.3.2.3. Flight Hardware Metallic Pressurized Structure Qualification Test Requirements.	I		

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12.3.2.3.1. Qualification tests shall be conducted on flight quality hardware to demonstrate structural adequacy of the design.	Select Status		
12.3.2.3.2. Because of the potential test facility size limitation, the qualification testing may be conducted at the component level provided that the boundary conditions are correctly simulated.	Select Status		
12.3.2.3.3. The test fixtures, support structures, and methods of environmental application shall not induce erroneous test conditions.	Select Status		
12.3.2.3.4. The sequences, combinations, levels, and duration of loads, pressure and environments shall demonstrate that design requirements have been met.	Select Status		
12.3.2.3.5. Qualification testing shall include pressure cycle testing and burst testing. The following delineates the required tests:	Select Status		
12.3.2.3.5.1. Pressure Cycle Testing.	I		
12.3.2.3.5.1.1. Requirements for application of external loads in combination with internal pressure during testing shall be evaluated based on the relative magnitude and on the destabilizing effect of stresses due to the external loads.	Select Status		
12.3.2.3.5.1.2. If limit-combined tensile stresses are enveloped by the MOP stress, the application of an external load is not required.	Select Status		
12.3.2.3.5.1.3. Unless otherwise specified, the peak pressure shall be equal to the MOP during each pressure cycle, and the number of cycles shall be 4 times the predicted number of operating cycles or 50 MOP cycles, whichever is greater.	Select Status		
12.3.2.3.5.2. Burst Testing.	I		
12.3.2.3.5.2.1. After the pressure cycle testing, the test article shall be pressurized (pneumatically or hydrostatically, as applicable and safe) to the design burst pressure, while simultaneously applying the ultimate external loads, if appropriate.	Select Status		
12.3.2.3.5.2.2. The design burst pressure shall be maintained for a sufficient period of time to ensure that the proper pressure is achieved.	Select Status		
12.3.2.4. Flight Hardware Metallic Pressurized Structure Acceptance Test Requirements. Every pressurized structure shall be proof tested to verify that the materials, manufacturing processes, and workmanship meet design specifications and that the hardware is suitable for flight. Acceptance testing shall meet the requirements of section 12.2.2.7. Exception: If personnel are exposed to the structure when pressurized above 50% of MOP, the minimum proof factor shall be 2.5. If personnel are not exposed to the structure when pressurized, the proof pressure factor shall be 1.1 times MOP.	Select Status		
12.3.2.5. Flight Hardware Metallic Pressurized Structure Recertification Test Requirements. Recertification testing shall meet the requirements of paragraph 12.2.2.8.	Select Status		

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12.3.3. Flight Hardware Metallic Pressurized Structures with Hazardous LBB or Brittle Failure Mode.	I		
12.3.3.1. Flight Hardware Metallic Pressurized Structures with Hazardous LBB or Brittle Failure Mode Factor of Safety Requirements. Unless otherwise specified, metallic pressurized structures that satisfy the LBB failure mode may be designed with a minimum ultimate safety factor of 1.25 for unmanned systems and 1.40 for manned systems.	Select Status		
12.3.3.2. Flight Hardware Metallic Pressurized Structures with Hazardous LBB or Brittle Failure Mode Safe-Life Demonstration.	Select Status		
12.3.3.2.1. Safe-life analysis of each pressurized structure shall be performed under the assumption of pre-existing initial flaws or cracks in the structure as specified in section 12.1.5.5.	Select Status		
12.3.3.2.2. In particular, the analysis shall show that the pressurized structure with flaws placed in the most unfavorable orientation with respect to the applied stress and material properties, of sizes defined by the acceptance proof test or NDE and acted upon by the spectra of expected operating loads, pressure, and environments meets the safe-life requirements of section 12.1.15.	Select Status		
12.3.3.2.3. Nominal values of fracture toughness and flaw growth rate data associated with each alloy system, temper, product form, thermal and chemical environments, and loading spectra shall be used along with a life factor of 4 on specified service life in all safe-life analysis.	Select Status		
12.3.3.2.4. Safe-life testing in lieu of safe-life analysis is an acceptable alternative, provided that, in addition to following a quality assurance program (see section 12.1.17) for each flight article, a qualification test program is implemented on pre-flawed specimen's representative of the structural design.	Select Status		
12.3.3.2.5. These flaws shall not be smaller than the minimum detectable flaw sizes established by the selected NDE method(s). Proof test logic shall not be used to determine minimum flaw size.	Select Status		
12.3.3.2.6. Safe-life requirements of section 12.1.15 are considered demonstrated when the pre-flawed test specimens successfully sustain the limit loads and pressure cycles in the expected operating environments.	Select Status		
12.3.3.2.7. A life factor of 4 on specified pressure cycles in the service life shall be applied in the safe-life demonstration testing.	Select Status		
12.3.3.3. Flight Hardware Metallic Pressurized Structures with Hazardous LBB or Brittle Failure Mode Qualification Test Requirements. Qualification testing shall include pressure cycle testing and burst testing. The following delineates the required tests:	Select Status		
12.3.3.3.1. Pressure Cycle Testing.	I		
12.3.3.3.1.1. Requirements for application of external loads in combination with internal pressure during testing shall be evaluated based on the relative magnitude and on the destabilizing effect of stresses due to the external loads.	Select Status		
12.3.3.3.1.2. If limit-combined tensile stresses are enveloped by the MOP stress, the application of external load is not required.	Select Status		

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12.3.3.3.1.3. Unless otherwise specified, the peak pressure shall be equal to the MOP during each pressure cycle, and the number of cycles shall be 4 times the predicted number of operating cycles or 50 MOP cycles, whichever is greater.	Select Status		
12.3.3.3.1.4. If the application of external loads is required, the load shall be cycled 4 times the predicted number of operating cycles of the most severe design condition; for example, destabilizing load with constant minimum internal pressure or maximum additive load with MOP.	Select Status		
12.3.3.3.2. Burst Testing.	I		
12.3.3.3.2.1. After the pressure cycle testing, the test article shall be pressurized (pneumatically or hydrostatically, as applicable and safe) to the design burst pressure while simultaneously applying the ultimate external loads, if appropriate.	Select Status		
12.3.3.3.2.2. The design burst pressure shall be maintained for a period of time sufficient to ensure that the proper pressure is achieved.	Select Status		
12.3.3.3.2.3. Unless otherwise specified, the minimum design burst pressure shall be 1.25 times MOP for unmanned systems, and 1.4 times for manned systems.	Select Status		
12.3.3.4. Flight Hardware Metallic Pressurized Structures with Hazardous LBB or Brittle Failure mode Acceptance Test Requirements.	I		
12.3.3.4.1. The acceptance test requirements for pressurized structures that exhibit brittle fracture failure mode, or hazardous LBB failure mode are identical to those with non-hazardous LBB failure mode as defined in section 12.3.2 except that the selected NDE techniques shall be capable of detecting flaws or cracks smaller than the allowable initial flaw size as determined by safe-life analysis.	Select Status		
12.3.3.4.2. Surface and volumetric NDE shall be performed on welds before and after proof testing if personnel are exposed to the structure when pressurized above 50% of MOP. If personnel will not be exposed to pressures greater than 50%, surface and volumetric NDE shall be performed on welds after the proof test.	Select Status		
12.3.3.5. Flight Hardware Metallic Pressurized Structures with Hazardous LBB or Brittle Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of paragraph 12.2.2.8.	Select Status		
12.4. Flight Hardware Special Pressurized Equipment Design, Analysis, and Test Requirements	I		
The detailed design, analysis, and test requirements for cryostats (or dewars), heat pipes, and sealed containers, which are classified as special pressurized equipment, are described below.	I		
12.4.1. Flight Hardware Cryostats or Dewars with LBB Failure Mode	I		
12.4.1.1. Flight Hardware Cryostats or Dewars with LBB Failure Mode General Requirements. Pressure containers of the cryostat or Dewar shall be demonstrated to exhibit LBB failure mode in accordance with the following criteria:	Select Status		

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12.4.1.1.1. The LBB failure mode shall be demonstrated analytically or by test showing that an initial surface flaw with a shape (a/2c) ranging from 0.1 to 0.5 will propagate through the vessel thickness to become a through-the-thickness crack with a length 10 times the vessel thickness and still remain stable at MOP.	Select Status		
12.4.1.1.2. Fracture mechanics shall be used if the failure mode is determined by analysis.	Select Status		
12.4.1.1.3. A pressure vessel that contains non-hazardous fluid and exhibits LBB failure mode is considered as a non-hazardous LBB pressure vessel.	Select Status		
12.4.1.2. Flight Hardware Cryostats or Dewars with LBB Failure Mode Factor of Safety Requirements. Unless otherwise specified, the minimum burst factor for the pressure container of a cryostat shall be 1.5.	Select Status		
12.4.1.3. Flight Hardware Cryostats or Dewars with LBB Failure Mode Qualification. Qualification tests shall be conducted on flight quality hardware to demonstrate structural adequacy of the design. The following tests are required:	Select Status		
12.4.1.3.1. Random Vibration Testing. Random vibration testing shall be performed on cryostats per the requirements of SMC-S-016.	Select Status		
12.4.1.3.2. Pressure Testing. The cryostat (Dewar) shall be pressurized to the design burst pressure that is 1.5 times MOP of the pressure container. The design burst pressure shall be maintained for a period of time sufficient to ensure that the proper pressure was achieved.	Select Status		
12.4.1.4. Flight Hardware Cryostats or Dewars with LBB Failure Mode Acceptance Test Requirements	I		
12.4.1.4.1. Acceptance tests should be conducted on every cryostat (or Dewar) before being committed to flight.	Select Status		
12.4.1.4.2. The following tests are required:	Select Status		
12.4.1.4.2.1. Proof-Pressure Test. Cryostats shall be proof-pressure tested to 1.25 times the MOP of the pressure container.	Select Status		
12.4.1.4.2.2. Nondestructive Examination. Surface and volumetric selected NDE techniques shall be performed after the proof-pressure test.	Select Status		
12.4.1.5. Flight Hardware Cryostats or Dewars with LBB Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	Select Status		
12.4.1.6. Flight Hardware Cryostats or Dewars with LBB Failure Mode Special Requirements. Outer shells (vacuum jackets) shall have pressure relief capability to preclude rupture in the event of pressure container leakage. If pressure containers do not vent external to the cryostats (or dewars) but instead vent into the volume contained by outer shells, the relief devices of outer shells shall be capable of safely venting at a rate to release full flow without outer shells rupturing. Relief devices shall be redundant and individually capable of full flow. Furthermore, pressure relief devices shall be certified to operate at the required condition of use without frozen moisture or fluid preventing proper operation.	Select Status		

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12.4.2. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode	**I**		
12.4.2.1. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Factor of Safety Requirements	**I**		
12.4.2.1.1. Safe-life design methodology based on fracture mechanics techniques shall be used to establish the appropriate design factor of safety and the associated proof factor for metallic pressure vessels that exhibit brittle fracture or hazardous leak-before-burst failure mode.	**Select Status**		
12.4.2.1.2. The loading spectra, material strengths, fracture toughness, and flaw growth rates of the parent material and weldments, test program requirements, stress levels, and the compatibility of the structural materials with the thermal and chemical environments expected in service shall be taken into consideration.	**Select Status**		
12.4.2.1.3. Nominal values of fracture toughness and flaw growth rate data corresponding to each alloy system, temper, and product form shall be used along with a life factor of 4 on specified service life in establishing the design factor of safety and the associated proof factor.	**Select Status**		
12.4.2.1.4. Unless otherwise specified, the minimum burst factor shall be 1.5.	**Select Status**		
12.4.2.2. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Safe-Life Demonstration Requirements	**I**		
12.4.2.2.1. After completion of the stress analysis conducted in accordance with the requirements of 12.1.15.3, safe-life analysis of each pressure container covering the maximum expected operating loads and environments, shall be performed under the assumption of pre-existing initial flaws or cracks in the vessel.	**Select Status**		
12.4.2.2.2. In particular, the analysis shall show that the metallic cryostat with flaws placed in the most unfavorable orientation with respect to the applied stress and material properties, of sizes defined by the acceptance proof test or NDE and acted upon by the spectra of expected operating loads and environments, meet the safe-life requirements of 12.1.15.	**Select Status**		
12.4.2.2.3. Nominal values of fracture toughness and flaw growth rate data associated with each alloy system, temper, product form, thermal and chemical environments, and loading spectra shall be used along with a life factor of 4 on specified service life in all safe-life analyses.	**Select Status**		
12.4.2.2.4. Cryostats that experience sustained stress shall also show that the corresponding applied stress intensity (K_I) during operation is less than K_{ISCC} in the appropriate environment.	**Select Status**		
12.4.2.2.5. Testing of metallic cryostats under fracture control in lieu of safe-life analysis is an acceptable alternative, provided that, in addition to following a quality assurance program (12.1.17.) for each flight article, a qualification test program is implemented on pre-flawed specimen's representative of the structure design.	**Select Status**		
12.4.2.2.6. These flaws shall not smaller than the minimum detectable flaw sizes established by the acceptance proof test or the selected NDE method(s). Proof test logic shall not be used to determine minimum flaw size.	**Select Status**		

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12.4.2.2.7. Safe-life requirements of 12.1.15 are considered demonstrated when the pre-flawed test specimens successfully sustain the limit loads and pressure cycles in the expected operating environments without rupture.	Select Status		
12.4.2.2.8. A life factor of 4 on specified service life shall be applied in the safe-life demonstration testing.	Select Status		
12.4.2.2.9. A report that documents the fracture mechanics safe-life analysis or safe-life testing shall be prepared to delineate the following:	Select Status		
12.4.2.2.9.1. Fracture mechanics data (fracture toughness and fatigue crack growth rates).	Select Status		
12.4.2.2.9.2. Loading spectrum and environments.	Select Status		
12.4.2.2.9.3. Initial Flaw sizes.	Select Status		
12.4.2.2.9.4. Analysis assumptions and rationales.	Select Status		
12.4.2.2.9.5. Calculation methodology.	Select Status		
12.4.2.2.9.6. Summary of significant results.	Select Status		
12.4.2.2.9.7. References:	Select Status		
12.4.2.2.10. This report shall be closely coordinated with the stress analysis report and shall be periodically revised and updated during the life of the program.	Select Status		
12.4.2.3. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Qualification Test Requirements. Qualification testing shall meet the requirements of 12.2.2.6.	Select Status		
12.4.2.4. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Acceptance Test Requirements	**I**		
12.4.2.4.1. The acceptance test requirements for cryostats that exhibit brittle fracture, or hazardous LBB failure mode are identical to those for metallic pressure vessels with ductile fracture failure mode as defined in 12.2.2.7 except that test level shall be that defined by the fracture mechanics analysis whenever possible.	Select Status		
12.4.2.4.2. At a minimum, surface and volumetric NDE technique shall be performed on all weld joints before and after the proof test.	Select Status		
12.4.2.4.3. Cryo-proof acceptance test procedures may be required to adequately verify initial flaw size.	Select Status		
12.4.2.4.4. The pressure container shall not rupture or leak at the acceptance test pressure.	Select Status		
12.4.2.5. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	Select Status		
12.4.2.6. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Special Provisions	**I**		

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12.4.2.6.1. For one-of-a-kind applications, a proof test of each flight unit to a minimum of 1.5 times MOP and a conventional fatigue analysis showing a minimum of 10 design lifetimes may be used in lieu of the required pressure testing as defined in 12.2.4 or 12.2.3.3, as applicable, for qualification.	**Select Status**		
12.4.2.6.2. Outer shells (vacuum jackets) shall have pressure relief capability to preclude rupture in the event of pressure container leakage. If pressure containers do not vent external to the cryostats or dewars, but instead vent into the volume contained by outer shells, the relief devices of outer shells shall be capable of venting at a rate to release full flow without the outer shall rupturing. Pressure relief devices shall be certified to operate at the required condition of use.	**Select Status**		
12.4.2.6.3. The implementation of this option needs prior approval by the payload project and the PSWG and Range Safety.	**Select Status**		
12.4.3. Flight Hardware Heat Pipe Requirements	**I**		
12.4.3.1. Flight Hardware Heat Pipe Factor of Safety	**I**		
12.4.3.1.1. Unless otherwise specified, the minimum burst factors for heat pipes with a diameter greater than 1.5 inches shall be 2.5.	**Select Status**		
12.4.3.1.2. For heat pipes with a diameter less than or equal to 1.5 inches, the minimum burst factor shall be 4.0.	**Select Status**		
12.4.3.2. Flight Hardware Heat Pipe Qualification Test Requirements. Pressure testing shall be conducted to demonstrate no failure at the design burst pressure.	**Select Status**		
12.4.3.3. Flight Hardware Heat Pipe Acceptance Test Requirements	**I**		
12.4.3.3.1. All fusion joints or full penetration welds on the heat pipes that contain hazardous fluids shall be inspected using acceptable surface and volumetric NDE techniques.	**Select Status**		
12.4.3.3.2. A proof pressure test shall be conducted to a minimum level of 1.5 times MOP on all heat pipes.	**Select Status**		
12.4.3.4. Flight Hardware Heat Pipe Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	**Select Status**		
12.4.3.5. Flight Hardware Heat Pipe Special Requirements. The heat pipe material shall satisfy the material compatibility requirements defined in 12.1.16 for the contained fluid at both the proof test temperature and operational temperature.	**Select Status**		
12.4.4. Flight Hardware Sealed Containers	**I**		
12.4.4.1. Sealed Containers with Non-Hazardous LBB Failure Mode. The LBB failure mode shall be demonstrated as defined in 12.2.2. ***Exception: Those containers made of aluminum, stainless steel, or titanium sheets that are acceptable as LBB designs do not have to demonstrate LBB failure mode.***	**Select Status**		

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12.4.4.1.1. Sealed Containers with Non-Hazardous LBB Failure Mode Factor of Safety. Unless otherwise specified, the minimum burst factor shall be 1.5.	Select Status		
12.4.4.1.2. Sealed Containers with Non-Hazardous LBB Failure Mode Qualification Test Requirements	I		
12.4.4.1.2.1. Sealed containers containing non-electronic equipment shall only be subjected to pressure testing.	Select Status		
12.4.4.1.2.2. For sealed containers containing safety-related electronic equipment, other qualification tests including functional, thermal vacuum, thermal cycling, random vibration, and pyro shock shall be conducted per SMC-S-016 or equivalent.	Select Status		
12.4.4.1.3. Sealed Containers with Non-Hazardous LBB Failure Mode Acceptance Test Requirements. Sealed containers shall be proof-pressure tested to a minimum level of 1.25 times maximum design pressure differential.	Select Status		
12.4.4.1.4. Sealed Containers with Non-Hazardous LBB Failure Mode Recertification Test Requirements	I		
12.4.4.1.4.1. All refurbished sealed containers shall be recertified after each refurbishment by the acceptance test requirements for new hardware to verify their structural integrity and to establish their suitability for continued service before commitment to flight.	Select Status		
12.4.4.1.4.2. Sealed containers that have exceeded the approved storage environment (temperature, humidity, time, and others) shall also be recertified by the acceptance test requirements for new hardware.	Select Status		
12.4.4.2. Sealed Containers with Brittle Fracture or Hazardous LBB Failure Mode	I		
12.4.4.2.1. Sealed containers that exhibit a brittle fracture failure mode or contain hazardous fluid, or both, shall meet the requirements of 12.2.3.	Select Status		
12.4.4.2.2. For sealed containers containing safety-related electronic equipment, qualification tests including functional, thermal vacuum, thermal cycling, and pyro shock shall be conducted in addition to random vibration and pressure testing.	Select Status		
12.5. Flight Hardware Pressure System Component Design and Test Requirements	I		
The requirements for the design and testing of flight hardware pressure system components are described below. Included are hydraulic, pneumatic, hypergolic, and cryogenic fluid and propellant system components.	I		
12.5.1. Flight Hardware Pneumatic and Hydraulic Pressure System Components	I		
12.5.1.1. Factor of Safety Requirements. Flight hardware pneumatic and hydraulic pressure system components shall be designed to the minimum factors shown in Table 12.3.	Select Status		

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Table 12.3. Pressure Components Safety Factors

Component	Proof	Design Burst
Lines and fittings diameter < 1.5 inches (38 mm)	1.5	4.0
Lines and fittings diameter > 1.5 inches (38 mm)	1.5	2.5
Fluid Return Sections	1.5	3.0
Fluid Return Hose	1.5	5.0
Other Pressure Components	1.5	2.5

1) Components subject to low or negative pressure shall be evaluated at 2.5 times maximum external pressure expected during service life.

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12.5.1.2. Flight Hardware Pneumatic and Hydraulic Pressure System Component General Selection and Design Requirements	I		
12.5.1.2.1. Components shall be selected to ensure that misconnections or reverse installations within the subsystem are not possible. Color codes, labels, and directional arrows shall be used to identify hazards and direction of flow.	Select Status		
12.5.1.2.2. The maximum fluid temperature shall be estimated early in design as part of data for selection of safety critical components, such as system fluid, pressurizing gas, oil coolers, and gaskets.	Select Status		
12.5.1.2.3. Components that are capable of safe actuation under pressure equal to the maximum relief valve setting in the circuit in which they are installed shall be specified.	Select Status		
12.5.1.2.4. Pumps, valves and regulators, hoses, and all such prefabricated components of a pressure system shall have proven pressure service ratings equal to or higher than the limit load (MOP) and rated life of the system.	Select Status		
12.5.1.2.5. The Standards of the Hydraulic Institute shall be used in evaluating safety in pump selection.	Select Status		
12.5.1.2.6. Where leakage or fracture is hazardous to personnel or critical equipment, valves shall be selected so that failure occurs at the outlet threads of valves before the inlet threads or body of the valve fails under pressure.	Select Status		
12.5.1.2.7. Pressure regulators shall be selected to operate in the center 50 percent of their total pressure range and avoid creep and inaccuracies at either end of the full operating range.	Select Status		

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12.5.1.2.8. In all cases, flareless tube fittings shall be properly preset before pressure application.	Select Status		
12.5.1.2.9. Where system leakage can expose hydraulic fluid to potential ignition sources or is adjacent to a potential fire zone and the possibility of flame propagation exists, fire-resistant or flame-proof hydraulic fluid shall be used.	Select Status		
12.5.1.3. Flight Hardware Oxygen System Components	I		
12.5.1.3.1. For oxygen systems of 3,000 psi or higher, valves and other components that are slow opening and closing types shall be selected to minimize the potential for ignition of contaminants.	Select Status		
12.5.1.3.2. Oxygen systems shall require electrical grounding to eliminate the possibility of the buildup of static electrical charges.	Select Status		
12.5.1.3.3. Oxygen system components, design, and material selection shall conform to ASTM MNL 36.	Select Status		
12.5.1.4. Flight Hardware Pneumatic and Hydraulic System Manual Valves and Regulators	I		
12.5.1.4.1. Manually operated valves and regulators shall be selected so that over-torquing of the valve stem of the regulator adjustment cannot damage soft seats to the extent that failure of the seat will result.	Select Status		
12.5.1.4.2. Valve designs that use uncontained seals are unacceptable and shall not be selected.	Select Status		
12.5.1.5. Flight Hardware Pneumatic and Hydraulic System Warning Devices and Safety Critical Components	I		
12.5.1.5.1. Warning devices that are activated by hazardous over or under pressure shall be selected whenever necessary.	Select Status		
12.5.1.5.2. The warning device shall either activate automatic response mechanisms or shall notify operational personnel of impending hazards.	Select Status		
12.5.1.5.3. Warning devices to indicate hazardous over or under pressures to operating personnel shall be specified.	Select Status		
12.5.1.5.4. These warning devices shall actuate at predetermined pressure levels designed to allow time for corrective action.	Select Status		
12.5.1.5.5. Safety critical actuation of pneumatic systems shall not be adversely affected by any back pressure resulting from concurrent operations of any other parts of the system under any set of conditions.	Select Status		
12.5.1.5.6. Components that can be isolated and contain residual pressure shall be equipped with gage reading and bleed valves for pressure safety checks.	Select Status		
12.5.1.5.7. Bleed valves shall be directed away from operating personnel.	Select Status		
12.5.1.5.8. Fittings or caps for bleeding pressure are not acceptable.	Select Status		

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12.5.1.5.9. Pressurized reservoirs that are designed for gas/fluid separation with provisions to entrap gas that may be hazardous to the system or safety critical actuation and prevent its recirculation in the system shall be specified. Specific instructions shall be posted adjacent to the filling point for proper bleeding when servicing.	Select Status		
12.5.1.5.10. Compressed gas emergency systems shall be bled directly to the atmosphere away from the vicinity of personnel rather than to reservoir.	Select Status		
12.5.1.5.11. If the gas is combustible, safety critical components shall be utilized and methods for reducing the potential for accidental ignition or explosion shall be assessed, controlled as required, and verified and documented through a hazard analysis.	Select Status		
12.5.1.5.12. Where necessary to prevent a hazardous sequence of operations and provide a fail-safe capability at all times, interlocks shall be specified. For example, the OPEN position of remotely controlled valves that can hazardously pressurize lines leading to remotely controlled (or automatic) disconnect couplings shall be interlocked to preclude the OPEN valve position coincident with the disconnected condition of the couplings.	Select Status		
12.5.1.5.13. Pressure systems that combine several safety critical functions shall have sufficient controls for isolating failed functions for the purpose of safely operating the remaining functions.	Select Status		
12.5.1.5.14. All pressure systems shall have pressure indicating devices to monitor critical flows and pressures marked to show safe upper and lower limits of system pressure.	Select Status		
12.5.1.5.15. The pressure indicators shall be located to be readily visible to the operating crew.	Select Status		
12.5.1.5.16. All systems shall be protected for pressure above 500 psi in all areas where damage can occur during servicing or other operational hazards.	Select Status		
12.5.1.5.17. Pressure lines and components of 500 psi or higher that are adjacent to safety critical equipment shall be shielded to protect such equipment in the event of leakage or burst of the pressure system.	Select Status		
12.5.1.5.18. Automatic disengagement or bypass shall be provided for pneumatic systems that provide for manual takeover in the event of a hazardous situation.	Select Status		
12.5.1.5.19. Positive indication of disengagement shall be provided.	Select Status		
12.5.1.5.20. Safety critical pneumatic actuators shall have positive mechanical stops at the extremes of safe motion.	Select Status		
12.5.1.5.21. Adjustable orifice restrictor valves shall not be used in safety critical pneumatic systems.	Select Status		
12.5.1.6. Flight Hardware System Pneumatic Components	I		
12.5.1.6.1. Pneumatic components (other than tanks) for safety critical systems shall exhibit safe endurance against hazardous failure modes for not less than 400 percent of the total number of expected cycles including system tests.	Select Status		

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12.5.1.6.2. The configuration of pneumatic components shall permit bleeding of entrapped moisture, lubricants, particulate material, or other foreign matter hazardous to the system.	Select Status		
12.5.1.6.3. Compressors that are designed to sustain not less than 2.5 times delivery pressure after allowance for loss of strength of the materials equivalent to not less than that caused by 1,000 hours aging at 275º F shall be selected.	Select Status		
12.5.1.7. Flight Hardware Pneumatic and Hydraulic System Design Loads	I		
12.5.1.7.1. Installation of all lines and components to withstand all expected acceleration and shock loads shall be specified.	Select Status		
Shock isolation mounts may be used if necessary, to eliminate destructive vibration and interference collisions.	I		
12.5.1.7.2. The mounting of components, including valves, on structures having sufficient strength to withstand torque and dynamic loads and not supported by the tubing shall be specified.	Select Status		
12.5.1.7.3. Light-weight components that do not require adjustment after installation (for example, check valves) may be supported by the tubing, provided that a tube clamp is installed on each such tube near the component.	Select Status		
12.5.1.7.4. Tubing shall be supported by cushioned steel tube clamps or by multiple-block type clamps that are suitably spaced to restrain destructive vibration.	Select Status		
12.5.1.8. Flight Hardware Pneumatic and Hydraulic System Electrical and Electronic Devices	I		
12.5.1.8.1. Electrical components for use in potentially ignitable atmospheres shall be demonstrated to be incapable of causing an explosion in the intended application.	Select Status		
12.5.1.8.2. Electrically energized hydraulic components shall not propagate radio-frequency energy that is hazardous to other subsystems in the total system or interfere in the operation of safety critical electronic equipment. (See MIL-STD-464, Systems Electromagnetic Environmental Effects Requirements.)	Select Status		
12.5.1.8.3. Pressure system components and lines shall be electrically grounded to metallic structures.	Select Status		
12.5.1.8.4. All solenoids shall be capable of safely withstanding a test voltage of not less than 1500 V rms at 60 cps for 1 minute between terminals and case at the maximum operating temperature of the solenoid in the functional envelope.	Select Status		
12.5.1.8.5. Electric motor-driven pumps used in safety critical systems shall not be used for ground test purposes unless the motor is rated for reliable, continuous, and safe operation. Otherwise, the test parameters may perturb reliability calculations.	Select Status		
12.5.1.9. Flight Hardware Pneumatic and Hydraulic System Pressure Relief Devices	I		

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12.5.1.9.1. Pressure relief devices shall be specified on all systems having a pressure source that can exceed the MAWP of the system or where the malfunction/failure of any component can cause the MAWP to be exceeded.	Select Status		
12.5.1.9.2. Relief devices are required downstream of all regulating valves and orifice restrictors unless the downstream system is designed to accept full source pressure.	Select Status		
12.5.1.9.3. On space systems, where operational or weight limitations preclude the use of relief valves and systems operate in an environment not hazardous to personnel, they can be omitted if (1) the ground or support system contains such devices and they cannot be isolated from the airborne system during the pressurization cycle, and (2) the space vehicle cannot provide its own protection.	Select Status		
12.5.1.9.3.1. Where a ground system is specifically designed to service an unmanned flight vehicle, pressure relief protection may be provided within the ground equipment, if no capability exists to isolate the pressure relief protection from the flight vehicle during the pressurization cycle.	Select Status		
12.5.1.9.4. Where safety factors of less than 2.0 are used in the design of flight hardware pressure vessels, a means for automatic relief, depressurization, and pressure verification of safety critical vessels in the event of launch abort shall be provided. Spacecraft (payload) pressure vessels may be designed without automatic relief (other means of safe relief shall be provided) if a safety analysis validates that a rupture will not damage the safety systems.	Select Status		
12.5.1.9.5. Whenever any pressure volume can be confined and/or isolated by system valving, an automatic pressure relief device shall be provided.	Select Status		
12.5.1.9.6. Pressure relief devices shall vent toxic or inert gases to safe areas, away from the vicinity of personnel. Scrubbers or vapor disposal systems shall also be used at a safe distance from personnel.	Select Status		
Pop-valves, rupture disks, blow-out plugs, armoring, and construction to contain the greatest possible overpressure that may develop are examples of corrective measures for system safety.	I		
12.5.1.9.7. Shut-off valves for maintenance purposes on the inlet side of pressurized relief valves are permissible if a means for monitoring and bleeding trapped pressure is provided and the requirements of ASME Boiler and Pressure Vessel (BPVC) Code for unfired pressure vessels, Section VIII Appendix M, Paragraph M-5 are met. It is mandatory that the valve be locked open when the system is re-pressurized.	Select Status		
12.5.1.9.8. Hydrostatic testing systems for vessels that are not designed to sustain negative internal pressure shall be equipped with fail-safe devices for relief of hazardous negative pressure during the period of fluid removal.	Select Status		
Check valves and valve interlocks are examples of devices that can be used for this purpose.	I		
12.5.1.9.9. Vessels that can be collapsed by a negative pressure shall have negative pressure relief and/or prevention devices for safety during storage and transportation.	Select Status		

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12.5.1.9.10. Pressurized reservoirs shall be designed so that all ullage volumes are connected to a relief valve that shall protect the reservoir and power pump from hazardous overpressure or back pressure of the system.	Select Status		
12.5.1.9.11. The air pressure control for pressurized reservoirs shall be an externally nonadjustable, pressure regulating device. If this unit also contains a reservoir pressure relief valve, it shall be designed so that no failure in the unit permits over-pressurization of the reservoir.	Select Status		
12.5.1.10. Flight Hardware Pneumatic and Hydraulic System Contamination. Contamination shall be prevented from entering or developing in safety and safety critical flight hardware pneumatic or hydraulic system components. Safety and safety critical systems shall be designed to include provisions for detection, filtration, and removal of contaminants.	Select Status		
1. The following contamination-related considerations should be addressed in the design of pressurized systems. Contamination includes solid, liquid, and gaseous material. **a. Contamination should be prevented from entering or developing within the system.** **b. The system should be designed to include provisions to detect contamination.** **c. The system should be designed to include provisions for removal of contamination and provisions for initial purge with fluid or gas that cannot degrade future system performance. The system should be designed to be tolerant of contamination.** **2. All pressurizing fluids entering safety critical system should be filtered through a 10 micron filter, or finer, before entering the system.** **3. All pressure systems should have fluid filters in the system, designed and located to reduce the flow of contaminant particles to a safe minimum.** **4. All of the circulating fluid in the system should be filtered downstream from the pressure pump or immediately upstream from safety critical actuators.** **5. Entrance of contamination at test points or vents should be minimized by downstream filters.** **6. The bypass fluid or case drain flow on variable displacement pumps should be filtered.** **7. When the clogging of small orifices could cause a hazardous malfunction or failure of the system, they should be protected by a filter element designed to prevent clogging of the orifice. Note that this includes servo valves.** **8. Filters or screens should not be used in suction lines of power pumps or hand pumps of safety critical systems.** **9. Air filters should be specified for hydraulic reservoir air pressurization circuits and located to protect the pressure regulating equipment from contamination.** **10. Dry compressed air should be specified for hydraulic reservoir pressurization.** **11. A moisture removal unit should be specified to protect the pressure regulation lines and equipment.** **12. Unpressurized Reservoirs. Unpressurized hydraulic reservoirs should have filters and desiccant units at the breather opening to preclude introduction of moisture and contaminants into the reservoir.**	I		
12.5.1.11. Flight Hardware Pneumatic and Hydraulic System Bleed Ports	I		
12.5.1.11.1. Where necessary, bleed ports shall be provided to remove accumulations of residue or contaminants.	Select Status		

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12.5.1.11.2. High point bleed ports shall be provided where necessary for removal of trapped gases.	Select Status		
12.5.1.11.3. The bleed valve shall be directed away from operating personnel and possible ignition sources.	Select Status		
12.5.1.11.4. Components, cavities, or lines that can be isolated shall be equipped with bleed valves that can be used to release retained pressure, or they shall indicate that continued pressure exists in the system.	Select Status		
12.5.1.11.5. Bleed valves used for reducing pressure on systems containing hazardous fluids shall be routed to a safe disposal area.	Select Status		
12.5.1.11.6. Auxiliary Bleed Ports	Select Status		
12.5.1.11.6.1. Auxiliary bleed ports shall be provided where necessary to allow bleed off for safety purposes.	Select Status		
12.5.1.11.6.2. Bleeder valves shall be located so that they can be operated without removal of other components and shall permit the attachment of a hose to direct the bleed-off fluid into a container.	Select Status		
12.5.1.11.7. Reservoir filler caps shall include design provisions that shall automatically bleed the reservoir on opening so that possible ullage pressure cannot impart hazardous kinetic energy to either the filler caps, the fluid in the reservoir, or the system.	Select Status		
12.5.1.12. Flight Hardware Pneumatic and Hydraulic System Control Devices	**I**		
12.5.1.12.1. Safety critical pressure systems incorporating two or more directional control valves shall be designed to preclude the possibility of inadvertently directing the flow or pressure from one valve into the flow path or pressure path intended for another valve, with any combination of valve settings possible in the total system.	Select Status		
12.5.1.12.2. Control devices shall be designed to prevent overtravel or under travel that may contribute to a hazardous condition or damage to the valve.	Select Status		
12.5.1.12.3. All pressure and volume controls shall have stops, or equivalent, to prevent settings outside their nominal safe working ranges.	Select Status		
12.5.1.12.4. Control components that have integral manually operated levers and stops shall be capable of withstanding the following limit torques in Table 12.4.	Select Status		

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Table 12.4. Limit Torque Requirements			

Lever Radius	Design Torque
Less than 3 inches	50 x R inch-pound
3 to 6 inches	75 x R inch-pound
Over 6 inches	150 x R inch-pound

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12.5.1.13. Flight Hardware Pneumatic and Hydraulic System Manually Operated Levers	I		
12.5.1.13.1. Components that have integrated manually operated levers shall provide levers and stops capable of withstanding the limit torques specified by MIL-STD-1472.	Select Status		
12.5.1.13.2. Levers and stops shall be provided on remote controls capable of withstanding a limit torque of 1,800 inch-pounds.	Select Status		
12.5.1.13.3. Because jamming is possible, sheathed flexible actuators shall not be used for valve controls in safety critical pressure systems (for example, push-pull wires and torque wires that are sheathed are not acceptable).	Select Status		
12.5.1.14. Flight Hardware Pneumatic and Hydraulic System Accumulators	Select Status		
12.5.1.14.1. Accumulators shall be designed in accordance with the pressure vessel standards for ground systems and located for minimal probability of mechanical damage and for minimum escalation of material damage or personnel injury in the event of a major failure such as tank rupture.	Select Status		
12.5.1.14.2. Accumulator gas pressure gauges shall not be used to indicate system pressure for operational or maintenance purposes.	Select Status		
12.5.1.14.3. Gas type and pressure level shall be posted on, or immediately adjacent to, the accumulator.	Select Status		
12.5.1.15. Flight Hardware Pneumatic and Hydraulic System Flexible Hose. Flexible hose requirements are specified in 12.1.10.4.	Select Status		
12.5.1.16. Flight Hardware Pneumatic and Hydraulic System Qualification Test Requirements. Qualification tests are not required on lines and fittings. Internal/external pressure testing shall be conducted on all other pressure components to demonstrate no failure at the design burst pressure. Seamless lines, tubing, and pipe are exempt.	Select Status		
12.5.1.17. Flight Hardware Pneumatic and Hydraulic System Acceptance Test Requirements	I		
12.5.1.17.1. Testing Flight Hardware Pneumatic and Hydraulic Components Before Assembly	I		

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12.5.1.17.1.1. All pressurized components such as valves, pipe, tubing, and pipe and tube fittings shall be hydrostatically proof tested to a minimum of 1.5 times the component MAWP for a minimum of 5 minutes. ***Note: In the event that component testing before assembly is not feasible, components may be hydrostatically tested after assembly into a subsystem or system to 1.5 times the system MOP. This approach shall be approved by PSWG and Range Safety.***	**Select Status**		
12.5.1.17.1.2. Proof testing shall demonstrate that the components sustain proof pressure levels without distortion, damage, or leakage.	**Select Status**		
12.5.1.17.1.3. Both the inlet and discharge sides of a relief valve shall be proof tested. When the discharge side has a lower pressure rating than the inlet, they are to be proof tested independently.	**Select Status**		
12.5.1.17.1.4. The following inspections shall be performed after proof testing:	**Select Status**		
12.5.1.17.1.4.1. Mechanical components such as valves and regulators shall be inspected for external deformation, deterioration, or damage.	**Select Status**		
12.5.1.17.1.4.2. Damaged, distorted, or deteriorated parts shall be rejected and replaced and the test repeated.	**Select Status**		
12.5.1.17.1.5. Functional and leak tests shall be performed at the component MAWP after the proof test.	**Select Status**		
12.5.1.17.1.6. Pneumatic pressure system components shall undergo sufficient qualification and acceptance testing to demonstrate that the system and components meet design and safety requirements when subjected to prelaunch and launch environments such as vibration, shock, acceleration, and temperature.	**Select Status**		
12.5.1.17.1.7. Test plans and test reports shall be submitted to the PSWG and made available to the PSWG and Range Safety.	**Select Status**		
12.5.1.17.1.8. Pressure relief valves shall be tested for proper setting and flow capacity before installation and first use on the ranges.	**Select Status**		
12.5.1.17.1.9. Pressure gauges and transducers shall be hydrostatically tested to a minimum of 1.5 times the system MOP/MEOP. ***Note: Depending upon the manufacturer or model of the pressure transducer, it may not be possible to hydrostatically test it to a minimum 1.5 times MOP without causing a shift in the transducer. This is dependent on the transducer's specification and manufacturer's recommendations for the transducer.***	**Select Status**		
12.5.1.17.1.10. Pressure gauges and transducers shall be calibrated before installation and periodically thereafter as recommended by the manufacturer.	**Select Status**		
12.5.1.17.1.11. Components may be initially hydrostatically proof tested after being assembled into a subsystem to 1.5 times the system MOP. This approach requires prior approval from the PSWG and Range Safety.	**Select Status**		

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12.5.1.17.1.12. Pneumatic proof testing to a proof pressure of 1.25 times MAWP is permissible only if hydrostatic proof testing is impractical, impossible, or jeopardizes the integrity of the system or system element. Prior approval for pneumatic proof testing at the payload processing facility and/or launch site area shall be obtained from the local safety authority.	Select Status		
12.5.1.17.2. Testing Flight Hardware Pneumatic and Hydraulic Systems After Assembly. All newly assembled pressure systems shall be hydrostatically tested to 1.5 times MOP before use. MOP here refers to the maximum operating pressure that personnel are exposed to. Where this is not possible, the PSWG and Range Safety shall determine the adequacy of component testing and alternate means of testing the assembled system.	Select Status		
12.5.1.17.3. Flight Hardware Pneumatic and Hydraulic System Leak Tests	I		
12.5.1.17.3.1. All newly assembled pressure systems shall undergo a dedicated leak test at the system MOP before first use at any payload processing facility and launch site area.	Select Status		
12.5.1.17.3.2. This test shall be conducted at the payload processing facility and launch site area unless prior approval from the PSWG and Range Safety has been obtained.	Select Status		
12.5.1.17.3.3. Minimum test requirements are as follows:	Select Status		
12.5.1.17.3.3.1 The gas used during the leak test shall be the same as the system fluid media except that for hazardous gas systems, a system compatible, non-hazardous gas may be used that has a density as near as possible to the system fluid; for example, helium should be used to leak test a gaseous hydrogen system.	Select Status		
12.5.1.17.3.3.2. Mechanical connections, gasketed joints, seals, weld seams, and other items shall be visually bubble tight for a minimum of 1 minute when an approved leak test solution is applied.	Select Status		
12.5.1.17.3.3.3. Alternate methods of leak testing (such as the use of portable mass spectrometers) may be specified when required on a case-by-case basis.	Select Status		
12.5.1.17.4. Flight Hardware Pneumatic and Hydraulic System Validation and Functional Tests	I		
12.5.1.17.4.1. All newly assembled pressure systems shall have a system validation test and a functional test of each component at system MOP before first use at the payload processing facility and/or launch site area.	Select Status		
12.5.1.17.4.2. These tests shall be conducted at the payload processing facility and launch site area unless prior approval from the PSWG and Range Safety has been obtained.	Select Status		
12.5.1.17.4.3. Minimum test requirements are as follows:	Select Status		
12.5.1.17.4.3.1. These tests shall demonstrate the functional capability of all non-passive components such as valves, regulators, and transducers.	Select Status		
12.5.1.17.4.3.2. All prelaunch operational sequences for the system shall be executed.	Select Status		

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12.5.1.17.4.3.3. All parallel or series redundant components shall be individually tested to ensure all failure tolerant capabilities are functional before launch.	**Select Status**		
12.5.1.17.4.3.4. All shutoff and block valves shall be leak checked downstream to verify their shutoff capability in the CLOSED position.	**Select Status**		
12.5.1.17.5. Flight Hardware Pneumatic and Hydraulic System Bonding and Grounding Tests. All newly assembled pressure systems containing flammable and combustible fluids or media shall be tested to verify that the requirements of 12.1.12 of this volume have been met.	**Select Status**		
12.5.1.17.6. Test Requirements for Modified and Repaired Flight Hardware Pneumatic Systems	**I**		
12.5.1.17.6.1. Any pressure system element, including fittings or welds, that has been repaired, modified, or possibly damaged before having been proof tested, shall be retested at proof pressure before its normal use.	**Select Status**		
12.5.1.17.6.2. A modified or repaired pressure system shall be leak tested at the system MOP before its normal use. This test shall be conducted at the ranges unless prior approval from the PSWG and Range Safety has been obtained.	**Select Status**		
12.5.1.17.6.3. A modified or repaired pressure system shall be revalidated and functionally tested at the system MOP before its normal use.	**Select Status**		
12.5.1.17.6.4. If any pressure system element such as a valve, regulator, gauges, or tubing has been disconnected or reconnected for any reason, the affected system or subsystem shall be leak tested at MOP.	**Select Status**		
12.5.2. Flight Hardware Hazardous Fluid System Components, Including Hypergolic, Cryogenic, and Hydraulic Systems. Hypergolic and cryogenic components are required to meet the requirements in 12.6, 12.7, 12.8, and 12.9 in addition to the following:	**Select Status**		
12.5.2.1. Cycling capability for safety critical components shall be not less than 400 percent of the total number of expected cycles, including system tests, but not less than 2,000 cycles.	**Select Status**		
12.5.2.2. For service above a temperature of 160ºF an additional cycling capability equivalent to the above shall be required as a maximum.	**Select Status**		
The intent of this requirement is twofold: (1) to prevent viscosity breakdown from heat in hydraulic systems, and (2) to consider the effects of elevated temperature in determining the safe cycle life of the components.	**I**		
12.5.2.3. Safety critical actuators shall have positive mechanical stops at the extremes of safe motion.	**Select Status**		
12.5.2.4. Hydraulic fluid reservoirs and supply tanks shall be equipped with remotely operated shutoff valves.	**Select Status**		
12.5.2.5. Shuttle valves shall not be used in safety critical hydraulic systems where the event of a force balance on both inlet ports may occur, causing the shuttle valve to restrict flow from the outlet port.	**Select Status**		

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12.5.2.6. Systems incorporating accumulators shall be interlocked to either vent or isolate accumulator fluid pressure when power is shutoff.	Select Status		
12.5.2.7. Adjustable orifice restrictor valves shall not be used in safety critical systems.	Select Status		
12.5.2.8. When two or more actuators are mechanically tied together, only one lock valve shall be used to lock all the actuators.	Select Status		
12.5.2.9. Lock valves shall not be used for safety critical lockup periods likely to involve extreme temperature changes unless fluid expansion and contraction effects are safely accounted for.	Select Status		
12.5.2.10. Flight Hardware Hazardous Fluid System Reservoirs:	Select Status		
12.5.2.10.1. Whenever possible, the hydraulic reservoir should be located at the highest point in the system.	Select Status		
12.5.2.10.2. If the requirement in 12.5.2.10.1 is not possible in safety critical systems, procedures shall be developed to detect air in actuators or other safety critical components and to ensure that the system is properly bled before each use.	Select Status		
12.5.2.11. Systems installations shall be limited to a maximum pressure of 15,000 psig.	Select Status		
There is no intent to restrain development of systems capable of higher pressures; however, the use of such systems shall be preceded by complete development and qualification that includes appropriate safety tests.	I		
12.5.2.12. The inlet pressure of pumps in safety critical systems shall be specified to prevent cavitation effects in the pump passages or outlets.	Select Status		
12.5.2.13. Safety critical systems shall have positive protection against breaking the fluid column in the suction line during standby.	Select Status		
12.5.2.15. Systems that provide for manual takeover shall automatically disengage or allow by-pass of the act of manual takeover.	Select Status		
12.5.2.16. Safety critical systems or alternate bypass systems provided for safety shall not be rendered inoperative because of back pressure under any set of conditions.	Select Status		
12.5.2.17. The system shall be designed so that a lock resulting from an unplanned disconnection of a self-seating coupling or other component shall not cause damage to the system or to adjacent property or injury to personnel.	Select Status		
12.5.2.18. Systems using power-operated pumps shall include a pressure regulating device and an independent safety relief valve.	Select Status		
12.5.2.19. Flight Hardware Hazardous Fluid System Thermal Pressure Relief Valves:	Select Status		

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12.5.2.19.1. Thermal expansion relief valves shall be installed as necessary to prevent system damage from thermal expansion of hydraulic fluid as in the event of gross overheating.	Select Status		
12.5.2.19.2. Internal valve leakage shall not be considered an acceptable method of providing thermal relief.	Select Status		
12.5.2.19.3. Thermal relief valve settings shall not exceed 150 psi above the value for system relief valve setting.	Select Status		
12.5.2.19.4. Vents shall outlet only to areas of relative safety from a fire hazard.	Select Status		
12.5.2.19.5. Hydraulic blow-out fuses (soft plugs) shall not be used in systems having temperatures above 160ºF.	Select Status		
12.5.2.20. Pressure relief valves shall be located in the systems wherever necessary to ensure that the pressure in any part of a power system shall not exceed the safe limit above the regulated pressure of the system.	Select Status		
12.6. Flight Hardware Pneumatic System Design Requirements	I		
Specific requirements for the design of flight hardware pneumatic systems and specific pneumatic system components are described below:	I		
12.6.1. Flight Hardware Pneumatic System Piping	I		
12.6.1.1. NPT connectors shall not be used in hazardous pressure system piping.	Select Status		
12.6.1.2. Socket-welded flanges shall not be used in hazardous pressure system piping.	Select Status		
12.6.1.3. All piping and fitting welds shall be 100% radiographically inspected.	Select Status		
12.6.2. Flight Hardware Pneumatic System Tubing. All tubing and fitting welds shall be 100% radiographically inspected before and after the pressure test and inspected by surface NDE techniques before and after the pressure test.	Select Status		
12.6.2.1. Welded connections shall meet the requirements of AWS D17.1, Specification for Fusion Welding for Aerospace Applications, as prescribed by NASA-STD-5006, General Fusion Welding Requirements for Aerospace Materials Used in Flight Hardware.	Select Status		
12.6.2.2. Tube and fitting welded joints shall meet the inspection requirements of AIA/NAS 1514, Radiographic Standard for Classification of Fusion Weld Discontinuities, and ASTM E1742, Standard Practice for Radiographic Examination. Qualification of visual inspection personnel shall be a minimum of VT Level II as per SNT-TC-1A. Surface inspection, if applicable, shall meet the requirements of ASTM E1417, Standard Practice for Liquid Penetrant Inspection.	Select Status		
12.6.3. Flight Hardware Pneumatic System Regulators	I		
12.6.3.1. Regulators shall be selected so that their working pressure falls within the center 50 percent of their total pressure range if it is susceptible to inaccuracies or creep at either end of its pressure range.	Select Status		

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12.6.3.2. Pressure regulator actuators shall be capable of shutting off the fluid when the system is at the maximum possible flow and pressure.	Select Status		
12.6.3.3. Designs using uncontained seats are unacceptable.	Select Status		
12.6.3.4. Systems that contain regulators that are remotely operated during prelaunch operations shall be designed to be fail-safe if pneumatic or electric control power to the regulator is lost.	Select Status		
12.6.4. Flight Hardware Pneumatic System Valves	I		
12.6.4.1. Valve actuators shall be operable under maximum design flow and pressure.	Select Status		
12.6.4.2. Manually operated valves shall be designed so that over torquing the valve stem cannot damage soft seats to the extent that seat failure occurs.	Select Status		
12.6.4.3. Designs using uncontained seats are prohibited.	Select Status		
12.6.4.4. Valves that are not intended to be reversible shall be designed or marked so that they shall not be connected in a reverse mode.	Select Status		
12.6.4.5. All electrical control circuits for remotely actuated valves shall be shielded or otherwise protected from hazardous stray energy.	Select Status		
12.6.4.6. Remotely controlled valves shall provide for remote monitoring of OPEN and CLOSED positions during prelaunch operations.	Select Status		
12.6.4.7. Systems that contain remotely operated valves shall be designed to be fail-safe if pneumatic or electric control power to the valve is lost during prelaunch operations.	Select Status		
12.6.4.8. Check valves shall be provided where back flow of fluids or media would create a hazard.	Select Status		
12.6.4.9. Special care shall be taken in the design of oxygen systems to minimize the heating effect due to rapid increases in pressure. Fast opening valves that can produce high velocity kinetic effects and rapid pressurization shall be avoided.	Select Status		
12.6.4.10. Valve stem travel on manual valves shall be limited by a positive stop at each extreme position.	Select Status		
12.6.4.11. The application or removal of force to the valve stem positioning device shall not cause disassembly of the pressure-containing structure of the valve.	Select Status		
12.6.5. Flight Hardware Pneumatic System Pressure Indicating Devices	I		
12.6.5.1. A pressure indicating device shall be located on the downstream side of each pressure regulator and on any storage system.	Select Status		
12.6.5.2. These pressure indicating devices shall be designed to be remotely monitored during prelaunch operations.	Select Status		

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12.6.6. Flight Hardware Pneumatic System Flexible Hoses. Flexible hose requirements are specified in 12.1.10.4.	Select Status		
12.6.7. Flight Hardware Pneumatic System Pressure Relief Devices	Select Status		
12.6.7.1. Pressure relief devices shall be installed on all systems having an on-board pressure source that can exceed the MAWP of any component downstream of that source unless the system is single failure tolerant against over pressurization during prelaunch operations.	Select Status		
12.6.7.2. Flight systems that require on-board pressure relief capability shall be designed to the following minimum requirements:	Select Status		
12.6.7.2.1. The pressure relief device shall be installed as close as practical downstream of the pressure reducing device or source of pressure such as a compressor and gas generator.	Select Status		
12.6.7.2.2. Pressure relief devices should be set to operate at a pressure not to exceed 110 percent of the system MOP/MEOP.	Select Status		
12.6.7.2.3. The relieving capacity of the relief device and any vent outlet piping shall be equal to or greater than the maximum flow capability of the upstream pressure reducing device or pressure source and should prevent the pressure from rising more than 20 percent above the system MOP/MEOP.	Select Status		
12.6.7.2.4. The relief device vent outlet piping shall be sized to prevent excessive back pressure from adversely affecting the function of the relief device.	Select Status		
12.6.7.2.5. All relief devices and associated piping shall be structurally restrained to minimize any thrust effects on the pressure system vessels or piping.	Select Status		
12.6.7.2.6. The effects of the discharge from relief devices shall be assessed and analyzed to ensure that operation of the device shall not be hazardous to personnel or equipment. Items to be analyzed are thrust loads, noise, impingement of high velocity gas or entrained particles, toxicity, oxygen enrichment, and flammability.	Select Status		
12.6.7.2.7. All pressure relief devices shall be vented separately unless the following can be positively demonstrated:	Select Status		
12.6.7.2.7.1. The creation of a hazardous mixture of gases in the vent system and the migration of hazardous substances into an unplanned environment is impossible.	Select Status		
12.6.7.2.7.2. The capacity of the vent system is adequate to prevent a pressure rise of more than 20 percent above MOP when all attached pressure relief devices are wide open, and the system is at full pressure and volume generating capacity.	Select Status		
12.6.7.2.8. No obstructions shall be placed downstream of the relief device.	Select Status		
12.6.7.2.9. Relief devices shall be located so that other components cannot render them inoperative.	Select Status		
12.6.8. Flight Hardware Pneumatic System Vents	I		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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12.6.8.1. Pressure systems shall be designed so that pressure cannot be trapped in any part of the system without vent capability.	Select Status		
12.6.8.2. Vent system outlets should be in a location normally inaccessible to personnel or shall be conspicuously identified.	Select Status		
12.6.8.3. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	Select Status		
12.6.8.4. Oxidizer and fuel vent outlets to the atmosphere shall be separated sufficiently to prevent mixing of vented fluids.	Select Status		
12.6.8.5. All vent outlets shall be designed to prevent accumulation of vented gases in dangerous concentrations (oxygen rich) in areas frequented by unprotected personnel.	Select Status		
12.6.8.6. Hydrogen vents shall discharge to atmosphere through an approved burner.	Select Status		
12.6.8.7. Special attention shall be given to the design of vent line supports at vent outlets due to potential thrust loads.	Select Status		
12.6.8.8. Each line venting into a multiple-use vent system shall be protected against back pressurization by means of a check valve if the upstream system cannot withstand the back pressure or where contamination of the upstream system cannot be tolerated.	Select Status		
12.7. Flight Hardware Hydraulic System Design and Test Requirements	Select Status		
In addition to the following requirements, flight hardware hydraulic systems shall meet the minimum design fabrication and test requirements of 12.5.1 and 12.5.2.	Select Status		
12.7.1. Flight Hardware Hydraulic System General Design Requirements	Select Status		
12.7.1.1. Where necessary, hydraulic system low-points shall be provided a drain fitting (bleed ports) to allow draining of condensates or residue for safety purposes.	Select Status		
Entrapped air, moisture, and cleaning solvents are examples of foreign substances that may be hazardous to the system, component, or control equipment.	I		
12.7.1.2. Bleed ports shall be located so that they can be operated without removal of other components and shall permit the attachment of a hose to direct the bleed off material into a container away from the positions of the operators.	Select Status		
12.7.1.3. Test points shall be provided on hydraulic systems so that disassembly for test is not required.	Select Status		
12.7.1.4. Test points shall be easily accessible for the attachment of ground test equipment.	Select Status		
12.7.1.5. For all power-generating components, pump pulsations shall be controlled to a level that does not adversely affect system tubing, components, and support installation.	Select Status		

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12.7.1.6. Where system leakage can expose hydraulic fluid to potential ignition sources, fire resistant, or flameproof hydraulic fluid shall be used.	Select Status		
12.7.2. Flight Hardware Hydraulic System Accumulators and Reservoirs. All accumulators and reservoirs that are pressurized with gas to pressures greater than 100 psig shall be designed in accordance with 12.2.	Select Status		
12.7.3. Flight Hardware Hydraulic System Pressure Indicating Devices	I		
12.7.3.1. A pressure indicating device shall be located on any pressurized storage system with a pressure greater than 100 psig.	Select Status		
12.7.3.2. These devices shall be designed to be remotely monitored during prelaunch operations.	Select Status		
12.7.4. Flight Hardware Hydraulic System Pressure Relief Devices	I		
12.7.4.1. Pressure relief devices shall be installed on all systems having an on-board pressure source that can exceed the MAWP of any component downstream of that source unless the system is single failure tolerant against over pressurization during prelaunch operations.	Select Status		
12.7.4.2. Flight systems that require on-board pressure relief capability shall meet the following minimum requirements:	Select Status		
12.7.4.2.1. The pressure relief device shall be installed as close as practical downstream of the pressure sources such as pumps, turbines, or gas generators.	Select Status		
12.7.4.2.2. Pressure relief devices shall be set to operate at a pressure not to exceed 110 percent of the system MOP.	Select Status		
12.7.4.2.3. The relieving capacity of the relief device shall be equal to or greater than the maximum flow capability of the upstream pressure source and should prevent the pressure from rising more than 20 percent above the system MOP.	Select Status		
12.7.4.2.4. The effects of discharge from relief devices shall be assessed and analyzed to ensure that operation of the device shall not be hazardous to personnel or equipment. Items to be analyzed include thrust loads, toxicity, combustibility, flammability, and others as necessary.	Select Status		
12.7.4.2.5. Relief devices shall be located so that other components cannot render them inoperative.	Select Status		
12.7.4.2.6. No obstructions shall be placed downstream of the relief valve or burst disk outlet.	Select Status		
12.7.5. Flight Hardware Hydraulic System Vent and Drain Systems. Hydraulic systems shall be designed so that pressure and fluids cannot be trapped in any part of the system without vent and/or drain capability.	Select Status		
12.7.6. Testing Flight Hardware Hydraulic System Components Before Assembly. All system elements pressurized with gas to pressures greater than 100 psig shall be qualification tested in accordance with 12.2.4.1 and acceptance tested in accordance with 12.2.4.2 and 12.5.1.17.1.	Select Status		
12.7.7. Testing Flight Hardware Hydraulic Systems After Assembly	I		

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12.7.7.1. Tests shall meet the requirements of 12.5.1.17.2.	Select Status		
12.7.7.2. Leak tests shall meet the requirements of 12.5.1.17.3.	Select Status		
12.7.7.3. System validation and functional tests shall meet requirements of 12.5.1.17.4.	Select Status		
12.7.7.4. Modified and repaired flight hardware shall meet the requirements of 12.5.1.17.6.	Select Status		
12.8. Flight Hardware Hypergolic Propellant System Design and Test Requirements	I		
12.8.1. Flight Hardware Hypergolic Propellant System General Design Requirements	I		
12.8.1.1. Propellant systems shall have low point drain capability unless designed for positive pressure purging.	Select Status		
12.8.1.2. Low point drains shall be accessible and located in the system to provide the capability of removing propellant from the tanks, piping, lines, and components at all times after loading. Estimated residual and locations shall be identified. ***Note: The design goal is the ability to depressurize and/or offload the entire quantity of propellant, if necessary, to safe the system for transport to a payload processing facility. The maximum residual quantity of propellant remaining after contingency offloading operations should be identified in contingency plans and procedures that reflect the required actions necessary for subsequent safing, transportation, decontamination, and processing activities.***	Select Status		
12.8.1.3. Propellant systems shall be designed to be flushed with compatible fluids and purged with inert gas.	Select Status		
12.8.1.4. For prelaunch failure modes that could result in a time-critical emergency, provision shall be made for automatic switching to a safe mode of operation. Caution and warning signals shall be provided for these time-critical functions.	Select Status		
12.8.1.5. Propellant systems shall also comply with the pneumatic system requirements of 12.6.	Select Status		
12.8.1.6. Items used in any fuel or oxidizer system shall not be interchanged after exposure to the respective media.	Select Status		
12.8.1.7. Bi-propellant systems shall have the capability of loading and/or unloading the fuel and oxidizer one at a time.	Select Status		
12.8.1.8. Propellant (liquid or gas) migration into an associated pneumatic system shall be controlled.	Select Status		
The pneumatic system should be compatible with all of the propellants served by the pneumatic supply.	I		
12.8.2. Flight Hardware Hypergolic Propellant System Piping and Tubing	I		
12.8.2.1. All flight hardware hypergolic propellant system piping and tubing connectors and fittings shall be welded in accordance with the design, performance and quality requirements prescribed in SAE Aerospace Recommended Practices (ARP) 899, Tube Fittings, Fluid Systems, Permanent Type, General Requirements for.	Select Status		

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12.8.2.2. Fittings and connectors with NPT or socket weld flanges shall not be used in hypergolic propellant systems.	Select Status		
Certain mechanically attached tube connections have been allowed in previous payload hypergolic propellant systems via the NASA waiver process. Nonwelded fittings and connectors in hypergolic propellant systems may be considered on a case-by-case basis but shall be used only in applications where additional hazard mitigations are included (i.e. upstream isolation valves, toxic vapor detection, restrictions on personnel access during ground processing, etc.). The payload project must provide sufficient details to allow for evaluation by the PSWG and Range Safety. All proposed applications of nonwelded fittings and connectors in hypergolic propellant systems must be approved by the PSWG and Range Safety. The level of system details and the required hazard mitigations will be determined by the PSWG and Range Safety based on fitting design, heritage, reliability, application, quantity of propellant, response plans, etc.	I		
12.8.2.3. All pipe and tube welded joints shall be 100% radiographically inspected before and after the acceptance pressure test and inspected by surface NDE techniques before and after the pressure test.	Select Status		
12.8.3. Flight Hardware Hypergolic Propellant System Valves	Select Status		
12.8.3.1. Valve actuators shall be operable under maximum design flow and pressure.	Select Status		
12.8.3.2. A remotely operated flow control valve shall be installed as close as practical to tanks to allow for isolating the tank(s) from the rest of the system when necessary. The valve shall be designed to be fail-safe if pneumatic or electric control power is lost during prelaunch operations.	Select Status		
12.8.3.3. Check valves shall be provided where back flow of fluids would create a hazard.	Select Status		
12.8.3.4. Valve connectors and connections shall be designed, selected, or located, or, as a last resort, marked to prevent connection to an incompatible system.	Select Status		
12.8.3.5. Remotely controlled valves shall provide for remote monitoring of open and closed positions during prelaunch operations. Monitoring of remotely controlled, pyrotechnically operated valve open and closed positions shall not be required if the function power is deenergized (in other words, an additional fourth inhibit is in place between the power source and the three required inhibits) and the control circuits for the three required inhibits are disabled (in other words, no single failure in the control circuitry will result in the removal of an inhibit) until the hazard potential no longer exists.	Select Status		
12.8.3.6. All electrical control circuits for remotely actuated valves shall be shielded or otherwise protected from hazardous stray energy.	Select Status		
12.8.3.7. Designs using uncontained seats are prohibited.	Select Status		
12.8.3.8. Valves that are not intended to be reversible shall be designed or marked so that they cannot be connected in a reverse mode.	Select Status		

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12.8.3.9. Manually operated valves shall be designed so that over torquing the valve stem cannot damage soft seats to the extent that seat failure occurs.	Select Status		
12.8.3.10. Valve stem travel on manual valves shall be limited by a positive stop at each extreme position.	Select Status		
12.8.3.11. The application or removal of force to the stem positioning device shall not cause disassembly of the pressure containing structure of the valve.	Select Status		
12.8.3.12. All electromechanical actuator electric wiring shall be sealed to prevent fluid ignition.	Select Status		
12.8.4. Flight Hardware Hypergolic Propellant System Pressure Indicating Devices	I		
12.8.4.1. A pressure indicating device shall be located on any storage vessel and on any section of the system where pressurized fluid can be trapped.	Select Status		
12.8.4.2. These pressure indicating devices shall be designed to be remotely monitored during prelaunch operations.	Select Status		
12.8.5. Flight Hardware Hypergolic Propellant System Flexible Hoses. Flexible hose requirements are specified in 12.1.10.4 in addition to the following:	Select Status		
12.8.5.1. Flexible hoses shall consist of a flexible inner pressure carrier tube (compatible with the service fluid). This tube shall be constructed of plastic (typically polytetrafluoroethylene [PTFE]) or corrugated metal (typically 300 series stainless steel) material reinforced by one or more layers of 300 series stainless steel wire and/or fabric braid.	Select Status		
In applications where stringent permeability and leakage requirements apply, hoses with a metal inner pressure carrier tube should be used. Where these hoses are used in a highly corrosive environment, consideration should be given to the use of Hastalloy C-22 in accordance with ASTM B575 for the inner pressure carrier tube and C-276 material for the reinforcing braid.	I		
12.8.5.2. Flexible hoses shall be dedicated to a service media. Interchanging of flexible hoses used in incompatible service media, such as hypergolic propellants, is not permitted. Permeation is not totally negated by the cleaning process.	Select Status		
12.8.6. Flight Hardware Hypergolic Propellant System Pressure Relief Devices	I		
12.8.6.1. Pressure relief devices shall be installed on all systems having an on-board pressure source that can exceed the MAWP or MOP of any component downstream of that source unless the system is single failure tolerant against over pressurization during prelaunch operation.	Select Status		
12.8.6.2. Flight systems that require on-board pressure relief capability shall be designed to the following minimum requirements:	Select Status		
12.8.6.2.1. The pressure relief device shall be installed as close as is practical downstream of the pressure reducing device or source of pressure such as a compressor or gas generator.	Select Status		

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12.8.6.2.2. Pressure relief devices should be set to operate at a set pressure not to exceed 110% of the system MOP.	Select Status		
12.8.6.2.3. The relieving capacity of the relief device shall be equal to or greater than the maximum flow capability of the upstream pressure reducing device or pressure source and should prevent the pressure from rising more than 20% above the system MOP.	Select Status		
12.8.6.3. The relief device vent outlet piping shall be sized to prevent excessive back pressure from adversely affecting the relief device function.	Select Status		
12.8.6.4. All relief devices and associated piping shall be structurally restrained to minimize any thrust effects to the pressure system vessels or piping.	Select Status		
12.8.6.5. The effects of the discharge from relief devices shall be assessed and analyzed to ensure that operation of the device shall not be hazardous to personnel or equipment. Items to be analyzed are thrust loads, toxicity, combustibility, flammability, and others as deemed necessary by PSWG and Range Safety.	Select Status		
12.8.6.6. All pressure relief devices shall be vented separately unless the following criteria can be positively demonstrated:	Select Status		
12.8.6.6.1. The creation of a hazardous mixture of gases in the vent system and the migration of hazardous substances into an unplanned environment is impossible.	Select Status		
12.8.6.6.2. The capacity of the vent system is adequate to prevent a pressure rise more than 20% above MOP when all attached pressure relief devices are fully opened, and the system is at full pressure and volume generating capacity.	Select Status		
12.8.6.7. No obstructions shall be placed downstream of the relief device.	Select Status		
12.8.6.8. Relief devices shall be located so that other components cannot render them inoperative.	Select Status		
12.8.7. Flight Hardware Hypergolic Propellant Vent Systems.	I		
12.8.7.1. All vent effluent resulting from routine operations shall be scrubbed and/or incinerated before venting to the atmosphere through vent stacks.	Select Status		
12.8.7.2. Hypergolic systems shall be designed so that vapors or liquids cannot be trapped in any part of the system without vent and/or drain capability.	Select Status		
12.8.7.3. Vent system outlets shall be in a location normally inaccessible to personnel and shall be conspicuously identified.	Select Status		
12.8.7.4. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	Select Status		
12.8.7.5. Oxidizer and fuel vent outlets to the atmosphere shall be separated sufficiently to prevent mixing of vented fluids.	Select Status		
12.8.7.6. Special attention shall be given to the design of vent line supports at vent outlets due to potential thrust loads.	Select Status		

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12.8.7.7. Each line venting into a multiple-use vent system shall be protected against back pressurization by means of a check valve if the upstream system cannot withstand the back pressure or where contamination of the upstream system cannot be tolerated.	Select Status		
12.8.7.8. Pressure relief vents shall be designed and located so that vapors cannot enter any inhabited areas.	Select Status		
12.8.7.9. Incompatible fluids shall not be discharged into the same vent or drain system.	Select Status		
12.8.7.10. Fuel and oxidizer vent systems shall be equipped with a means of purging the system with an inert gas to prevent explosive mixtures.	Select Status		
12.8.8. Testing Flight Hardware Hypergolic Propellant System Components Before Assembly	I		
12.8.8.1. All systems elements shall be qualification tested in accordance with 12.2.2.6 and acceptance tested in accordance with 12.2.2.7 and 12.5.1.17.1.	Select Status		
12.8.8.2. Pneumatic proof testing to a proof pressure of 1.25 times MOP/MEOP (not to exceed MAWP) is permissible only if hydrostatic proof testing is impractical, impossible, or jeopardizes the integrity of the system or system element. Prior approval for pneumatic proof testing at the payload processing facility and launch site area shall be obtained from PSWG and Range Safety.	Select Status		
12.8.8.3. All hypergolic propellant valves shall be tested for both internal and external leakage at their MAWP.	Select Status		
12.8.8.3.1. No external leakage is allowed. Valves shall be visually bubble tight, using approved soap solution and techniques. Internal leakage of valves shall not exceed limits specified in the valve performance specification.	Select Status		
12.8.8.3.2. Certain critical system components may require helium leak checks using a mass spectrometer to verify leak rates not to exceed 1×10^{-6} cc/sec of helium gas at standard temperature and pressure (STP).	Select Status		
12.8.9. Testing Flight Hardware Hypergolic Propellant Systems After Assembly. All newly assembled propellant pressure systems shall meet the test requirements of 12.5.1.17.2 after assembly.	Select Status		
12.8.9.1. Flight Hardware Hypergolic Propellant System Leak Tests	I		
12.8.9.1.1. Pneumatic leak testing at system MOP/MEOP of all completely assembled and cleaned vessel pipe and tubing sections, with components installed, shall be completed before introduction of propellant.	Select Status		
12.8.9.1.2. Minimum test requirements are as follows:	Select Status		
12.8.9.1.2.1. Test gas should use a minimum volume of 10 percent helium.	Select Status		
12.8.9.1.2.2. All mechanical joints such as gasket joints, seals, and threaded joints and weld seams shall be visually bubble tight, using approved soap solution and techniques.	Select Status		

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12.8.9.1.2.3. The functional validity of installed block valves should be checked by incrementally venting downstream sections and pin hole leak checking. This test shall be conducted as a preparation to propellant loading operations at the payload processing facility unless prior approval from PSWG and Range Safety has been obtained.	Select Status		
12.8.9.1.3. When required, a more sensitive method of leak detection (e.g. mass spectrometers) may be specified on a case-by-case basis.	Select Status		
12.8.9.2. Flight Hardware Hypergolic Propellant System Validation and Functional Tests. All newly assembled pressure systems shall meet the system validation and functional testing requirements of 12.5.1.17.4.	Select Status		
12.8.9.3. Flight Hardware Hypergolic Propellant Systems Bonding and Grounding. All newly assembled pressure systems shall meet the bonding and grounding requirements of section 12.1.12	Select Status		
12.8.10. Testing Modified and Repaired Flight Hardware Hypergolic Propellant Systems. Modified and repaired flight hardware propellant systems shall meet the test requirements of 12.5.1.17.6.	Select Status		
12.9. Flight Hardware Cryogenic Systems Design and Test Requirements	I		
12.9.1. Flight Hardware Cryogenic System General Design Requirements	I		
12.9.1.1. Propellant systems shall have low point drain capability.	Select Status		
12.9.1.1.1. Low point drains shall be accessible and located in the system to provide the capability of removing propellant from the tanks, piping, lines, and components.	Select Status		
12.9.1.1.2. In addition, the cryogenic fuel system shall be designed to be purged with inert fluids.	Select Status		
12.9.1.2. Bi-propellant systems shall have the capability of loading the fuel and oxidizer one at the time.	Select Status		
12.9.1.3. For prelaunch failure modes that could result in a time-critical emergency, provision shall be made for automatic switching to a safe mode of operation. Caution and warning signals shall be provided for these time-critical functions.	Select Status		
12.9.1.4. Pneumatic systems servicing cryogenic systems shall comply with the pneumatic pressure system requirements of 12.6.	Select Status		
12.9.1.5. Cryogenic systems shall be designed to control liquefaction of air.	Select Status		
12.9.1.6. For systems requiring insulation, nonflammable materials shall be used in compartments or spaces where fluids and/or vapors could invade the area.	Select Status		
12.9.1.7. Vacuum-jacketed systems shall be capable of having the vacuum verified.	Select Status		
12.9.1.8. Purge gas for LH_2 and cold GH_2 lines should be gaseous helium (GH_e).	Select Status		

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12.9.1.9. Precautions shall be taken to prevent cross-mixing of media through common purge lines by use of check valves to prevent back flow from a system into a purge distribution manifold.	Select Status		
12.9.1.10. Titanium and titanium alloys shall not be used where exposure to GOX (cryogenic) or LO_2 (LOX) is possible.	Select Status		
12.9.2. Flight Hardware Cryogenic System Vessels and Tanks. Cryogenic vessels and tanks shall be designed in accordance with the requirements in 12.2.	Select Status		
12.9.3. Flight Hardware Cryogenic System Piping and Tubing	I		
12.9.3.1. The amount and type of thermal insulation (insulation material or vacuum-jacketed) shall be determined from system thermal requirements.	Select Status		
12.9.3.2. The use of slip-on flanges shall be avoided.	Select Status		
12.9.3.3. Flanged joints in LH_2 systems shall be seal welded.	Select Status		
12.9.3.4. Flanged joint gaskets shall not be reused.	Select Status		
12.9.3.5. Cryogenic systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.	Select Status		
Bellows, reactive thrust bellows, or other suitable load relieving flexible joints may be used.	I		
12.9.3.6. All pipe and tube welded joints shall be 100 percent radiographically inspected before and after the acceptance proof test. The accept/reject criteria shall be submitted to PSWG and Range Safety for review and approval.	Select Status		
12.9.3.6.1. Welded connections shall meet the requirements of AWS D17.1, Specification for Fusion Welding for Aerospace Applications, as prescribed by NASA-STD-5006, General Fusion Welding Requirements for Aerospace Materials Used in Flight Hardware.	Select Status		
12.9.3.6.2. Tube and fitting welded joints shall meet the inspection requirements of AIAA/NAS 1514-72, Radiographic Standard for Classification of Fusion Weld Discontinuities, and ASTM E 1742, Standard Practice for Radiographic Examination, and be visually inspected using appropriate mechanical aids as needed to ensure compliance with weld specifications and requirements in accordance with aerospace industry practices. Surface inspection, if applicable, shall meet the requirements of ASTM E 1417, Standard Practice for Liquid Penetrant Inspection.	Select Status		
12.9.4. Flight Hardware Cryogenic System Valves	I		
12.9.4.1. Cryogenic systems shall be designed to ensure icing does not render the valve inoperable.	Select Status		
12.9.4.2. Remotely controlled valves shall provide for remote monitoring of the open and closed positions.	Select Status		

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12.9.4.3. Remotely operated valves shall be designed to be fail-safe if pneumatic or electric control power is lost during prelaunch operations.	Select Status		
12.9.4.4. All electrical control circuits for remotely actuated valves shall be shielded or otherwise protected from hazardous stray energy.	Select Status		
12.9.4.5. Manually operated valves shall be designed so that over torquing the valve stem cannot damage seats to the extent that seat failure occurs.	Select Status		
12.9.4.6. Valve stem travel on manual valves shall be limited by a positive stop at each extreme position.	Select Status		
12.9.4.7. The application or removal of force to the stem positioning device shall not cause disassembly of the pressure containing structure of the valve.	Select Status		
12.9.4.8. Manual or remote valve actuators shall be operable under maximum design flow and pressure.	Select Status		
12.9.4.9. Valves that are not intended to be reversible shall be designed or marked so that they cannot be connected in a reverse mode.	Select Status		
12.9.4.10. Stem position local or remote indicators shall sense the position of the stem directly, not the position of the actuating device.	Select Status		
12.9.4.11. All electromechanical actuator electrical wiring shall be sealed to prevent fluid ignition.	Select Status		
12.9.5. Flight Hardware Cryogenic System Pressure Indicating Devices	I		
12.9.5.1. A pressure indicating device shall be located on any cryogenic vessel and/or tank and on any section of the system where cryogenic liquid can be trapped.	Select Status		
12.9.5.2. These pressure indicating devices shall be designed to be remotely monitored during prelaunch operations.	Select Status		
12.9.6. Flight Hardware Cryogenic System Flexible Hoses. Flexible hose requirements are specified in 12.1.10.4 in addition to the following:	Select Status		
12.9.6.1. Flexible hoses used in cryogenic system shall be of the single-wall, double-wall, or double-wall, vacuum-jacketed type.	Select Status		
12.9.6.2. All convoluted portions of flexible hoses shall be covered with stainless steel wire band.	Select Status		
12.9.7. Flight Hardware Cryogenic System Pressure Relief Devices	I		
12.9.7.1. All cryogenic vessels and tanks shall be protected against overpressure by means of at least one pressure relief valve.	Select Status		
12.9.7.2. Minimum design requirements are as follows:	Select Status		

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12.9.7.2.1. The pressure relief device shall be installed as close as practical to the cryogenic vessel or tank.	Select Status		
12.9.7.2.2. Pressure relief valves shall be set to operate at pressures determined on a case-by-case basis by the payload project.	Select Status		
12.9.7.2.3. The relieving capacity of the relief valve shall be determined on a case-by-case basis by the payload project.	Select Status		
12.9.7.3. All pressure relief devices shall be vented separately unless the following can be positively demonstrated:	Select Status		
12.9.7.3.1. The creation of a hazardous mixture of gases in the vent system and the migration of hazardous substances into an unplanned environment is impossible.	Select Status		
12.9.7.3.2. The capacity of the vent system is adequate to prevent a pressure rise more than 20 percent above MOP when all attached pressure relief devices are fully opened, and the system is at full pressure and volume generating capacity.	Select Status		
12.9.7.4. All relief devices and associated piping shall be structurally restrained to eliminate any deleterious thrust effects on cryogenic system vessels or piping.	Select Status		
12.9.7.5. The effects of the discharge from relief devices shall be assessed and analyzed to ensure that operation of the device shall not be hazardous to personnel or equipment.	Select Status		
Items to be analyzed are thrust loads, impingement of high velocity gas or entrained particles, toxicity, oxygen enrichment, and flammability.	I		
12.9.7.6. No obstructions shall be placed downstream of the relief valves.	Select Status		
12.9.7.7. Relief valves shall be located so that other components cannot render them inoperative.	Select Status		
12.9.8. Flight Hardware Cryogenic System Vents	I		
12.9.8.1. GH_2 shall be vented to atmosphere through a burner system.	Select Status		
12.9.8.2. Cryogenic systems shall be designed so that fluids cannot be trapped in any part of the system without drain or vent (relief valve or vent valve) capability.	Select Status		
12.9.8.3. Each line venting into a multiple-use vent system shall be protected against back pressurization by a check valve if the upstream system cannot withstand the back pressure or where contamination of the upstream system cannot be tolerated.	Select Status		
12.9.8.4. Vents shall be placed in a location normally inaccessible to personnel and at a height or location where venting is not normally deposited into habitable spaces.	Select Status		
12.9.8.5. Each vent shall be conspicuously identified using appropriate warning signs, labels, and markings.	Select Status		

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12.9.8.6. Vent outlets shall be located far enough away from incompatible propellant systems and incompatible materials to ensure no contact is made during vent operations.	Select Status		
12.9.8.7. Incompatible fluids shall not be discharged into the same vent or drain system.	Select Status		
12.9.8.8. Fuel vent systems shall be equipped with a means of purging the system with an inert gas to prevent explosive mixtures.	Select Status		
12.9.8.9. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	Select Status		
12.9.8.10. Special attention shall be given to the design of vent line supports at vent outlets due to potential thrust loads.	Select Status		
12.9.9. Testing Flight Hardware Cryogenic System Components Before Assembly	I		
12.9.9.1. All cryogenic vessels and tanks shall be qualification tested in accordance with 12.2.2.6 and acceptance tested in accordance with 12.2.2.7.	Select Status		
12.9.9.2. Flight hardware cryogenic system components shall meet the test requirements of 12.5.1.17.1 before assembly.	Select Status		
12.9.10. Testing Flight Hardware Cryogenic Systems After Assembly	I		
12.9.10.1. Flight hardware cryogenic systems shall meet the test requirements of 12.5.1.17.2 after assembly.	Select Status		
12.9.10.2. All newly assembled cryogenic systems shall be leak tested.	Select Status		
12.9.10.3. The system shall be pressurized to the system MOP using gaseous helium for LH_2 systems and GN_2 for LO_2 (LOX) systems.	Select Status		
12.9.10.4. Following the leak test, all newly assembled cryogenic systems shall have a system validation test performed at system MOP before first operational use at the payload processing facility and launch site area.	Select Status		
12.9.10.5. Minimum test requirements are as follows:	Select Status		
12.9.10.5.1. The intended service fluid (LO_2[LOX], LH_2) shall be used as the validation test fluid.	Select Status		
12.9.10.5.2. The functional capability of all components and subsystems shall be validated.	Select Status		
12.9.10.5.3. All prelaunch operational sequences for the system shall be exercised, including emergency shutdown, safing, and unloading procedures.	Select Status		
12.9.10.5.4. Vacuum readings of all vacuum volumes shall be taken and recorded before, during, and after the test.	Select Status		
12.9.10.5.5. No deformation, damage, or leakage is allowed.	Select Status		
12.9.11. Testing Modified and Repaired Flight Hardware Cryogenic Systems	I		

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12.9.11.1. Any cryogenic system element, including fittings or welds, that have been repaired, modified, or possibly damaged before the system leak test shall be retested.	Select Status		
12.9.11.2. The component retest sequence shall be as follows:	Select Status		
12.9.11.2.1. The component shall be hydrostatically proof tested at ambient temperature to 1.5 times the component MOP/MEOP (not to exceed MAWP).	Select Status		
12.9.11.2.2. The component shall be reinstalled into the cryogenic system and a leak check performed at system MOP/MEOP.	Select Status		
12.9.11.2.3. The functional capability of the modified and/or repaired component shall be revalidated using the intended service fluid at system MOP.	Select Status		
12.9.11.3. If any cryogenic system elements such as valves, regulators, gauges, or pipes have been disconnected or reconnected for any reason, the affected connection shall be leak checked at MOP/MEOP.	Select Status		
12.10. Flight Hardware Pressure Systems Data Requirements	I		
12.10.1. General. The minimum data required to certify compliance with the design, analysis, and test requirements of this chapter are described below.	I		
12.10.1.1. Data required by 12.10.2 through 12.10.5 shall be incorporated into the Missile System Prelaunch Safety Package (MSPSP) or submitted as a separate package when appropriate.	Select Status		
12.10.1.2. Data required by 12.10.2 through 12.10.6 shall be placed in a system certification file that shall be to be maintained and updated by the hazardous pressure system operator.	Select Status		
12.10.1.3. This data shall be reviewed and approved by the PSWG and Range Safety before the first operational use of hazardous pressure systems at the payload processing facility and launch site area.	Select Status		
12.10.2. Flight Hardware Pressure Systems General Data Requirements. The following general flight hardware pressure systems data is required:	Select Status		
12.10.2.1. Hazard analysis of hazardous pressure systems in accordance with a jointly tailored SSP. (See Volume 1, Attachment 3.)	Select Status		
12.10.2.2. A material compatibility analysis shall be performed in accordance with the requirements specified in 12.1.13 and 12.1.16 of this chapter.	Select Status		
12.10.2.3. General flight hardware pressure systems data shall be submitted in accordance with Attachment 1, A1.2.4.7.1of this volume.	Select Status		
12.10.3. Flight Hardware Pressure System Design Data Requirements. Flight hardware pressure system design data shall be provided in accordance with Attachment 1, A1.2.4.7.2 of this volume.	Select Status		

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12.10.4. Flight Hardware Pressure System Component Design Data	I		
12.10.4.1. Identification of each component with a reference designation permitting cross-reference with the system schematic.	Select Status		
12.10.4.2. MAWP for all pressure system components and the MOP the component will see when installed in the system.	Select Status		
12.10.4.3. Safety factors or design burst pressure for all pressure system components and identification of actual burst pressures, if available.	Select Status		
12.10.4.4. Proof pressure for each system component and identification of the proof pressure the component will see after installation in the system, if applicable.	Select Status		
12.10.4.5. Materials used in the fabrication of each element within the component including soft goods and other internal elements.	Select Status		
12.10.4.6. Cycle limits if fatigue is a factor of the component.	Select Status		
12.10.4.7. Temperature limits of each system component.	Select Status		
12.10.4.8. Component information shall be placed in tables.	Select Status		
12.10.5. Flight Hardware Pressure System Test Procedures and Reports	I		
12.10.5.1. All test plans, test procedures and test reports required by this chapter shall be submitted to the PSWG for PSWG and Range Safety review and approval.	Select Status		
12.10.5.2. A list and synopsis of all hazardous pressure system test procedures shall be submitted to the PSWG for PSWG and Range Safety review and approval.	Select Status		
12.10.6. Flight Hardware Pressure System Certification Files	I		
12.10.6.1. Certification files shall be maintained and updated by the hazardous pressure system operator.	Select Status		
12.10.6.2. These files shall be accessible for PSWG review and located at the ranges.	Select Status		
12.10.6.3. The certification file for each hazardous pressure system shall contain the data required in 12.10.1 through 12.10.5 in addition to the following:	Select Status		
12.10.6.3.1. As applicable, stress, safe-life, fatigue, and fracture mechanics analysis in accordance with 12.1.5.3, 12.1.5.4, and 12.1.5.5.	Select Status		
12.10.6.3.2. Specification drawings and documents for all components.	Select Status		

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12.10.6.3.3. If necessary, a cross-sectional assembly drawing of the component to assess the safety aspects of the internal elements.	Select Status		
12.10.6.3.4. Certification that welding and weld NDE meet applicable standards and have been performed by certified personnel.	Select Status		
12.10.6.3.5. Qualification and acceptance test plans and test reports.	Select Status		
12.10.6.3.6. Certification documentation describing how pressure systems, vessels, and pressurized structures are designed, fabricated, and tested in accordance with 12.1, 12.2, and 12.3, as applicable.	Select Status		
12.10.6.3.7. Certification that all components, including pipe and tube fittings, have successfully passed a hydrostatic proof test.	Select Status		

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CHAPTER 13 ORDNANCE SYSTEMS	I		
13.1. Ordnance Hazard Classification	I		
Safety requirements for non-explosive actuators, ordnance devices, and circuits specific for NASA Payloads are provided in this publication. ***Note: For purposes of these requirements the term ordnance items is meant to include non-explosive actuators such as, paraffin actuators, phase change devices, and others as determined by the PSWG and Range Safety.***	I		
13.1.1. Ordnance General Classification	I		
13.1.1.1. Ordnance items shall be assigned the appropriate DoD and United Nations (UN) hazard classification and storage compatibility group in accordance with DESR 6055.09_AFMAN 91-201, Explosive Safety Standard and NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.	Select Status		
13.1.1.2. Items that have not previously been classified and cannot be classified based on similarity with previously classified items shall be tested in accordance with AFTO 11A-1-47/ (NAVSEAINST 8020.3/TB700-2/DLAR 8220.1), Explosive Hazard Classification Procedures, and classified accordingly.	Select Status		
13.1.1.3. Ordnance items shall also have a DOT classification. The payload project is responsible for obtaining DOT classification.	Select Status		
13.1.1.4. The payload project shall provide the UNO, DoD, and DOT documentation demonstrating proper classification for review and approval by PSWG and Range Safety before delivering ordnance.	Select Status		
13.2. Ordnance System General Requirements	I		
All the remaining parts of this chapter establish the design requirements for hazardous ordnance and ordnance systems during transportation, handling, storage, installation, testing, and connection on the ranges. Hazard division 1.4S ordnance and ordnance systems, considered as articles that present no significant hazard, do not have to meet the design requirements identified in this chapter; however, they shall meet the operational requirements identified in Volume 6 of this publication.	Select Status		
13.2.1. Ordnance Subsystem Identification. Ordnance systems include the following subsystems. All of these subsystems are subject to the design requirements described below.	Select Status		
13.2.1.1. Power Source. The firing power source may be a battery, a dedicated power bus, or a capacitor.	Select Status		
13.2.1.2. Firing Circuit (the path between the power source and the initiating device). The firing circuit includes the electrical path and the optical path for laser initiated ordnance.	Select Status		
13.2.1.3. Control Circuit. The control circuit activates and deactivates the safety devices in the firing circuit.	Select Status		
13.2.1.4. Monitor Circuit. The monitor circuit monitors status of the firing circuits.	Select Status		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

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13.2.1.5. Initiating Device. The initiating device converts electrical, mechanical, or optical energy into explosive energy.	Select Status		
13.2.1.6. Receptor Ordnance. Receptor ordnance includes all ordnance items such as the explosive transfer system (ETS), separation charge, explosive bolt installed downstream of the initiating devices.	Select Status		
13.2.2. Preclusion of Inadvertent Firing. Ordnance devices and systems shall be designed to preclude inadvertent firing of any explosive or pyrotechnic components when subjected to environments encountered during ground processing including shock, vibration, and static electricity encountered during ground processing.	Select Status		
13.2.3. Failure Mode Effects and Criticality Analysis. A comprehensive FMECA shall be performed on all ordnance systems in accordance with MIL-STD-1629 Procedures for Performing a Failure Mode Effects and Criticality Analysis, or equivalent.	Select Status		
13.3. Ordnance Electrical Circuits and Optical Circuits	I		
13.3.1. Ordnance Electrical Circuit General Design Requirements	Select Status		
13.3.1.1. Ordnance system circuitry shall be protected to preclude energy sources such as electromagnetic energy or stray light from the ranges and/or launch vehicle from causing undesired output of the system.	Select Status		
Solutions for protection of ordnance system circuitry include shielding, filtering, grounding, and other isolation techniques that can preclude the energy sources such as electromagnetic energy or stray light from the ranges and/or launch vehicle from causing undesired output of the system.	I		
13.3.1.2. Hazardous ordnance systems shall be designed so that the initiating devices can be installed in the system just before final electrical and/or optical hookup on the launch pad.	Select Status		
It is understood that the requirement for designing ordnance so that the initiating devices can be installed in the system just before final electrical hookup on the launch pad cannot always be met. Exceptions are handled on a case-by-case basis where the payload processing facility and/or launch site user has demonstrated compliance with the intent.	I		
13.3.1.2.1. Initiating device locations shall be accessible to facilitate installation and removal and electrical and/or optical connections as late as possible in the launch countdown.	Select Status		
13.3.1.2.2. Access required at the launch complexes shall be identified and demonstrated to accommodate this accessibility requirement.	Select Status		
13.3.1.3. Separate power sources and/or busses shall be required for ordnance initiating systems.	Select Status		
13.3.1.4. RF energy shall not be used to ignite initiating devices.	Select Status		
13.3.1.5. Electrical firing circuits shall be isolated from the initiating ordnance case, electronic case, and other conducting parts of the flight hardware.	Select Status		

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13.3.1.5.1. If a circuit is grounded, there shall be only one interconnection (single ground point) with other circuits. Static bleed resistors of 10 kilo-ohms to 100 kilo-ohms are not considered to violate the single point ground.	Select Status		
13.3.1.5.2. This interconnection shall be at the power source only.	Select Status		
13.3.1.5.3. Other ground connections with equivalent isolation shall be handled on a case-by-case basis.	Select Status		
13.3.1.6. Ungrounded circuits capable of building up static charge shall be connected to the structure by static bleed resistors of between 10 kilo-ohms and 100 kilo-ohms.	Select Status		
13.3.1.7. Firing circuit design shall preclude sneak circuits and unintentional electrical paths due to such faults as ground loops and failure of solid state switches.	Select Status		
13.3.1.8. Redundant circuits shall be required if loss of power or signal may result in injury to personnel or be a detriment to safety critical systems.	Select Status		
13.3.1.9. The elements of a redundant circuit shall not be terminated in a single connector where the loss of such connector will negate the redundant feature.	Select Status		
Redundant circuits should be separated to the maximum extent possible.	I		
13.3.2. Ordnance Electrical Circuit Shielding	I		
13.3.2.1. Shields shall not be used as intentional current-carrying conductors.	Select Status		
13.3.2.2. Electrical firing circuits shall be completely shielded or shielded from the initiating ordnance back to a point in the firing circuit at which filters, or absorptive devices eliminate RF entry into the shielded portion of the system.	Select Status		
13.3.2.3. RF shielding shall provide a minimum of 85 percent of optical coverage ratio.	Select Status		
Optical coverage ratio is the percentage of the surface area of the cable core insulation covered by a shield. A solid shield rather than a mesh shield would have 100 percent coverage.	I		
13.3.2.4. There shall be no gaps or discontinuities in the termination at the back faces of the connectors or apertures in any container that houses elements of the firing circuit.	Select Status		
13.3.2.5. Electrical shields terminated at a connection shall be joined around the full 360 degree circumference of the shield.	Select Status		
13.3.2.6. All metallic parts of the initiating ordnance subsystem that are physically connected shall be bonded with a DC resistance of less than 2.5 milliohms.	Select Status		
13.3.2.7. Firing, control, and monitor circuits shall all be shielded from each other.	Select Status		
13.3.3. Ordnance Electrical Circuits Wiring	I		

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13.3.3.1. Twisted shielded pairs shall be used unless other configurations such as coaxial leads can be shown to be more effective.	Select Status		
13.3.3.2. For low voltage circuits, insulation resistance between the shield and conductor at 500 volts DC minimum shall be greater than 2 megaohms.	Select Status		
13.3.3.3. For high voltage circuits, insulation resistance between the shield and conductor at 150 percent of rated output voltage or 500 volts, whichever is greater, shall be greater than 50 mega-ohms.	Select Status		
13.3.3.4. Wires shall be of sufficient size to adequately handle 150 percent of the design load for continuous duty signals (100 seconds or more) on the safety critical circuit.	Select Status		
13.3.3.5. Splicing of firing circuit wires or overbraid shields is prohibited.	Select Status		
13.3.3.6. The use of wire wrap to connect wire shields is prohibited.	Select Status		
13.3.4. Ordnance Electrical Connectors	I		
13.3.4.1. The outer shells of electrical connectors shall be made of metal.	Select Status		
13.3.4.2. Electrical connectors shall be selected to eliminate the possibility of mis-mating. Mis-mating includes improper installation as well as connecting wrong connectors.	Select Status		
13.3.4.3. Electrical connectors shall be of the self-locking type or lock wiring shall be used to prevent accidental or inadvertent demating.	Select Status		
13.3.4.4. The design shall ensure that the shielding connection for an electrical connector is complete before the pin connection.	Select Status		
13.3.4.5. Shields need not be carried through a connector if the connector can provide RF attenuation and electrical conductivity at least equal to that of the shield.	Select Status		
13.3.4.6. Circuit assignments and the isolation of firing pins within an electrical connector shall be so that any single short circuit occurring as a result of a bent pin shall not result in more than 10 percent of the no-fire current. A bent pin analysis shall be performed on all electrical connectors.	Select Status		
13.3.4.7. There shall be only one wire per pin and in no case shall an electrical connector pin be used as a terminal or tie-point for multiple connections.	Select Status		
13.3.4.8. Spare pins shall be allowed in electrical connectors except where a broken spare pin may have an adverse effect on a firing or control circuit.	Select Status		
13.3.4.9. Source circuits shall terminate in an electrical connector with female contacts.	Select Status		
13.3.4.10. Electrical connectors shall not rely on spring force to mechanically lock mating halves together if they are to be used on safety critical circuits.	Select Status		

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13.3.4.11. Electrical connectors shall be capable of adequately handling 150 percent of the designed electrical load continuous duty signal (100 seconds or more) on safety critical circuits.	Select Status		
13.3.4.13. Separate cables and connectors shall be used when redundant circuits are required.	Select Status		
13.3.5. Ordnance Electrical Circuit Switches and Relays	I		
13.3.5.1. Switches and relays shall be designed to function at expected operating voltage and current ranges under worst case ground environmental conditions, including maximum expected cycle life.	Select Status		
13.3.5.2. Switches and relays used for inhibits shall not be considered adequate for RF isolation and absorption unless demonstrated by analysis and test for the specific environment of use.	Select Status		
13.3.6. Ordnance Electrical Monitoring, Checkout, and Control Circuits	I		
13.3.6.1. All circuits used to arm or disarm the firing circuit shall contain means to provide remote electrical indication of their armed or safe status.	Select Status		
13.3.6.1.1. These inhibits shall be directly monitored.	Select Status		
13.3.6.1.2. GSE shall be provided to electrically monitor arm and safe status of the firing circuit at all processing facilities including launch complexes up to launch.	Select Status		
13.3.6.2. Monitoring, control, and checkout circuits shall be completely independent of the firing circuits and shall use a separate and non-interchangeable electrical connector.	Select Status		
13.3.6.3. Monitoring, control, and checkout circuits shall not be routed through arm or safe plugs.	Select Status		
13.3.6.4. The electrical continuity of one status circuit (safe or arm) shall completely break before the time that electrical continuity is established for the other status circuit (arm or safe).	Select Status		
13.3.6.5. The safety of the ordnance system shall not be affected by the external shorting of a monitor circuit or by the application of any positive or negative voltage between 0 and 35 volts DC to a monitor circuit.	Select Status		
13.3.6.6. Monitoring and checkout of current in a low voltage electro-explosive system firing line shall not exceed 1/10 the no-fire current of the EED or 50 milliamperes, whichever is less.	Select Status		
13.3.6.7. Monitor circuits shall be designed so that the application of the operational voltage will not compromise the safety of the firing circuit nor cause the ordnance system to be armed.	Select Status		
13.3.6.8. Tolerances for monitor circuit outputs shall be compatible with the tolerances specified for the PSWG and Range Safety required parameter to be verified. Tolerances for monitor circuit outputs shall be specified for both RF and hardline.	Select Status		
13.3.6.9. Maximums and minimums for monitor circuit outputs shall be specified.	Select Status		

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13.3.6.10. No single point failure in monitoring, checkout, or control circuitry and equipment shall compromise the safety of the firing circuit.	Select Status		
13.3.6.11. Firing circuits that do not share a common fire command shall be electrically isolated from one another so that current in one firing circuit does not induce a current greater than 20 dB below the no-fire current in any firing output circuit. Control circuits shall be electrically isolated so that a stimulus in one circuit does not induce a stimulus greater than 20 dB below the activation level in any firing circuit.	Select Status		
13.3.6.12. The monitor circuit that applies current to the EED shall be defined to limit the open circuit output voltage to 1 volt.	Select Status		
13.4. Initiator Electrical Circuits	I		
13.4.1. Electrical Low Voltage Electromechanical Circuits Design Requirements	Select Status		
13.4.1.1. All solid rocket motor ignition circuits and other high hazard ordnance systems (as determined by the PSWG and Range Safety) using low voltage initiators shall provide a minimum of three independent inhibits.	Select Status		
The term high hazard refers to specific catastrophic events such as the inadvertent firing of a solid rocket motor or actuation of a destruct system that could result in multiple fatalities, typically threatening more than just the ordnance technicians handling the hazardous item, and/or "total" destruction of high value hardware such as the payload, launch vehicle, or facility.	I		
13.4.1.2. EED ordnance systems other than solid rocket motor ignition circuits and other high hazard ordnance systems shall provide two independent inhibits. At least one inhibit shall be a mechanical device like a safing plug. Any alternative not including such a mechanical device requires PSWG and Range Safety approval.	Select Status		
Table 13.1. Clarification on Valid and Independent Inhibits. ***A key consideration in providing inhibits in an ordnance circuit is that they be both valid and independent. Valid means that the inhibits reside in the direct current path for firing the EED, not in the control circuit used to change the status of an inhibit. For example, if a two-inhibit compliance approach is to close two control circuit relays to close a single firing line relay, it is not compliant because there are not two valid inhibits. In other words, the single firing line relay is the only inhibit. Independent means a singular action to remove a singular inhibit. Two inhibits is possible; for example, two open relays in a firing line. However, if a single command removes both inhibits, (for example, closes both relays), then the inhibits are not independent. In other words, there are not two independent inhibits. A concept that is often overlooked is that inhibits are not independent if a single failure can negate both inhibits.***	I		
13.4.1.3. The safe plug shall provide interruption of the circuit after the “enable” and “fire” switches and as close to the end item ordnance as possible.	Select Status		
13.4.1.4. The final electrical connection of an EED to the firing circuit shall be as close to the EED as possible.	Select Status		

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13.4.1.5. EEDs shall be protected from electrostatic hazards by the placement of resistors from line-to-line and line-to-ground (structure). The placement of line-to-structure static bleed resistances is not considered to violate the single point ground requirement as long as the parallel combination of these resistors is 10 kilo-ohms or more.	Select Status		
13.4.1.6. The system circuitry shall be designed and/or located to limit RF power at each EED (produced by range and/or vehicle transmitter) to a level at least 20 dB below the pin-to-pin DC no-fire power of the EED.	Select Status		
Electromagnetic environment evaluation should either be by analysis or electromagnetic compatibility (EMC) testing. RF power density levels for facilities are available from the SLD 30 and SLD 45 for VSFB and CCSFS, respectively, and the KSC Electromagnetics Lab.	I		
13.4.2. High Voltage Exploding Bridgewire Circuits	I		
13.4.2.1. Launch vehicles and payloads using exploding bridgewire (EBW) systems shall include an EBW-firing unit (EBW-FU) or an electronic safe-and-arm-device firing unit (ESAD-FU).	Select Status		
13.4.2.2. An EBW-FU shall be required on all other EBW systems. A manual arming and safing plug may also be required depending on the degree of hazard and confidence in inhibits as determined by the PSWG and Range Safety.	Select Status		
13.5. Ordnance Safety Devices	I		
13.5.1. Ordnance Safety Device General Design Requirements. Ordnance safety devices are electrical, electromechanical, or mechanical devices used in all ordnance subsystems to provide isolation between the power source to firing circuits and firing circuits to initiating devices or receptor ordnance.	Select Status		
Examples of ordnance safety devices include S&A devices, arm/disarm devices, relays, switches, EBW-FUs, and manual arming/safing plugs.	I		
13.5.1.1. Electrical and electronic safety devices shall remain or transfer back to their safe state in the event of input power loss.	Select Status		
13.5.1.2. All safety devices shall be capable of being functionally tested by ground test equipment.	Select Status		
13.5.1.3. Manual safety devices on the payload that are required to be in place in order for the launch pad to be open for normal work shall be accessible up to launch, requiring only a minimal crew to access the device and safe it.	Select Status		
Maintaining accessibility to manual safety devices up to launch and maintaining accessibility to remotely activated devices up to launch and after launch abort cannot always be met. Exceptions are handled on a case-by-case basis and supported with the detailed system design and hazard assessment.	I		
13.5.1.4. The arrangement of safety devices shall maximize safety by placing the most positive and reliable form of interruption closest to the initiating device.	Select Status		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

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For example, a safe plug would be located downstream of a solid state switch.	I		
13.5.1.5. Ordnance mechanical barriers used for safety devices shall demonstrate a reliability of 0.999 at the 95 percent confidence level to prevent initiation of the receptor ordnance. The test method shall be a Bruceton procedure or other statistical testing method acceptable to the PSWG and Range Safety.	Select Status		
13.5.1.6. Safety devices shall not require adjustment throughout their service life.	Select Status		
13.5.1.7. Each safety device shall be designed for a service life of at least 10 years after passing the acceptance test.	Select Status		
13.5.2. Ordnance Arming and Safing Plugs	I		
13.5.2.1. Safing plugs shall be designed to be manually installed to provide electrical isolation of the input power from the electrical and optical ordnance firing circuits.	Select Status		
13.5.2.2. Arming plugs shall be designed to be manually installed to provide electrical continuity from the input power to the electrical and optical ordnance firing circuits.	Select Status		
13.5.2.3. Safe and arm plugs on the payload that are required to be in place in order for the launch pad or processing facility to be open for normal work shall be accessible at all times, requiring only a minimal crew to access the plug and remove/install it.	Select Status		
Maintaining accessibility to arming and safing plugs up to just before final launch complex clear cannot always be met. Exceptions are handled on a case-by-case basis and supported with detailed system design and hazard assessments.	I		
13.5.2.4. Arming and safing plugs shall be designed to be positively identifiable by color, shape, and name.	Select Status		
13.5.2.5. For low voltage systems (EEDs) that use a safing plug instead of an electromechanical S&A, the safing plug shall be designed to electrically isolate and short the initiator side of the firing circuit. Isolation shall be a minimum of 10 kilo-ohms.	Select Status		
13.5.3. Low Voltage EED Electromechanical S&As	I		
13.5.3.1. Electromechanical S&As shall provide mechanical isolation of the EED from the explosive train and electrical isolation of the firing circuit from the EEDs.	Select Status		
13.5.3.2. When the S&A is in the safe position, the power and return lines of the firing circuit shall be disconnected. The bridgewire shall be shorted and grounded through a 10 kilo-ohm to 100 kilo-ohm resistor and the explosive train shall be interrupted by a mechanical barrier capable of containing the EED output energy without initiating the explosive.	Select Status		

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13.5.3.3. Transition from the safe to arm position shall require 90 degrees of rotation of the mechanical barrier for rotating S&As containing ordnance in the barrier. Safe to arm transition tolerances for other electromechanical S&A devices require PSWG and Range Safety approval.	Select Status		
13.5.3.4. The S&A device shall not be capable of propagating the detonation with the barrier rotated at least 50 degrees from safe for a 90-degree rotational barrier. This position shall be 50 percent of the travel distance between arm and safe for sliding barriers.	Select Status		
13.5.3.5. The mechanical lock in the S&A shall prevent inadvertent transfer from the arm to safe position (or vice versa) under all ground operational environments without the application of any electrical signal.	Select Status		
13.5.3.6. S&A design shall incorporate provisions to safe the ordnance train from any rotor and/or barrier position.	Select Status		
13.5.3.7. S&As shall be capable of being remotely safed and armed. They shall not be capable of being manually armed but shall be capable of being manually safed.	Select Status		
13.5.3.8. Remote and manual safing shall be accomplished without passing through the arm position.	Select Status		
13.5.3.9. The S&A safe signal shall not be indicated visually or remotely unless the device is less than 10 degrees from the safe position for rotating systems or 10 percent from the safe position for sliding barriers.	Select Status		
13.5.3.10. No visual indication of safe or arm shall appear if the device is in between the safe and arm positions. The S&A will be considered “not safe” or armed if the indicator does not show “safe.”	Select Status		
13.5.3.11. The electrical continuity of one status circuit of the S&A device (safe or arm) shall completely break before the time that the electrical continuity is established for the other status circuit (arm or safe).	Select Status		
13.5.3.12. A remote status indicator shall be provided to show the armed or safed condition.	Select Status		
13.5.3.12.1. The device shall also indicate its arm or safe status by visual inspection.	Select Status		
13.5.3.12.2. There shall be easy access to this visual indication throughout ground processing.	Select Status		
13.5.3.13. S&A device locations on the vehicle shall be accessible to facilitate installation and removal and electrical and ordnance connections during final vehicle closeout.	Select Status		
13.5.3.14. A safing pin shall be used in the S&A to prevent movement from the safe to the arm position when the arming signal is applied.	Select Status		
13.5.3.14.1. Rotation and/or transition of the mechanical barrier to align the explosive train and electrical continuity of the firing circuit to the EEDs shall not be possible with the safing pin installed.	Select Status		
13.5.3.14.2. When inserted and rotated, the pin shall manually safe the device.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.3.14.3. Safing pins on the launch vehicle and the payload that are required to be in place in order for the launch pad to be open for normal work shall be accessible up to launch, requiring only a minimal crew to access the device and safe it.	Select Status		
13.5.3.14.4. Safing pin insertion shall require a reasonable force of resistance.	Select Status		
The force required for safing pin insertion should be between 20 and 40 pounds and/or 20 to 40 inch-pounds of torque.	I		
13.5.3.14.5. The safing pin shall provide a means of attaching warning streamers.	Select Status		
13.5.3.14.6. When installed, each safing pin shall be marked by a red streamer.	Select Status		
13.5.3.14.7. The following requirements apply whenever the arm command has been energized:	Select Status		
13.5.3.14.7.1. Removal of the safing pin shall not be possible if the arming circuit is energized.	Select Status		
13.5.3.14.7.2. The safing pin retention mechanism shall be capable of withstanding applied forces of tension or torque without failure.	Select Status		
Typical values for previously approved designs had the S&A safing pin retention mechanism capable of withstanding an applied force of at least 100 pounds tension or a torque of at least 100 inch-pounds without failure.	I		
13.5.3.14.8. The following requirements apply whenever the arm command is not energized:	Select Status		
13.5.3.14.8.1. Removal of the safing pin shall not cause the S&A to automatically arm.	Select Status		
13.5.3.14.8.2. Removal of the safing pin shall be inhibited by a locking mechanism requiring 90 degrees rotation of the pin.	Select Status		
The removal force should be 3 to 10 inch-pounds of torque.	I		
13.5.3.15. All S&A devices shall be designed to withstand repeated cycling from arm to safe for at least 1,000 cycles, or at least 5 times the expected number of cycles, whichever is greater, without any malfunction, failure, or deterioration in performance.	Select Status		
13.5.3.16. A constant 1-hour application of S&A arming voltage with the safing pin installed shall not cause the explosive in the unit to function or degrade to a point that it will no longer function if such a failure could create a hazard.	Select Status		
13.5.3.17. The time required to arm or safe an S&A device shall not exceed 1 second after application of the actuation signal.	Select Status		
13.5.3.18. The S&A shall not initiate and shall be safe to handle for subsequent disposal after being subjected to a 20-foot drop on to a steel plate.	Select Status		

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13.5.3.19. The S&A shall have shielding caps attached on the firing connectors during storage, handling, transportation, and installation up to firing line connection.	Select Status		
13.5.3.20. The shielding cap shall have a solid metal outer shell that makes electrical contact with the firing circuit case in the same manner as the mating connector.	Select Status		
13.5.4. Mechanical S&As	I		
13.5.4.1. Electrically actuated S&As shall be used unless justification for mechanical S&As is provided to and approved by PSWG and Range Safety.	Select Status		
13.5.4.2. Mechanical S&As shall incorporate the same features as electrically actuated devices except that arming and safing is performed mechanically.	Select Status		
Normally, these devices are armed by a liftoff lanyard or by stage separation.	I		
13.5.4.3. These S&As shall be designed to withstand repeated cycling from the arm to the safe position for at least 300 cycles without malfunction, failure, or deterioration in performance.	Select Status		
13.5.5. EBW-Firing Units (FUs)	I		
13.5.5.1. The EBW-FU shall provide circuits for capacitor charging, bleeding, charge interruption, and triggering.	Select Status		
13.5.5.2. The charged capacitor circuit shall have a dual bleed system with either system capable of independently bleeding off the stored capacitor charge.	Select Status		
The time interval for bleeding of stored capacitor charge should be based on the level of associated hazard and concept of operations, but not to exceed 5 minutes after power removal.	I		
13.5.5.3. Two separate and independent ground command actions shall be required for removing capacitor charging inhibits and shall be positively locked out and limited to only authorized personnel.	Select Status		
13.5.5.4. EBW-FU design shall provide a positive remotely controlled means of interrupting the capacitor charging circuit.	Select Status		
13.5.5.5. A gap tube shall be provided that interrupts the EBW trigger circuit.	Select Status		
13.5.5.6. EBW-FUs shall be designed to be discriminatory to spurious signals in accordance with MIL-STD-461 G, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.	Select Status		
13.5.5.7. At a minimum, EBW-FU monitor circuits shall provide the status of the trigger capacitor, high voltage capacitor, arm input, inhibit input (if used), and power.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.5.8. The insulation resistance between each EBW-FU high voltage output circuit and the case shall be designed to not be less than 50 mega-ohms at 500 VDC.	**Select Status**		
13.5.5.9. The isolation resistance between EBW-FU output circuits and any other circuits shall not be less than 50 mega-ohms at 500 VDC.	**Select Status**		
13.5.5.10. Remote discharged indicators for EBW-FUs shall not appear unless the capacitor bank voltage is one-tenth or less of the no-fire voltage of the EBW. The EBW-FU shall be considered “not safe” if the indicator does not show “discharged.”	**Select Status**		
13.5.5.11. The EBW-FU shall be capable of being remotely safed and armed.	**Select Status**		
13.5.6. Laser Firing Units, Optical Barriers, Optical S&As, and Ordnance S&As ***Note: Laser Firing Units, Optical Barriers, Optical S&As are not anticipated to be used. If they are used, they must comply with SSCMAN 91-710, Volume 3, section 13.5.6.***	**I**		
13.5.6.6. Ordnance S&As	**I**		
13.5.6.6.1. Ordnance S&A General Design Requirements	**Select Status**		
13.5.6.6.1.1. Ordnance S&As shall provide mechanical isolation of the explosive train.	**Select Status**		
13.5.6.6.1.2. When the device is in the safe position, the explosive train shall be interrupted by a mechanical barrier capable of containing the explosive.	**Select Status**		
13.5.6.6.1.3. Safe to Arm Transition	**Select Status**		
13.5.6.6.1.3.1. Transition from the safe to arm position shall require 90 degrees of rotation of the mechanical barrier for rotating S&As containing ordnance in the barrier.	**Select Status**		
13.5.6.6.1.3.2. Safe to arm transition tolerances for other electromechanical S&A devices shall be approved by PSWG and Range Safety.	**Select Status**		
13.5.6.6.1.4. Detonation Propagation	**Select Status**		
13.5.6.6.1.4.1. The device shall not be capable of propagating the detonation with the barrier rotated less than 50 degrees from safe for a 90-degree rotational barrier.	**Select Status**		
13.5.6.6.1.4.2. The device shall not be capable of propagating the detonation with the barrier at 50 percent of the travel distance between arm and safe for sliding barriers.	**Select Status**		
13.5.6.6.1.5. Ordnance S&A device locations shall be accessible to facilitate installation and/or removal of ordnance connections, including accessibility on the launch pad.	**Select Status**		

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13.5.6.6.1.6. The S&A shall not initiate and shall be safe to handle for subsequent disposal after being subjected to a 20-foot drop on to a steel plate.	Select Status		
13.5.6.6.2. Ordnance S&A Arm and Safe Mechanisms	Select Status		
13.5.6.6.2.1. The S&A device shall be designed to incorporate provisions to safe the ordnance train from any rotor or barrier position.	Select Status		
13.5.6.6.2.2. The time required to arm or safe an S&A device shall not exceed one second after application of the actuation signal.	Select Status		
13.5.6.6.2.3. All S&A devices shall be designed to withstand repeated cycling from arm to safe for at least 1,000 cycles or at least 5 times the expected number of cycles, whichever is greater, without any malfunction, failure, or deterioration in performance.	Select Status		
13.5.6.6.2.4. A mechanical lock in the S&A shall prevent inadvertent transfer from the arm to safe position or the safe to arm position under all operating environments without the application of any electrical signal.	Select Status		
13.5.6.6.2.5. S&As shall be capable of being remotely safed and armed.	Select Status		
13.5.6.6.2.6. Ordnance S&As shall not be capable of being manually armed but they shall be capable of being manually safed.	Select Status		
13.5.6.6.2.7. Remote and manual safing shall be accomplished without passing through the armed position.	Select Status		
13.5.6.6.3. Ordnance S&A Status Indicators	Select Status		
13.5.6.6.3.1. The electrical continuity of one status circuit of the S&A device (safe or arm) shall completely break before the time that the electrical continuity is established for the other status circuit (arm or safe).	Select Status		
13.5.6.6.3.2. Ordnance S&A Remote and Visual Status Indicators	Select Status		
13.5.6.6.3.2.1. A remote status indicator shall be provided to show the armed or safed condition.	Select Status		
13.5.6.6.3.2.2. A visual status indicator shall be provided to show the armed or safed condition by simple visual inspection.	Select Status		
13.5.6.6.3.2.3. Easy access to the visual status indicator shall be provided throughout ground processing.	Select Status		
13.5.6.6.3.3. The S&A safe signal shall not be indicated visually or remotely unless the device is less than 10 degrees from the safe position for rotating systems or 10 percent from the safe position for sliding barriers.	Select Status		
13.5.6.6.3.4. No visual indication of safe or arm shall appear if the device is in between safe and arm positions. The S&A will be considered “not safe” or armed if the indicator does not show “safe.”	Select Status		
13.5.6.6.4. Ordnance S&A Safing Pins	Select Status		

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13.5.6.6.4.1. A safing pin shall be used in the S&A device to prevent movement from the safe to the arm position when an arming signal is applied.	Select Status		
13.5.6.6.4.2. Rotation and/or transition of the mechanical barrier to align the explosive train shall not be possible with the safing pin installed.	Select Status		
13.5.6.6.4.3. When inserted and rotated, the pin shall manually safe the device.	Select Status		
13.5.6.6.4.4. Safing pins on the payload that are required to be in place in order for the launch pad to be open for normal work shall be accessible up to launch, requiring only a minimal crew to access the device and safe it.	Select Status		
13.5.6.6.4.5. Safing pin insertion shall require a reasonable force of resistance.	Select Status		
The force required for safing pin insertion should be between 20 and 40 pounds and/or 20 to 40 inch-pounds of torque.	I		
13.5.6.6.4.6. The safing pin shall provide a means of attaching warning streamers.	Select Status		
13.5.6.6.4.7. When installed, each safing pin shall be marked by a red streamer.	Select Status		
13.5.6.6.4.8. A constant one-hour application of S&A arming voltage, with the safing pin installed, shall not cause the explosive in the unit to function.	Select Status		
13.5.6.6.4.9. The following requirements apply whenever the arm command has been energized:	Select Status		
13.5.6.6.4.9.1. Removal of the safing pin shall not be possible if the arming circuit is energized.	Select Status		
13.5.6.6.4.9.2. The safing pin retention mechanism shall be capable of withstanding applied forces of tension or torque without failure.	Select Status		
Typical values for previously approved designs had the S&A safing pin retention mechanism capable of withstanding an applied force of at least 100 pounds tension or a torque of at least 100 inch pounds without failure.	I		
13.5.6.6.4.10. The following requirements apply whenever the arm command is not energized:	Select Status		
13.5.6.6.4.10.1. Removal of the safing pin shall not cause the S&A to automatically arm.	Select Status		
13.5.6.6.4.10.2. Removal of the safing pin shall be inhibited by a locking mechanism requiring 90 degrees rotation of the pin.	Select Status		
The removal force should be 3 to 10 inch-pounds of torque.	I		
13.6. Ordnance Initiating Devices	I		
13.6.1. Ordnance Initiating Device General Design Requirements	Select Status		

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13.6.1.1. The explosive or pyrotechnic mix shall not degrade, decompose, or change chemically over its service life, causing a more sensitive device.	Select Status		
13.6.1.2. Periodic testing of ordnance to verify that no sensitivity changes have occurred shall be in accordance with AIAA S-113A-2016, Criteria for Explosive Systems and Devices on Space and Launch Vehicles , unless it can be shown that sensitivity with aging is not a credible concern with the specific explosive composition.	Select Status		
13.6.1.3. Ordnance should be designed for a service life of at least 10 years with a design goal of 15 years.	Select Status		
13.6.1.4. The decomposition, cook-off, and melting temperatures of all explosives shall be at least 30ºC higher than the maximum predicted environmental temperature to which the material will be exposed during storage, handling, transportation, and launch.	Select Status		
13.6.2. Low Voltage EEDs	I		
13.6.2.1. One amp/one watt no-fire survivability of low voltage EEDs is required, as determined from the 0.1 percent firing level of the EED with 95 percent confidence using the Bruceton test or other statistical testing methods acceptable to the PSWG and Range Safety.	Select Status		
13.6.2.2. EEDs shall be designed to withstand a constant DC firing pulse of one ampere and one watt power for a period of five minutes without initiation or deterioration of performance.	Select Status		
13.6.2.3. The EED main body shall not rupture or fragment when the device is fired. Displacement or deformation of the connector and main housing is permissible; rupture or deformation of the outer end is permissible.	Select Status		
13.6.2.4. The auto-ignition temperature shall not be less than 150ºC.	Select Status		
13.6.2.5. Carbon bridgewires and conductive mixes without bridgewires are prohibited.	Select Status		
13.6.2.6. EEDs shall not fire or deteriorate in performance (if failure can create a hazard) as a result of being subjected to an electrostatic discharge of 25 kV from a 500 picofarad capacitor applied in the pin-to-case mode without a series resistor, and in the pin-to-pin mode with a 5 kilo-ohms resistor in series.	Select Status		
13.6.2.7. The EED shall not initiate and will perform to specification (if failure can create a hazard) after being subjected to a 6-foot drop on to a steel plate.	Select Status		
13.6.2.8. The EED shall not initiate or be damaged to the extent it is unsafe to handle after being subjected to a 40-foot drop on to a steel plate.	Select Status		
13.6.2.9. Insulation resistance between pin-to-case shall not be less than 2 mega-ohms at 500 VDC.	Select Status		
13.6.2.10. The outer case of the EED main body shall be made of conductive material, preferably metal.	Select Status		
13.6.2.11. RF survivability shall meet the testing criteria described in AIAA S-113A-2016, Criteria for Explosive Systems and Devices on Space and Launch Vehicles.	Select Status		

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13.6.2.12. Shielding caps shall be provided and placed on the EED during shipment, storage, handling, and installation up to the point of electrical connection.	Select Status		
13.6.2.12.1. The shielding cap shall have an outer shell made of conductive material that provides an RF shield and makes electrical contact with the EED case.	Select Status		
13.6.2.12.2. There shall be no RF gaps around the full 360-degree mating surface between the shielding cap and EED case.	Select Status		
13.6.2.12.3. The shielding cap shall be designed to accommodate the torque tool during installation.	Select Status		
13.6.2.12.4. Shorting plugs (caps) shall not be used as a substitute for shielding caps.	Select Status		
13.6.3. High Voltage Exploding Bridgewires	I		
13.6.3.1. Explosive materials shall be secondary explosives.	Select Status		
Examples of secondary explosives include pentaerythritoltetranitrate (PETN) or cyclotrimethylenetrinitramine (RDX).	I		
13.6.3.2. Insulation resistance pin-to-case shall be designed to not be less than 50 mega-ohms at 500 VDC.	Select Status		
13.6.3.3. A voltage blocking gap shall be provided.	Select Status		
13.6.3.3.1. The gap breakdown voltage shall not be less than 650 VDC when discharged from a 0.025 +10 percent microfarad capacitor.	Select Status		
13.6.3.3.2. The nominal gap breakdown voltage tolerance shall be specified and approved by the PSWG and Range Safety.	Select Status		
13.6.3.4. The EBW shall not fire or deteriorate in performance (if failure can create a hazard) upon being subjected to a voltage of 125 to 130 volts root mean square (Vrms) at 60 Hz applied across the terminals or between the terminals and the EBW body for 5 minutes +10 sec.	Select Status		
13.6.3.5. The EBW shall not fire or degrade to the extent that it is unsafe to handle when 230 +10 Vrms at 60 Hz is applied across the terminals or between the terminals and EBW body for 5 minutes +10 sec.	Select Status		
13.6.3.6. The EBW shall not fire or deteriorate in performance (if failure can create a hazard) upon being subjected to a source of 500 +25 VDC having an output capacitance of 1.0 +10 percent microfarads applied across the terminals or between the terminals and the EBW body for 60 to 90 seconds.	Select Status		
13.6.3.7. The EBW shall not fire or deteriorate in performance (if failure can create a hazard) after exposure to that level of power equivalent to absorption by the test item of 1.0 watt average power at any frequency within each RF energy range, as specified in Table 13.3. The frequency shall be applied across the input terminals of the EBW detonator for 5.0 to 6.0 seconds.	Select Status		

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Frequency (in MHz.)	Type
5 – 100	Continuous Wave
250 – 300	Continuous Wave
400 – 500	Continuous Wave
800 – 1,000	Continuous Wave
2,000 – 2,400	Continuous Wave
2,900 – 3,100	Continuous Wave
5,000 – 6,000	Continuous Wave
9,800 – 10,000	Continuous Wave
16,000 – 23,000	Pulse Wave *
32,000 – 40,000	Pulse Wave *
* Pulsed repetition frequency shall not be less than 100 Hz and the pulse width shall be a minimum of 1.0 microseconds.	

Table 13.3. RF Sensitivity

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13.6.3.8. The EBW shall not fire or deteriorate in performance (if failure can create a hazard) as a result of being subjected to an electrostatic discharge of 25 kV from a 500 picofarad capacitor applied in the pin-to-case mode without a series resistor and in the pin-to-pin mode with a 5 kilo-ohm resistor in series.	Select Status		
13.6.3.9. The autoignition temperature of the EBW shall not be less than 150ºC.	Select Status		
13.6.3.10. The EBW shall not initiate and shall perform to specification (if failure can create a hazard) after being subjected to a 6-foot drop on to a steel plate.	Select Status		
13.6.3.11. The EBW shall not initiate or be damaged to the extent it is unsafe to handle after being subjected to a 40-foot drop on to a steel plate.	Select Status		
13.6.4. Laser Initiated Devices ***Note: Laser initiated devices are not anticipated to be used. If they are used, they must comply with SSCMAN 91-710, Volume 3 section 13.6.4.***	I		
13.6.5. Percussion Activated Devices	I		
13.6.5.1. Stab initiation of percussion activated devices (PADs) is prohibited.	Select Status		

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13.6.5.2. Each initiator shall have a positive safety interrupter feature that can be mechanically locked in place.	Select Status		
13.6.5.3. The initiator and its interrupter shall be designed to withstand all transportation, handling, and installation environments.	Select Status		
13.6.5.4. The interrupter safety lock shall be designed to remain in place during and after installation.	Select Status		
13.6.5.5. The interrupter safety lock shall be designed to be removed after installation.	Select Status		
13.6.5.6. The design shall ensure the PAD cannot be assembled without the interrupter.	Select Status		
13.6.5.7. Percussion initiators shall be designed so that the operating energy is at least twice the all-fire energy.	Select Status		
13.6.5.8. Percussion initiator no-fire energy shall be such that the percussion initiator shall not fire when subjected to an energy of 50 percent of the all-fire energy.	Select Status		
13.6.6. Non-Explosive Initiators. Non-explosive initiators (NEI s) shall be handled on a case-by-case basis to ensure safety of the system design.	Select Status		
13.7. Explosive Transfer Systems and Receptor Ordnance	I		
Explosive Transfer Systems and Receptor Ordnance. Explosive transfer systems (ETS) are used to transmit the initiation reaction from the initiator to the receptor ordnance. ETSs shall be designed to meet the applicable safety sections of AIAA S-113A-2016, Criteria for Explosive Systems and Devices on Space and Launch Vehicles and the requirements below.	Select Status		
Most ETS harnesses contain flexible confined detonation cord, mild detonating cord, or mild detonating fuse terminated by end booster caps or manifolds.	I		
13.7.1. The explosive or pyrotechnic mix shall not degrade, decompose, or change chemically over its life causing a more sensitive device.	Select Status		
13.7.2. Periodic testing of ordnance to verify no sensitivity changes shall be in accordance with AIAA S-113A-2016, Criteria for Explosive Systems and Devices on Space and Launch Vehicles, unless it can be shown that the sensitivity with aging is not a credible concern with the specific explosive composition.	Select Status		
13.7.3. Explosives used in ETS lines shall be secondary explosives.	Select Status		
13.7.4. Flexible confined detonation cord (FCDC) shall not fragment or separate from end fittings upon initiation. Gaseous emission is permissible.	Select Status		
13.7.5. The ETS shall not detonate and shall be capable of performing its function (if failure can create a hazard) after being subjected to a 6-foot drop on to a steel plate.	Select Status		

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13.7.6. The ETS shall not initiate or be damaged to the extent it is unsafe to handle after being subjected to a 40-foot drop on to a steel plate.	Select Status		
13.7.7. All ETS interconnections shall provide for safety (lock) wiring or a PSWG and Range Safety approved equivalent.	Select Status		
13.7.8. An electrically conductive path shall exist between ETS components and their attachment fittings. The bonding resistance should be designed to be 2.5 milliohms but in no case shall the resistance exceed 5 ohms.	Select Status		
13.7.9. ETS fittings shall be designed and located to facilitate installation of the end receptor ordnance components in the launch vehicle as late as practical.	Select Status		
13.7.10. Fittings that should not be reversed or interchanged (because they may cause a hazard) shall be designed so that reverse installation or interchange is not possible.	Select Status		
13.7.11. Exposed end fittings shall be equipped with protective caps.	Select Status		
13.7.12. Receptor ordnance shall be designed to meet the applicable safety sections of AIAA S-113A-2016 and this part and shall use secondary high explosives.	Select Status		
Examples of secondary high explosives used for receptor ordnance include such items as PETN, RDX, cyclotetramethylenetetranitramine (HMX), or 2,2,4,4,6,6 hexanitrostilbene (HNS).	I		
13.7.12.1. Explosives shall be non-hygroscopic.	Select Status		
13.7.12.2. Specific approval from the PSWG and Range Safety is required for all explosive compositions.	Select Status		
13.7.13. The receptor ordnance shall not detonate after being subjected to a 6-foot drop test on to a steel plate.	Select Status		
13.7.14. The receptor ordnance shall not initiate or be damaged to the extent it is unsafe to handle after being subjected to a 40-foot drop onto a steel plate.	Select Status		
13.8. Ordnance Test Equipment	I		
13.8.1. Ordnance Test Equipment General Design Requirements	I		
13.8.1.1. All ordnance test equipment, such as continuity and bridgewire resistance measurement devices, shall be inspected and tested for voltage and optical isolation and limitation.	Select Status		
13.8.1.1.1. These devices shall be designed so that they will not pass greater than 1/10 of the no-fire energy across an EED bridgewire, or 50 mA, whichever is less.	Select Status		
13.8.1.1.2. These devices shall be analyzed to verify that rough handling, dropping, or single component failure will not result in negating the current-limiting feature.	Select Status		

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13.8.1.1.3. Clear cases of unacceptable energy or current for a particular resistance range or ranges shall be excluded from use by disablement by the manufacturer or local authority before certification.	**Select Status**		
13.8.1.1.4. Certification of each device shall include a tabular listing (to be kept with or marked on each meter) of the energy level and current levels available at each of the selectable ranges for the meter.	**Select Status**		
13.8.1.1.5. All test equipment shall be designed to meet standard industry safety requirements such as those established by ANSI, IEEE, and NFPA, as well as applicable Volume 3, Chapter 14 requirements.	**Select Status**		
13.8.1.2. The test results shall be submitted to the PSWG for PSWG and Range Safety approval before equipment use at the payload processing facility and launch site area.	**Select Status**		
13.8.2. Stray Current Monitors	**I**		
13.8.2.1. A stray current monitor shall be provided for all low voltage (EED) solid rocket motor ignition circuits and other high hazard ordnance systems as determined by the PSWG and Range Safety.	**Select Status**		
The term high hazard refers to specific catastrophic events such as the inadvertent firing of a solid rocket motor or actuation of a destruct system that could result in multiple fatalities, typically threatening more than just the ordnance technicians handling the hazardous item, and/or "total" destruction of high value hardware such as the payload, launch vehicle, or facility.	**I**		
13.8.2.2. The stray current monitor shall be installed and remain connected until the electrical connection of the actual initiators is accomplished. The monitor shall be installed at a time determined by the PSWG, Range Safety and the payload project.	**Select Status**		
13.8.2.3. The stray current monitor shall provide a stray current device capable of detecting 1/10 of the maximum safe no-fire current.	**Select Status**		
Fuses or automatic recording systems capable of detecting 1/10 of the maximum safe no-fire current are acceptable stray current devices for the stray current monitor.	**I**		
13.8.2.4. The monitoring device shall be installed in the firing line.	**Select Status**		
13.8.3. Ground Support Test Equipment. The design of test equipment used to test ground support equipment shall be reviewed and approved by the PSWG and Range Safety.	**Select Status**		
13.8.4. Laser Test Equipment ***Note: Laser test equipment are not anticipated to be used. If they are used, they must comply with SSCMAN 91-710, Volume 3, section 13.8.4.***	**I**		
13.9. Ordnance and Non-Explosive Initiator Data Requirements	**I**		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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Ordnance data items shall be submitted in accordance with the requirements of Attachment 1, A1.2.4.9 and A1.2.5.11. of this volume.	Select Status		
13.9.1. Data to verify compliance with the design and test requirements of this volume shall be submitted to the PSWG for PSWG and Range Safety review and approval before the arrival of ordnance at the payload processing facility and launch site area.	Select Status		
13.9.2. All schematics and functional diagrams shall have well defined, standard Institute of Electrical and Electronics Engineers (IEEE) Std 315-1975 (ANSI Y32.2-1975) terminology and symbols.	Select Status		

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CHAPTER 14 ELECTRICAL AND ELECTRONIC EQUIPMENT	I		
14.1. Electrical and Electronic Ground Support Equipment and Flight Hardware General Design Requirements and Standards	I		
14.1.1. Electrical equipment and Electronic Ground Support Equipment (EGSE) shall be designed, fabricated, inspected, and tested in accordance with NFPA 70, National Electric Code (NEC) .	Select Status		
MIL-HDBK-454, General Guidelines for Electronic Equipment, should be used as guidance in the design, fabrication, inspection, and Mismating testing of electrical equipment.	I		
14.1.2. All wiring shall be copper and contact with dissimilar metals shall be avoided. Aluminum wire shall not be used.	Select Status		
14.1.3. At a minimum, EGSE shall be designed to operate within the voltage ratings of ANSI C84.1, Electric Power Systems and Equipment - Voltage Ratings (60 Hz).	Select Status		
14.1.4. EGSE and Flight Hardware Power Cutoff. All EGSE and flight hardware shall have a means to cut off power before installing, replacing, or interchanging units, assemblies, or portions thereof.	Select Status		
14.1.5. EGSE and Flight Hardware Power Transient. Safety critical systems shall be protected against power transients and power outages.	Select Status		
14.1.6. EGSE and Flight Hardware Connectors. Connector design shall avoid the generation of a hazardous condition that could lead to a hazardous event.	Select Status		
A hazardous condition is where there is a possibility for the inadvertent connection of an electrical circuit to cause unintentional current to flow where it would cause a short, spark, energize equipment, or initiate ordnance that would create a hazardous event.	I		
14.1.6.1. If a hazardous condition can be created by mismating or reverse polarity, a positive means of preventing connector mismating shall be provided.	Select Status		
Mismating includes improper installation as well as connecting wrong connectors. Prevention of connector mis-mating includes alignment pins and key-way arrangements or other possible means to make it impossible to mismate. Color coding may be used in addition to, but not in lieu of, the more positive means of connector mis-mate prevention.	I		
14.1.6.2. If a hazardous event can occur, the following precautions shall be taken:	Select Status		
14.1.6.2.1. Power and signal leads shall not be terminated on adjacent pins of a connector.	Select Status		

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14.1.6.2.2. Wiring shall be isolated so that a single short circuit occurring in a connector cannot affect other components.	Select Status		
14.1.6.2.3. Pin locations shall be assigned to prevent inadvertent pin-to-pin and pin-to-case shorts.	Select Status		
14.1.6.2.4. Spare pins shall not be used in connectors controlling hazardous operations or safety critical functions.	Select Status		
14.1.6.2.5. The payload project shall provide a bent pin analysis to the PSWG for PSWG and Range Safety review on all safety critical and/or hazardous system connectors.	Select Status		
14.1.6.3. Connectors used in safety critical or hazardous systems shall be of the locking type.	Select Status		
14.1.6.4. Connectors relying solely on springs to maintain an electrical contact shall not be used in safety critical or hazardous systems. Connectors for safety critical or hazardous systems shall have a positive locking mechanism to prevent inadvertent, momentary electrical disruption or disconnection of the circuit	Select Status		
14.1.6.5. Plug and socket type connectors shall be used in safety critical or hazardous systems.	Select Status		
14.1.6.6. Connectors shall be of a “scoop-proof design” that will prevent a partial inadvertent mismate from providing incorrect pin to pin contact or shell-to-pin contact.	Select Status		
14.1.7. EGSE and Flight Hardware Grounding, Bonding, and Shielding	I		
14.1.7.1. Equipment shall be designed and constructed to ensure that all external parts, shields and surfaces, exclusive of radiating antennas and transmission line terminals, are at ground potential.	Select Status		
14.1.7.2. Shields shall not be used as current carrying ground connections, except for coaxial cables.	Select Status		
14.1.7.3. Circuits that operate safety critical or hazardous functions shall be protected from the electromagnetic environment to preclude inadvertent operation.	Select Status		
14.1.8. EGSE and Flight Hardware Cables	I		
14.1.8.1. Cables shall be supported and protected against abrasion or crimping.	Select Status		
14.1.8.2. Cables shall be located or protected so as not to present a tripping hazard.	Select Status		
14.1.8.3. Cables in hazardous areas shall be designed so that they do not, in and of themselves, create a hazard.	Select Status		
14.1.8.4. Cables shall be selected to include factors such as toxicity, combustibility and smoke production, off-gassing, and compatibility with liquids in the area and environmental exposure.	Select Status		
14.1.9. EGSE and Flight Hardware Batteries	I		
14.1.9.1. EGSE and Fight Hardware Battery General Design Requirements	Select Status		
14.1.9.1.1. All batteries shall be capable of being readily accessible for electrical disconnection and/or removal.	Select Status		

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14.1.9.1.2. Battery connectors shall be designed to prevent reverse polarity.	Select Status		
14.1.9.1.3. The capability for reverse current to cause a hazardous condition shall be prevented.	Select Status		
Diodes may be used to prevent reverse current. Diodes may be placed in the battery or in external circuitry.	I		
14.1.9.1.4. If a battery is not connected to the system, the battery terminals or connector plug shall be given positive protection against shorting.	Select Status		
Protection against shorting of connector terminals may be accomplished by taping or guarding with a suitable temporary connector.	I		
14.1.9.1.5. Polarity of battery terminals shall be marked	Select Status		
14.1.9.1.6. Identification. Each battery shall be permanently identified with the following appropriate information:	Select Status		
14.1.9.1.6.1. Component name.	Select Status		
14.1.9.1.6.2. Type of construction; for example, lead-acid or nickel-cadmium, lithium, lithium-Ion, etc, etc.	Select Status		
14.1.9.1.6.3. Manufacturer identification.	Select Status		
14.1.9.1.6.4. Part number.	Select Status		
14.1.9.1.6.5. Lot and serial number.	Select Status		
14.1.9.1.6.6. Date of manufacture.	Select Status		
14.1.9.2. EGSE and Flight Hardware Lithium Batteries. The following additional requirements are applicable to lithium batteries used in flight hardware and EGSE.	Select Status		
Note: Batteries that have a UL listing and are intended for public use and used in a manner consistent with the UL certification are exempt from these requirements.	I		
14.1.9.2.1. All lithium battery designs shall be reviewed and approved by the PSWG and Range Safety before arrival, usage, packing, storage, transportation, or disposal at the payload processing facility and launch site area.	Select Status		
14.1.9.2.2. Safety devices shall be incorporated into the lithium battery design.	Select Status		
Table 14.1. Safety Devices for Lithium Battery Design.	I		

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Safety devices include fuses, overpressure relief devices, over temperature cutoff, reverse current blocking diode, current limiting resistor, or other device determined to be acceptable by the PSWG and Range Safety. The following are examples of safety devices that should be incorporated into the lithium battery design: ***(1) The use of thermistors or fuses for each battery output.*** ***(2) Placement of internal diodes between each cell, unless proven by test that any single cell cannot be driven into reversal by the remaining cells.*** ***(3) The use of shunt diode protection for cells in series.*** ***(4) The use of blocking diodes for parallel rows of cells.***	**I**		
14.1.9.2.3. Each electrical safety device shall have a specific quality control program approved by the PSWG and Range Safety.	**Select Status**		
14.1.9.2.4. Safety critical steps and processes shall be identified during development for the manufacturing process. These points in manufacturing shall be reviewed by the appropriate local safety authorities identified by the PSWG and Range Safety and a determination made of what points require approval before change and what points the payload project can approve with just notification after the fact.	**Select Status**		
14.1.9.2.5. Batteries shall be designed not to create a catastrophic hazard even when the safety tests described in 14.4 are performed.	**Select Status**		
14.1.9.3. EGSE and Flight Hardware Lithium-ion Batteries. In addition to the other design and operational requirements of this publication, the following requirements are applicable to lithium-ion batteries used in flight hardware and EGSE.	**Select Status**		
The following Li-Ion system safety requirements are applicable to any flight hardware or aerospace ground support equipment (GSE) without UL or Mine Safety Appliances (MSA) approval for the cells, batteries, and battery chargers approved specifically for the cell pack used. ***The following Lithium-ion (Li-Ion) battery system safety requirements are not applicable to Li-Ion batteries used in UL or MSA-approved appliances that have Li Ion batteries as part of the certification. Examples include batteries that are in cell phones and computers.*** ***Lithium-ion battery designs should address requirements contained in RTCA DO-311, Minimum Operational Performance Standards for Rechargeable Lithium Battery Systems.***	**I**		
14.1.9.3.1. Charging and Discharging	**I**		
14.1.9.3.1.1. GSE used for charging and discharging shall prevent each cell from exceeding 4.4 volts or driving cells to less than 0 volts.	**Select Status**		

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14.1.9.3.1.2. The GSE used for charging and discharging shall be dual failure tolerant. ***Note: The requirements for charging and discharging are also applicable to any charging, power, or battery management activities such as current compensation, topping charge, constant current, constant voltage (CCCV) charging, etc. where a battery is in the same circuit as the external voltage and/or current source.*** ***Note: Individual cells that have an internal design which provides high rate discharge protection, (e.g., Positive Temperature Coefficient Devices and Internal Fuses) may be considered to already have one inhibit.***	**Select Status**		
14.1.9.3.1.3. Battery/cell monitoring and recording is required during charging and discharging. (1) Cell voltages shall be recorded at least every minute. For charge rates that exceed the battery capacity (i.e., if capacity is 1 Amp-Hour and charger is supplying greater than 1 Amp of current), record voltages every 10 seconds for charge rates between 1 and 2 times battery capacity and every second for charge rates that exceed 2 times battery capacity. (2) Data shall be reviewed for anomalies and verification of voltage limits real-time throughout charging or discharging activities.	**Select Status**		
14.1.9.3.1.4. Charging, monitoring, and recording EGSE shall be intrinsically safe if used within the Class I Division 1 or Division 2 areas and shall prevent high heat, sparking, and high charge/ discharge current rates.	**Select Status**		
14.1.9.3.1.5. Discharge shall not take place below -20C or above 60C.	**Select Status**		
14.1.9.3.2. Battery and Cell Case Design	**I**		
14.1.9.3.2.1. High pressure protection for cells is required. ***Note: Examples include burst disks and heat-sealed pouches.*** (1) Battery and cell case design shall have a minimum 3:1 burst pressure based on operating pressure. Note: The cell case operating pressures shall be defined based on normal use from beginning of cell life to design end of life. (2) Cell pressure relief devices shall be demonstrated by test to show that the vent operates as intended and that the vent is adequate to prevent cell fragmentation. (3) Battery case design/cell/cell pack integration shall not impede cell safe functional operation. Battery design shall accommodate the worst-case condition of cells within the battery experiencing internal pressure relief. The worst-case venting condition shall be demonstrated by test or analysis.	**Select Status**		
14.1.9.3.2.2. Batteries/cells shall be evaluated for toxic, reactive, flammable, and combustion materials. This evaluation shall include the products if the cell case vents. Fratricide of all cells in a pack will be assumed in this evaluation unless the design incorporates mechanical and thermal barriers between cells that are proven by test to prevent fratricide.	**Select Status**		

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14.1.9.3.3. Design Requirements for Li-Ion Batteries/Cells	**I**		
Table 14.2. Li-Ion Battery Maximum Operating Pressure (MOP) Clarification. In the case of small cell formats (e.g., 18650, 26650, 21700 cells), purchased in large cell lots and manufactured under specifically applicable consensus industry standards, MOP will be characterized as a quality within the context of that lot buy. If MOP is demonstrated to be a De Minimis quality for nominal cell operation, pressure specific items do not need to be addressed.	**I**		
14.1.9.3.3.1. Cell design shall have a minimum 1.5:1 burst pressure based on maximum venting pressure. The cell case shall demonstrate leak before burst characteristics. Cell burst pressure to vent pressure ratio may be tailored based on test qualification data showing consistent margin of system vent before reaching burst pressure.	**Select Status**		
14.1.9.3.3.2. Each cell and battery shall incorporate a safety-venting device or be designed and manufactured in such a manner that will preclude a violent rupture as a result of the cell venting. The design and construction of the integrated battery will not degrade or obstruct the vent.	**Select Status**		
14.1.9.3.4. Test Requirements for Li Ion Batteries/Cells.	**I**		
14.1.9.3.4.1. Battery/Cell Case LBB Failure Mode Qualification Testing.	**Select Status**		
14.1.9.3.4.1.1. Safety-venting shall be demonstrated by test to show that the venting operates as intended and that the vent is adequate to prevent cell/battery fragmentation. ***Recommended test is NAVSEA 9310 High Temperature Test.***	**Select Status**		
14.1.9.3.4.1.2. Qualification tests shall be conducted on flight quality batteries to demonstrate structural adequacy of the design.	**Select Status**		
14.1.9.3.4.1.3. Nondestructive inspection (NDI) techniques and methodologies shall be identified in the acceptance test plan. ***Microfocus X-ray technology may be an acceptable NDI technique to verify the integrity of the pressure relief mechanism.***	**Select Status**		
14.1.9.3.4.1.4. Qualification tests shall be conducted on flight quality batteries to ensure the battery can withstand grounds environments during transportation, storage and processing.	**Select Status**		
14.1.9.3.4.1.5. The Safety Data Package shall state lot testing specifications for safety venting device to be reviewed and approved by the PSWG and Range Safety.	**Select Status**		
14.1.9.3.4.1.6. Pressure testing. A pressure cycle test shall be conducted on battery cells. The peak pressure minimum shall be equal to the ground MOP of the battery cells during each cycle, and the number of cycles shall be a minimum of 4 times the predicted number of ground cycles or 50 cycles, whichever is greater. After the completion of the pressure cycle test, the pressure shall be increased to actual burst of the battery cell. This pressure test may be satisfied by life cycle testing.	**Select Status**		

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14.1.9.3.4.1.7. Cell Short Circuit Test.	I		
14.1.9.3.4.1.7.1. Simulating a battery short circuit failure mode, or if a pressure relief mechanism is not provided, case integrity shall be determined under conditions simulating a battery short circuit failure mode.	Select Status		
14.1.9.3.4.1.7.2. After all internal electrical safety devices have been bypassed, the battery shall be shorted, through a load of 0.1 ohms or less, leaving the load attached for not less than 24 hours or the cell case temperature has returned to ambient +/- 10° C.	Select Status		
14.1.9.3.4.1.7.3. Voltage, current, pressure, and temperature shall be continuously monitored and recorded.	Select Status		
14.1.9.3.5. Operational Requirements for Li Ion Batteries/Cells.	I		
14.1.9.3.5.1. Storage of the batteries (when not installed in GSE or Airborne hardware) shall be in approved battery storage locations.	Select Status		
14.1.9.3.5.2. Battery and cells shall be treated as always having a voltage potential; therefore, connection or disconnection of battery shall be considered an electrical personnel hazard and a "spark" potential.	Select Status		
14.1.9.3.5.3. Range users shall have an operational plan for battery/cell handling that includes emergency contingency operations for physical abuse incident and battery installation/removal.	Select Status		
14.1.9.3.5.4. Support equipment (ground or airborne) shall be verified to operate correctly prior to first operational use, including all failure tolerant devices or subsystems, prior to connecting battery. Verification shall include inducing overvoltage/under-voltage/temperature extremes to the monitoring devices as intended when in use prior to connecting of the battery.	Select Status		
14.1.9.3.5.5. Transportation to the launch site shall meet DOT requirements. When batteries are not incorporated into flight hardware, they shall meet the following: (1) Transported on publicly-accessed roadways, they shall not exceed 50 percent of rated charge. (2) When lithium content exceeds 8.0 grams per battery, transportation packaging of individual batteries shall have caution labels in accordance with 49 CFR 173.185.	Select Status		
14.1.9.3.5.6. Batteries that are transported incorporated into flight hardware shall be approved on a case-by-case basis.	Select Status		
14.1.9.3.5.7. External heating sources for battery/cell maintenance shall be dual fault tolerant and provide feedback monitoring capability or be analyzed for failure modes on cell/battery heating.	Select Status		
14.2. EGSE Design Requirements	I		
14.2.1. EGSE Design Standards. The following requirements supplement the requirements specified in the 14.1, NFPA 70, and the guidance provided in MIL-HDBK-454, Requirement 1.	Select Status		
14.2.2. EGSE Switches and Controls	I		
14.2.2.1. A main power switch shall be provided to cut off power to all circuits in the equipment. A power indicator light shall be provided. If fault isolation switches are incorporated, they shall not operate independently of the main power switch.	Select Status		

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14.2.2.2. Power switches shall be located so that accidental contact by personnel cannot place equipment in operation.	Select Status		
14.2.2.3. All switches and controls shall be clearly marked.	Select Status		
14.2.2.4. Switches and controls shall be sufficiently separated and protected if they could be inadvertently actuated, creating a hazardous condition.	Select Status		
14.2.2.5. Critical switches that can produce or induce hazardous conditions if inadvertently activated shall have a protective cover over them.	Select Status		
14.2.3. EGSE Circuit Protection	I		
14.2.3.1. Protective devices shall be provided for EGSE primary circuits.	Select Status		
Protective devices include fuses and circuit breakers that are suitable to provide overload/short circuit protection.	I		
14.2.3.2. Protective devices shall be connected to the load side of the main power switch unless neutral power sensing is essential for proper protection of the equipment.	Select Status		
14.2.3.3. Protection shall be provided in each of the three ungrounded conductors of all three-phase EGSE motors so that failure of one conductor shall result in de-energizing all three conductors.	Select Status		
14.2.3.4. All safety devices shall be located for easy access.	Select Status		
Safety devices include fuses, circuit breakers, resets, and others.	I		
14.2.3.5. Circuit breaker trips shall be detectable by visual inspection.	Select Status		
14.2.3.6. Replaceable components and test points shall be readily accessible.	Select Status		
14.2.3.7. Electrical fuse and switch boxes shall be properly marked to show the voltage present, rated fuse capacity, and EGSE that the circuit controls.	Select Status		
Outside marking should be made on enclosures to identify the existence of a safety protective device within the enclosure. The safety device rating should be marked on the outside or inside of the enclosure/switchbox.	I		
14.2.3.8. Each redundant EGSE circuit shall have its own circuit breaker or fuse.	Select Status		
14.2.3.9. Each circuit shall not have the capability to inhibit, by loss of control, more than one safety critical control device.	Select Status		
14.2.3.10. Megohm meters (Megger high voltage resistance meters) shall be current limited depending on application.	Select Status		

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Fuses or equivalent devices may be used as current limiting devices, as applicable.	I		
14.2.4. EGSE Cables. EGSE cables shall not share the same trench as propellant lines.	Select Status		
14.2.5. EGSE Batteries	I		
14.2.5.1. Sufficient ventilation shall be provided for EGSE batteries that produce flammable gasses to ensure concentrations of vapor do not reach 25 percent of the Lower Explosive Limit (LEL).	Select Status		
14.2.5.2. Polarity of EGSE battery terminals shall be marked.	Select Status		
14.2.6. EGSE Battery Charging Equipment	I		
14.2.6.1. Battery charging EGSE shall be current limited by design and shall provide protection and monitoring to prevent battery damage or failure.	Select Status		
For protection of the battery, the EGSE battery charging equipment charging rate should not be able to initiate or sustain a run-away failure of the battery. A temperature monitoring system should also be used in addition to other methods of charge control to protect the battery.	Select Status		
14.2.6.2. Analysis or testing shall be conducted to demonstrate compliance with the requirements of paragraph 14.2.6.1	Select Status		
14.2.7. Fixed and Portable EGSE in Hazardous Locations	I		
14.2.7.1. General. At a minimum, electrical equipment and its installation shall comply with the requirements of the most recent edition of the NFPA 70. The PSWG and Range Safety shall approve exceptions.	Select Status		
14.2.7.2. Definition of Hazardous (Classified) Locations. Hazardous (Classified) locations are defined in NEC Article 500, Hazardous (Classified) Locations. Definition of Hazardous (Classified) Locations. Hazardous (Classified) locations are defined in NFPA 70 Article 500, Hazardous (Classified) Locations.	Select Status		
14.2.7.3. Explosives and Propellants Not Covered in NEC Article 500. The following paragraphs define the minimum requirements to be applied in the definitions of locations in which explosives, pyrotechnics, or propellants are present or are expected to be present. These requirements shall be followed unless less stringent classifications are justified and approved as part of the design data submittal process. PSWG, Range Safety and local Fire Marshal shall approve all potential critical facility hazardous location designations.	Select Status		
14.2.7.3.1. Class I, Division 1. Complete definitions of classified locations are found in NFPA 70. These include the following locations:	I		
14.2.7.3.1.1. Within 25 feet of any vent opening unless the discharge is normally incinerated or scrubbed to nonflammable conditions [less than 25 percent of Lower Explosive Limit (LEL)]. This distance may be increased if the vent flow rate creates a flammability concern at a distance greater than 25 feet.	Select Status		

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14.2.7.3.1.2. Below grade locations in a Class I, Division 2 area.	Select Status		
14.2.7.3.1.3. Locations in which flammable liquids, vapors, or gases may be present in the air during normal operations.	Select Status		
14.2.7.3.1.4. Locations in which there is a credible risk that ignitable concentration of vapors or gases may be present in the air during abnormal operations due to a failure, leakage, or maintenance/repair.	Select Status		
14.2.7.3.2. Class I, Division 2. Complete definitions of classified locations are found in NFPA 70. These include the following locations:	I		
Class I, Division 2 usually includes locations where volatile flammable liquids or flammable gases or vapors are used but, in the judgment of the appropriate local safety authorities as identified by the PSWG and Range Safety and the local Fire Marshal, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of an accident, the adequacy of ventilating equipment, and the total area involved are all factors that merit consideration in determining the classification and extent of each location.	I		
14.2.7.3.2.1. Piping without valves, check valves, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Locations used for the storage of flammable liquids or of liquefied or compressed gases in sealed containers would not normally be considered hazardous unless also subject to other hazardous conditions.	Select Status		
14.2.7.3.2.2. As determined by the PSWG and Range Safety and the local Fire Marshal, locations may actively change classification depending on the flammable fluid system activity and configuration. For these types of locations, fixed or permanently installed electrical equipment shall be designed for the worst case hazardous environment.	Select Status		
14.2.7.3.2.3. Portable electrical equipment shall be designed for the worst case hazardous environment in which it will be used. Portable equipment that is not designated for use in a particular hazardous environment is not allowed in that environment.	Select Status		
14.2.7.3.2.4. Class I, Division 2 locations include the following equipment or areas:	Select Status		
14.2.7.3.2.4.1. Storage vessels (including carts and drums): 25 feet horizontally and below to grade and 4 feet vertically above the vessel (25 feet in any direction for hydrogen).	Select Status		
14.2.7.3.2.4.2. Transfer lines: 25 feet horizontally and below to grade and 4 feet above the line (25 feet in any direction for hydrogen).	Select Status		
14.2.7.3.2.4.3. Launch vehicle (liquid fueled vehicle, stage, or payload): 100 foot radius horizontally from and 25 feet vertically above (100 feet for hydrogen) the highest leak or vent source and below the vehicle to grade.	Select Status		
14.2.7.3.2.4.4. Enclosed locations such as rooms, work bays, and launch complex clean rooms that are used to store and handle flammable and combustible propellants when the concentration of vapors inside the room resulting from a release of all fluids stored and handled equals or exceeds the LEL. The quantity of fluids used in the analysis to determine vapor concentration shall be the maximum amount allowed in the explosives site plan.	Select Status		

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14.2.7.3.2.4.5. Locations adjacent to a Class I, Division 1 location into which ignitable concentrations of gases or vapors might occasionally be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.	Select Status		
14.2.7.3.3. Hazardous Commodity Groups. Hazardous commodities are grouped by similar characteristics.	Select Status		
14.2.7.3.3.1. These fuels shall be considered ignitable regardless of the ambient temperature.	Select Status		
14.2.7.3.3.2. The following fuels shall be categorized as follows:	Select Status		
14.2.7.3.3.2.1. Group B: Liquid or gaseous hydrogen.	Select Status		
14.2.7.3.3.2.2. Group C: Hypergolic propellant fuels such as N_2H_4, MMH, UDMH, A50.	Select Status		
14.2.7.3.3.2.3. Group D: Hydrocarbon fuels (RP and JP).	Select Status		
14.2.7.3.3.2.4. Group D: Oxidizers. Oxidizers shall be considered Group D hazardous substances in addition to the fluids listed in NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.	Select Status		
14.2.7.3.3.2.5. Exposed Solid Propellants. The atmosphere within 10 feet horizontally and directly overhead of exposed solid propellant shall be classified as a Class I, Division 2, Group D location. Solid rocket motors are considered exposed in the following situations:	Select Status		
14.2.7.3.3.2.5.1. The motor nozzle is not attached, and the aft end of the motor does not have a cover.	Select Status		
14.2.7.3.3.2.5.2. The motor nozzle is attached but does not have a nozzle plug.	Select Status		
14.2.7.3.3.2.5.3. The unassembled motor segments do not have front and rear covers.	Select Status		
14.2.7.3.3.2.5.4. The igniter is removed from the motor and cover is not provided.	Select Status		
14.2.7.4. Electrical Systems and Equipment Hazard Proofing. Electrical systems and equipment used in hazardous locations shall be designed and listed for the locations in accordance with the following requirements:	Select Status		
14.2.7.4.1. Explosion proof apparatus shall meet the requirements of NFPA 70, Article 501 for Class I, Division 1 or Division 2, and shall be listed and labeled by a nationally recognized testing laboratory per 29 CFR 1910.7, *Definition and Requirements for a Nationally Recognized Testing Laboratory*.	Select Status		
14.2.7.4.2. Non-incendive apparatus shall meet the requirements of NFPA 70, Article 501 and are restricted to installations in Class I, Division 2 locations only. They shall be listed and labeled by a nationally recognized testing laboratory such as UL, FM, or those accredited by OSHA under the Nationally Recognized Testing Laboratory (NRTL) accreditation program, 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.	Select Status		

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14.2.7.4.3. Intrinsically safe equipment and systems intended for Class I, Division 1 or Division 2 locations shall meet the requirements of the NEC Article 504, Intrinsically Safe Systems, and UL 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous Areas, and be listed and labeled by a nationally recognized laboratory such as UL, FM, or those accredited by 29 CFR 1910.7.	Select Status		
14.2.7.4.4. The use of purged and pressurized electrical enclosures, designed in accordance with NFPA 496, Purges and Pressurized Enclosures for Electrical Equipment, for the purpose of eliminating or reducing the hazardous location classification as defined in NFPA, Article 500 is acceptable with the following additional requirements:	Select Status		
For example, a fueled payload flight hardware liquid propulsion system would normally result in the classification of a location as Class I, Division 2, Zone 2. Type Z Pressurizing of the protected enclosure of the EGSE is normally adequate to reduce the area to an unclassified location as specified in NFPA 496.	I		
14.2.7.4.4.1. The purged and pressurized enclosure shall be maintained at a nominal 1/2 inch of water. In no case shall the pressure in the enclosures be less than 1/10 inch of water.	Select Status		
14.2.7.4.4.2. Rooms into which unprotected personnel may enter shall be purged with air only.	Select Status		
14.2.7.4.4.3. Purged rooms and enclosures shall be provided with an audible alarm set to trigger when the pressure drops below 1/4 inch water. The alarm shall be at a constantly attended location. The alarm trigger shall monitor the purged enclosure and not the purge gas supply.	Select Status		
Instrument quality air is preferred over other protective non-flammable gases such as nitrogen. Purged systems that use other media may require compliance to confined space or potentially oxygen deficient atmosphere requirements due to asphyxiation hazards.	I		
14.2.7.4.4.4. Protective gas supplies shall be free of flammable vapor or gas and designed to prevent contaminants from entering system.	Select Status		
14.2.7.4.4.5. Purge supply lines shall be constructed of noncombustible material, designed to prevent migration of flammable gas, dust or vapor into the protective gas.	Select Status		
14.2.7.4.5. Equipment inspected and tested to other government standards such as MIL-STD-810, Environmental Engineering Considerations and Laboratory Testing, may be used if approved by the PSWG and Range Safety.	Select Status		
14.3. Electrical and Electronic Flight Hardware	I		
14.3.1. Electrical and Electronic Flight Hardware Design Standards. To prevent payloads from igniting a flammable atmosphere that may result from a fuel leak during dynamic operations (e.g., fueling, spin tests, lifts, transport, other payload movements), airborne electrical and electronic equipment shall be designed to meet the intent of NFPA 70, Article 501, Class I Locations, to the maximum extent possible.	Select Status		

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The preferred method for providing payload electrical safety during fueling and other dynamic operations is to power down the payload in a manner that restricts current from flowing to payload electrical systems.	**I**		
14.3.2. Flight Hardware Electromechanical Initiating Devices and Systems	**I**		
14.3.2.1. Electromechanical initiating devices and systems shall be evaluated to determine associated ordnance hazard classification.	**Select Status**		
Electromechanical initiating devices and systems, including nonexplosive initiators (NEIs), are used for such purposes as structure deployment or actuation release mechanisms.	**I**		
14.3.2.2. Design, test, and data requirements shall be determined by the PSWG and Range Safety on a case-by-case basis.	**Select Status**		
14.3.2.3. At a minimum, the system safety failure tolerances described in Chapter 3 of this volume and the initiating ordnance design requirements shall be addressed.	**Select Status**		
14.3.3. Flight Hardware Batteries	**I**		
14.3.3.1. Flight battery cases shall be designed to an ultimate safety factor of 3 to l with respect to worst case pressure buildup for normal operations. For flight hardware batteries with LBB failure modes, 12.4.1.1 (factor of safety of 1.5) applies.	**Select Status**		
14.3.3.1.1. This pressure buildup shall consider hydraulic and temperature extremes.	**Select Status**		
14.3.3.1.2. Batteries that have chemically limited pressure increases and whose battery/cell case can be designed to withstand worst case pressure buildup in abnormal conditions can reduce the safety factor to 2:1 (ultimate) and 1.5:1 (yield). Lower factors of safety determined by PSWG and Range Safety approved analysis can be used on a case-by-case basis.	**Select Status**		
Batteries that have nickel hydrogen chemistries are examples of batteries that have chemically limited pressure increases. Examples of abnormal conditions are direct short and extreme temperatures. PSWG and Range Safety approved analyses include fracture mechanics that can be used on a case-by-case basis.	**I**		
14.3.3.2. Sealed batteries shall have pressure relief capability unless the battery case is designed to a safety factor of at least 3 to 1 based on worst case internal pressure.	**Select Status**		
14.3.3.2.1. Pressure relief devices shall be set to operate at a maximum of 1.5 times the operating pressure and sized so that the resulting maximum stress of the case does not exceed the yield strength of the case material.	**Select Status**		
14.3.3.2.2. Nickel-hydrogen batteries and/or cells that are proven by test to withstand worst case pressure buildup in abnormal conditions (such as direct short and thermal extremes that can be experienced when installed with no reliance on external controls such as heaters and air conditioning) are not required to have pressure relief capability.	**Select Status**		

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14.3.3. Flight Hardware Batteries with LBB (Leak Before Burst) Failure Mode. The battery cells shall be demonstrated to have a LBB failure mode per 12.2.2; and when sealed battery cases are used, they shall also be demonstrated to have a LBB failure mode. If a cell case design incorporates no pressure relief devices and cell leakage is determined to be a catastrophic hazard, the cell case shall be demonstrated to comply with the Hazardous LBB requirements per 12.2.3 of this volume.	Select Status		
14.3.3.3.1. Flight Hardware Batteries with LBB Failure Mode Factor of Safety. Unless otherwise specified, and approved by the PSWG and Range Safety, flight battery cells and cases shall be designed to an ultimate safety factor of 3:1 with respect to the worst case pressure buildup for normal operations.	Select Status		
14.3.3.3.2. Flight Hardware Batteries with LBB Failure Mode Fatigue-Life Demonstration. In addition to the stress analysis conducted in accordance with the requirements of 12.1.5.3, a conventional fatigue-life analysis shall be performed, as appropriate, on the unflawed structure to ascertain that the pressure vessel, acted upon by the spectra of operating loads, pressures and environments, meets the life requirements.	Select Status		
14.3.3.3.2.1. A life factor of 5 shall be used in the analysis.	Select Status		
14.3.3.3.2.2. Testing of unflawed specimens to demonstrate fatigue-life of a specific pressure vessel together with stress analysis is an acceptable alternative to fatigue test of the vessel.	Select Status		
14.3.3.3.2.3. Fatigue-life requirements are considered demonstrated when the unflawed specimens that represent critical areas such as membrane section, weld joints, heat-affected zone, and boss transition section successfully sustain the limit loads and MOP in the expected operating environments for the specified test duration without rupture.	Select Status		
14.3.3.3.2.4. The required test duration is 4 times the specified service life.	Select Status		
14.3.3.3.3. Flight Hardware Batteries with LBB Failure Mode Qualification Testing	Select Status		
14.3.3.3.3.1. Qualification tests shall be conducted on flight quality batteries to demonstrate structural adequacy of the design.	Select Status		
14.3.3.3.3.2. The following tests are required.	I		
14.3.3.3.3.2.1. Random Vibration Testing. Random vibration testing shall be performed on batteries per the requirements of SMC-S-016 as tailored.	Select Status		
14.3.3.3.3.2.2. Thermal Vacuum Testing. Thermal vacuum test shall be performed on batteries per requirements of SMC-S-016 as tailored.	Select Status		
14.3.3.3.3.2.3. Pressure Testing. A pressure cycle test shall be conducted on battery cells. The peak pressure shall be equal to the MOP of the battery cells during each cycle, and the number of cycles shall be 4 times the predicted number of operating cycles or 50 cycles, whichever is greater. After the completion of the pressure cycle test, the pressure shall be increased to actual burst of the battery cell. The actual burst pressure shall be greater than or equal to 1.5 times MOP of the battery cell. For batteries having sealed cases, similar tests shall be conducted on the sealed cases, if applicable.	Select Status		

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14.3.3.3.4. Flight Hardware Batteries with LBB Failure Mode Acceptance Test Requirements	**Select Status**		
14.3.3.3.4.1. Acceptance tests shall be conducted on batteries before being committed to flight.	**Select Status**		
14.3.3.3.4.2. The following tests are required:	**I**		
14.3.3.3.4.2.1. Proof Pressure Test. Whenever feasible, battery cells shall be proof pressure tested to 1.25 times the MOP of the cells. For sealed battery cases, pressure tests shall be performed at a level of 1.25 times the MOP of the cases.	**Select Status**		
14.3.3.3.4.2.2. Nondestructive Inspection. Surface and volumetric NDE techniques shall be performed after the proof pressure test.	**Select Status**		
14.3.3.3.5. Flight Hardware Batteries with LBB Failure Mode Recertification Test Requirements	**I**		
14.3.3.3.5.1. All refurbished pressure vessels shall be recertified after each refurbishment by the acceptance test requirements for new hardware to verify their structural integrity and to establish their suitability for continued service before commitment to flight.	**Select Status**		
14.3.3.3.5.2. Pressure vessels that have exceeded the approved storage environment (temperature, humidity, time, and others) shall also be recertified by the acceptance test requirements for new hardware.	**Select Status**		
14.3.3.3.6. Flight Hardware Batteries with LBB Failure Mode Special Requirements. Batteries shall be designed such that battery cells are within containment devices (or cases). These containment devices (or cases) shall be demonstrated to be able to prevent the escape of any hazardous contents over an insignificant quantity deemed acceptable by the procuring and safety agencies.	**Select Status**		
14.3.3.4. Flight Hardware Batteries with Brittle Fracture Failure Mode	**I**		
14.3.3.4.1. Batteries with battery cells exhibiting brittle fracture failure mode shall meet the requirements defined in 12.2.3.	**Select Status**		
14.3.3.4.2. In addition, a thermal vacuum test shall be conducted as part of the qualification testing.	**Select Status**		
14.4. Test Requirements for Lithium Batteries.	**I**		
Li-Ion battery safety see section 14.1.9.3	**I**		
Detailed design, analysis, and test requirements for batteries, which are classified as special pressurized equipment, are described below, and shall meet the requirements of ANSI/AIAA S-080.	**I**		
Table 14.5. Lithium Batteries.	**I**		

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Lithium batteries are thermal batteries, also called molten salt batteries. Lithium batteries are different from Li-ion batteries, even though they both contain the element Lithium. Lithium batteries are primary cell batteries, that is, batteries where the electrochemical reaction is not reversible. Lithium batteries are non-rechargeable.	I		
14.4.1. Unless otherwise agreed to by PSWG and Range Safety, the following tests shall be performed before the use or storage of lithium batteries at a NASA facility or the payload processing facility and launch site area. These tests are likely to cause violent reactions, so all possible safety precautions shall be observed.	Select Status		
Batteries that have a UL listing and are intended for public use are exempt from these requirements.	I		
14.4.2. Lithium Battery Constant Current Discharge and Reversal Test	I		
14.4.2.1. The constant current discharge and reversal test shall determine if the pressure relief mechanism functions properly or case integrity is sustained under circumstances simulating a high rate of discharge.	Select Status		
14.4.2.2. The test shall be performed according to the following criteria:	Select Status		
14.4.2.2.1. The test shall consist of a constant current discharge using a DC power supply.	Select Status		
14.4.2.2.2. The fusing of the battery shall be bypassed (shorted).	Select Status		
14.4.2.2.3. The discharge shall be performed at a level equal to the battery fuse current rating and the voltage of the battery.	Select Status		
14.4.2.2.4. After the battery voltage reaches 0 volts, the discharge shall be continued into voltage reversal at the same current for a time equivalent to l.5 times the stated ampere-hour capacity of the battery pack.	Select Status		
14.4.2.2.5. Voltage, pressure, and temperature shall be continuously monitored and recorded.	Select Status		
14.4.3. Lithium Battery Short Circuit Test	I		
14.4.3.1. The short circuit test shall determine if the pressure relief mechanism functions properly under conditions simulating a battery short circuit failure mode; or if a pressure relief mechanism is not provided, case integrity shall be determined under conditions simulating a battery short circuit failure mode.	Select Status		
14.4.3.2. The test shall be performed according to the following criteria:	Select Status		
14.4.3.2.1. After all internal electrical safety devices have been bypassed, the battery shall be shorted, through a load of 0.0l ohms or less, leaving the load attached for not less than 24 hours.	Select Status		
14.4.3.2.2. Voltage, current, pressure, and temperature shall be continuously monitored and recorded.	Select Status		
14.4.4. Lithium Battery Drop Test. A drop test shall be performed according to the following criteria:	Select Status		

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Other tests may be required by the PSWG and Range Safety depending upon design, storage, operating environments, and other criteria. If required, additional tests shall be identified by the PSWG and Range Safety. Manufacturing lot acceptance tests may be required of safety devices in the battery design to ensure safety critical functions have not been altered.	**I**		
14.4.4.1. The battery in the activated state shall be dropped from a 3-foot height to a concrete pad on the edge of the battery, on the corner of the battery, and on the terminals of the battery.	**Select Status**		
14.4.4.2. The battery shall not vent or start a hazardous event when dropped.	**Select Status**		
14.4.4.3. A physical analysis shall be performed after the drop test to determine what handling procedures are required to safely dispose of the batteries if dropped at the payload processing facility and launch site area.	**Select Status**		
14.5. Electrical and Electronic Equipment Data Requirements. EGSE data shall be submitted in accordance with the requirements of Attachment 1, A1.2.5.10 of this volume.	**Select Status**		

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CHAPTER 15 MOTOR VEHICLES	I		
15.1. General	I		
15.1.1. This chapter applies to payload project provided motor vehicle under their responsibility (e.g., leased, rented, etc.). For purposes of this chapter, the term motor vehicles encompass conventional trucks, truck-tractors, trailers, tankers, and lift trucks and special-purpose trailers intended for exclusive use on the payload processing facility and launch site area and/or the range.	Select Status		
15.1.2. These design, test, and documentation requirements apply to motor vehicles used for general purposes and to transport critical hardware or bulk hazardous materials such as toxics, flammables, combustibles and explosives, and hazardous commodities at payload processing facility and launch site area, on range roads and tracks.	Select Status		
15.1.3. Hazardous commodities not listed in NFPA 497 shall be evaluated by the PSWG and Range Safety for appropriate hazard classification on a case-by-case basis.	Select Status		
15.2. Motor Vehicles Other Than Lift Trucks	I		
15.2.1. General Design Standards	I		
15.2.1.1. Motor vehicles that do not meet DOT public transportation requirements shall not be permitted to transport hazardous materials at the payload processing facility and launch site area unless the vehicle is covered by a formal DOT exemption and is approved by the PSWG and Range Safety. Motor vehicles shall also comply with state and municipal regulations.	Select Status		
15.2.1.2. Motor vehicles for the transport of explosives shall conform to DESR 6055.09_AFMAN 91-201, Explosive Safety Standards when on Air Force property, and NASA-STD-8719.12 when on NASA property.	Select Status		
15.2.1.3. Special-purpose trailers for range use only shall conform to DESR 6055.09_AFMAN 91-201, Explosive Safety Standards.	Select Status		
15.2.1.4. If the motor vehicle does not meet DOT and DoD requirements, the following data shall be submitted by the payload project before using the vehicles at the payload processing facility and launch site area:	Select Status		
15.2.1.4.1. Design, test, and NDE inspection requirements for vehicles.	Select Status		
15.2.1.4.2. FMECA in accordance with MIL-STD-882 or equivalent on selected applications.	Select Status		
15.2.1.4.3. Engineering documentation such as analyses (performance, stress, SFPs), tests, and inspections that justifies acceptance of DOT noncompliances based on “equivalent safety” or “meets DOT intent” criteria.	Select Status		
15.2.2. Special-Purpose Trailers Used to Transport Critical or Hazardous Loads Design Requirements:	Select Status		

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15.2.2.1. Trailers and their ancillary support equipment such as outriggers and support stands shall be designed with a yield factor of safety of at least 2 based on limits loads and material minimum yield strength and 1.5 against overturning at worst case conditions expected over the transit route.	Select Status		
15.2.2.2. Load test tags shall be attached to the trailer and marked with the following minimum information:	Select Status		
15.2.2.2.1. Part number.	Select Status		
15.2.2.2.2. Date and weight of most recent load test (or date of next load test).	Select Status		
15.2.2.2.3. Rated load.	Select Status		
15.2.2.2.4. Date of most recent NDE (or date of next NDE).	Select Status		
15.2.3. Special-Purpose Trailers Used to Transport Critical or Hazardous Loads Tests:	Select Status		
15.2.3.1. Initial Tests. At a minimum, the following tests shall be performed before first operational use at the payload processing facility and launch site area:	Select Status		
15.2.3.1.1. Road/load test at 125 percent rated load at typical terrain and design speeds for selected applications.	Select Status		
15.2.3.1.2. Volumetric and surface NDE shall be performed on all SFP components and SFP welds and 10 percent of non-SFP welds located in the load path before and after the road/load test.	Select Status		
15.2.3.2. Periodic Tests. A periodic road/load test at 100 percent rated load shall be performed on trailers used to transport flight hardware (hazardous or non-hazardous) on the ranges every 4 years, with SFP weld inspection limited to surface NDE. Unless otherwise agreed to by the PSWG and Range Safety, the initial road/load test shall also be performed after a trailer has experienced structural modification or repair.	Select Status		
15.2.4. Motor Vehicles Used to Transport Critical or Hazardous Loads Data Requirements. Initial and recurring data requirements shall be submitted in accordance with the requirements of Attachment 1, A1.2.5.17 of this volume.	Select Status		
15.3. Lift Trucks	I		
15.3.1. Lift Truck Standards	I		
15.3.1.1. Lift trucks shall be in accordance with NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation and UL 583, UL Standard for Safety Electric-Battery-Powered Industrial Trucks.	Select Status		
15.3.1.2. Lift trucks to be used in locations classified as hazardous by the NEC Article 500 shall meet the requirements of NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation. Replacement tires and other components shall be those approved for the specific application and/or environment.	Select Status		

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Battery powered equipment and its use shall comply with OSHA and NFPA standards. Type EX rated battery powered equipment is the only equipment approved for use in specifically named Class I, Group D or Class II, Group G hazardous locations.	**I**		
15.3.1.3. Lift trucks used to transport explosives and propellants or operate in explosive and propellant locations shall also meet the requirements of NASA-STD-8719.12, and DESR 6055.09_AFMAN 91-201, Explosive Safety Standards.	**Select Status**		
15.3.2. Lift Truck General Design Requirements	**Select Status**		
15.3.2.1. Lift trucks shall be equipped with shoulder-high Range Safety seats with seatbelts.	**Select Status**		
15.3.2.2. Personnel platforms attached to lift trucks shall be designed and tested in accordance with 6.4 of this volume.	**Select Status**		
15.3.2.3. Critical loads shall not exceed 75 percent of the lift truck rated capacity.	**Select Status**		
15.3.3. Lift Truck Tests. Lift trucks shall be tested in accordance with ASME B56 Series Safety Standards, NFPA 505 and UL 583.	**Select Status**		
15.3.4. Lift Truck Data Requirements. Initial and recurring data requirements shall be submitted in accordance with the requirements of Attachment 1, A1.2.5.17 of this volume.	**Select Status**		

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CHAPTER 16 COMPUTER SYSTEMS AND SOFTWARE	I		
16.1. General	I		
16.1.1. NPR 7150.2, NASA Software Engineering Requirements, provides requirements for project computer systems and software. The payload project shall follow the requirements of NASA-STD-8739.8, Software Assurance and Safety Standard, for project computer systems and software. The requirements for computer systems and software that are used to control and/or monitor operations identified as safety critical are described in NASA-STD-8739.8 and below. The term software, as used in this publication, includes firmware and software that is executed on processors in operations within complex electronics. Software requirements do not apply to the design or hardware description language for complex electronic devices. Firmware is software stored in nonvolatile memory and it does not represent complex electronic devices.	Select Status		
Complex electronics encompasses programmable and designable complex integrated circuits. "Programmable" logic devices can be programmed by the user and range from simple chips to complex devices capable of being programmed on-the-fly. "Designable" logic devices are integrated circuits that can be designed but not programmed by the user.	I		
These requirements are not intended to be used as a checklist; instead, they are to be used in conjunction with safety analyses performed in accordance with applicable standards and directives.	I		
16.1.2. The requirements shall be tailored to the system or system type under development. Unless specifically excluded by the PSWG and Range Safety, these requirements shall apply to all computer systems and subsystems that perform safety critical functions during the assembly, handling, checkout, test, and launch of payloads.	Select Status		
These systems and subsystems include ground support equipment (such as test equipment, battery charging/monitoring equipment), and spaceflight hardware systems supplied by the payload project. The payload project should assess all such equipment for possible safety critical computer system functions in software and firmware use.	I		
16.1.3. In addition to contractor-developed computer systems and software, these requirements shall apply to programmable logic controllers (PLCs), firmware such as erasable programmable read only memory (EPROM), commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) products, and reused code. These requirements shall apply to software that is executed on processors (where applicable) on Complex Programmable Logic Devices (CPLDs), Field Programmable Gate Arrays (FPGAs), Application Specific Integrated Circuits (ASICs), and System on a Chip (SOC) applications, but not to the devices themselves or the hardware description language logic or text.	Select Status		

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Table 16.1. Firmware, COTS, GOTS and Reused Software. ***Chapter 16, in its entirety, applies to all forms of software and firmware; however, special attention should be paid to the following:*** ***(1) EPROMs or EEPROMs should contain unique version identifiers and be validated via checksum or some other method before installation and use.*** ***(2) COTS, GOTS, and re-use software should be examined and evaluated as to their appropriateness for the intended new use. Unused portions of re-use software should be removed.***	I		
16.1.4. Software shall be classified, designed, developed, tested, and assessed for risk in accordance with MIL-STD-882, which in turn references the Joint Software Systems Safety Engineering Handbook (JSSSEH) for further details. Joint Services – Software Safety Authorities Software System Safety – Implementation Process and Tasks Supporting MIL-STD-882 (JS-SSA-IG), provides implementation details and options for how developers can take the requirements of MIL-STD-882 and the guidance of the JSSEH to define processes and tasks required for a compliant software safety program. Software design, development and testing shall be conducted according to a software safety plan which is integrated into the overall system safety plan.	Select Status		
16.2. Determination of Safety Critical Computer System Functions	I		
The payload project shall perform reliability and hazard analysis to identify all safety critical software and Safety Critical Computer Systems Functions (SCCSFs) in accordance with NASA-STD-8739.8, Software Assurance and Software Safety Standard, and the provisions of this document.	Select Status		
It is recommended that SCCSFs be identified and agreed to by the PSWG and Range Safety very early in the program along with detailed documentation for each.	I		
16.2.1. The payload project shall identify all of the following:	Select Status		
16.2.1.1. All software contributions to system hazards. Safety-significant functions shall be positively identified in hardware, software, and firmware domains.	Select Status		
Table 16.2. Safety Significant Software Functions. ***Safety-significant is a term applied to a condition, event, operation, process, or item that is identified as either safety-critical or safety-related. Safety-critical applies when the mishap severity consequence is either catastrophic or critical, and safety-related applies when the mishap severity consequence is either marginal or negligible. It is recommended that safety critical functions (SCF) be identified and agreed to by PSWG and Range Safety very early in the program along with detailed documentation. SCFs are defined as any computer system function that,*** ***(1) if not performed, (2) if performed out of sequence, or (3) if performed incorrectly, may directly or indirectly cause a safety hazard to exist.***	I		

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16.2.1.2. The safety requirements associated with safety-significant software components and safety-related items.	Select Status		
16.2.1.3. All safety-critical functions, which include, but are not necessarily limited to:	Select Status		
16.2.1.3.1. Software used to control and/or monitor safety critical systems.	Select Status		
16.2.1.3.2. Software used for fault detection in safety critical computer hardware or software.	Select Status		
16.2.1.3.3. Software used to transmit safety critical data, including time-critical data and data about hazardous conditions.	Select Status		
16.2.1.3.4. Software that responds to the detection of a safety critical fault.	Select Status		
16.2.1.3.5. FTS Software.	Select Status		
16.2.1.3.6. Software that computes safety critical data.	Select Status		
16.2.1.3.7. Software used to access safety critical data.	Select Status		
16.2.1.3.8. Processor interrupt software associated with previously designated safety critical computer system functions.	Select Status		
16.2.1.4. The mapping to the architecture, interfaces, and designs of safety-significant functions.	Select Status		
16.2.1.5. The identification of the software assurance process as it relates to developing safe software using a software control category (SCC), software safety criticality level, and level of rigor (LOR) approach to software development and testing.	Select Status		
16.2.1.6. The identification of how defined safety-significant functions possess the appropriate integrity within the design (as defined by the level of rigor tasks) for fault detection, isolation, annunciation, tolerance, and recovery.	Select Status		
16.2.2. Safety-significant software functions (SSSF) shall be assigned a software criticality index (SwCI) based on severity and SCC, as outlined in MIL-STD-882, Table V – Software Safety Criticality Matrix. Derivation of criticality shall be based on both requirements and concept of operations.	Select Status		
It is recommended that SwCI 1 software functions be avoided and that additional levels of protection be implemented as a preferred means of hazard mitigation strategy. At SwCI 3 or above, configuration control must apply to the smallest compiled module or unit.	I		
16.2.3. Application of LOR shall be based on SwCI in accordance with Appendix A of the JS-SSA-IG, as tailored by the program. Appendix A LOR requirements specify minimum design, analysis, development, test, inspection, and data requirements for safety software. Single-point failure analysis shall account for potential system failures due to software and its interaction with other software components, hardware components, and human components of the system.	Select Status		

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Table 16.3. Level of Rigor (LOR)Lessons Learned. ***Failure to achieve all LOR requirements will result in safety program requirements to re-assess risk with missing or deficient artifacts or processes. Failure to achieve all LOR requirements does not mean increased risk but unknown uncharacterized software behavior that may increase safety risk.*** ***If the safety system is susceptible to security vulnerabilities, then consultation with security personnel may be warranted to discuss the security concerns during the planning phase and tailoring. If security implementations would adversely affect personnel or public safety, preference must be given to the safety software.***	I		
16.3. Hardware and Software Safety Design Requirements	I		
16.3.1. Computer Systems. The following subparagraphs identify general hardware that shall be met for all safety critical computer system functions.	I		
16.3.1.1. Computer systems shall be validated for operation in the intended environment.	Select Status		
Validation of central processing unit (CPU) functionality should be based on testing.	I		
16.3.1.2. Under maximum system loads, CPU throughput shall not exceed 80 percent of its design value.	Select Status		
Although CPU throughput of 80 percent is acceptable, experience has shown that a value of 70 percent is desirable.	I		
16.3.1.3. Computer system architecture shall be single fault tolerant.	Select Status		
16.3.1.3.1. No single software failure/output shall initiate a hazardous operation.	Select Status		
Safety will also be enhanced if the system is designed so that memory locations not intended to be used during a particular operation will tend to bring the system to a safe or stable state if inadvertently executed.	I		
16.3.1.3.2. No single software failure/output shall cause a critical accident.	Select Status		
16.3.1.3.3. No single or double software failure/output shall cause a catastrophic accident.	Select Status		
16.3.1.3.4. Fulfilling the following requirements in addition to the other requirements in Chapter 16 shall constitute meeting the computer system requirements in 16.3.1.3.1 through 16.3.1.3.3 above. The payload project shall identify and provide the following items to the PSWG and Range Safety:	Select Status		
16.3.1.3.4.1. All hazardous operations that can be triggered by software, either intentionally or unintentionally.	Select Status		
16.3.1.3.4.2. All critical accidents that can be triggered by software.	Select Status		
16.3.1.3.4.3. Catastrophic accidents that can be triggered by software.	Select Status		

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16.3.1.3.4.4. Scenarios where a single software failure/output can create a condition that can trigger a hazardous operation or critical accident. Consideration shall be given to data integrity, memory use, timeliness and correct sequencing of data, and situations where the interaction of modules, hardware, software, and/or users may be problematic.	Select Status		
16.3.1.3.4.5. Scenarios where a single or double software failure/output can produce a condition that can trigger a catastrophic accident.	Select Status		
16.3.1.3.4.6. Analyses and test reports that verify the capability to monitor the system during runtime to ensure the faulty conditions are corrected.	Select Status		
16.3.1.4. Safety critical computer system function flight architecture that will be exposed to cosmic radiation shall protect against CPU single event upset (SEU) and other single event effects (SEE). An SEU occurs when an energetic particle travels through a transistor substrate and causes electrical signals within the transistor.	Select Status		
SEUs can be protected against through redundancy, error correcting memory, voting between parallel CPUs, or other approved approaches.	I		
16.3.1.5. Sensitive components of computer systems shall be protected against the harmful effects of electromagnetic radiation and/or electrostatic discharge.	Select Status		
16.3.1.6. The computer system shall periodically verify that safety critical hardware and SCCSF, including safety data transmission, are operating correctly, as agreed to by the PSWG and Range Safety.	Select Status		
16.3.2. Computer System Power	I		
16.3.2.1. Computer systems shall be powered up and/or restarted in a safe state.	Select Status		
16.3.2.2. A computer system shall not enter a hazardous state as a result of an intermittent power transient or fluctuation.	Select Status		
16.3.2.3. In the event of the single failure of primary power to a computer system or computer system component, that system or some cooperating system shall take action automatically to transition to a stable state.	Select Status		
In the context of response to failure or retreat from some unsafe state, a stable state is the safest possible state that can be achieved without causing a more hazardous state to occur during that transition.	I		
16.3.2.4. Software used to power up safety critical systems shall power up the required systems in a safe state.	Select Status		
16.3.3. Computer System Anomaly and Failure Detection	I		

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Table 16.4. Anomaly and Failure Detection Alerts. ***In addition to those anomalies listed, software should be designed to alert appropriate operators to such things as:*** ***(1) CPU running at greater than 80 percent of specified load.*** ***(2) Pending memory overflow.*** ***(3) Pending buffer overflows.***	**I**		
16.3.3.1. Before initiating hazardous operations, computer systems shall perform checks to ensure that they are in a safe state and functioning properly. These checks include checking safety critical circuits, components, inhibits, interlocks, exception limits, safing logic, memory integrity, and program loads.	**Select Status**		
16.3.3.2. The following hazardous conditions and failures, including those from multiple sources, shall be detected:	**Select Status**		
16.3.3.2.1. Invalid input - data or sequences of data passed to software modules, either by human input, other software modules, or environmental sensors, that are outside a specified range for safe operation.	**Select Status**		
16.3.3.2.2. Invalid output - data output from software modules that are outside a specified range for safe operation.	**Select Status**		
16.3.3.2.3. Timing errors - the state when software-timed events do not happen according to specification.	**Select Status**		
16.3.3.2.4. Data transmission errors.	**Select Status**		
16.3.3.2.5. Loss of memory integrity.	**Select Status**		
16.3.3.2.6. Greater than allowed safe input data rates.	**Select Status**		
16.3.3.2.7. The existence of an invalid pattern regardless of its storage location.	**Select Status**		
16.3.3.2.8. Software exceptions, such as “divide by zero” or “file not found.”	**Select Status**		
16.3.3.2.9. Data transfer messages corrupted or not in the proper format.	**Select Status**		
16.3.4. Computer System Anomaly and Failure Response	**I**		
16.3.4.1. All events mentioned in 16.3.3 shall be reported to the appropriate system operator consoles in real time, prioritized as to severity, and logged to an audit file.	**Select Status**		
Table 16.5. Safety Critical Function (SCF) Display Alerts. ***Displays that support SCCSFs can vary widely but every attempt should be made to ensure that the operators are alerted to the most important anomalies. A method of prioritization is necessary. For example, anomalies of the same priority should be grouped together; all warnings displayed first, cautions next, and advisories last. The most recent anomaly should be displayed at the top of the priority subgroup. Details of each anomaly should be accessible with a single operator action.***	**I**		

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16.3.4.1.1. The display shall distinguish between read and unread anomaly alerts.	Select Status		
16.3.4.1.2. The display shall support reporting multiple anomalies.	Select Status		
16.3.4.1.3. The display shall distinguish between anomaly alerts for which corrective action has been taken and those that are still pending.	Select Status		
16.3.4.2. Upon detecting an event described in 16.3.3, the software shall remain in or revert to a stable state.	Select Status		
16.3.4.3. For payloads with a FTS, upon detecting a failure during processing, the software shall maintain the FTS in its current state in addition to meeting the requirements in 16.3.4.1 and 16.3.4.2 above.	Select Status		
16.3.4.3.1. The software shall maintain the FTS in the safe state before arming.	Select Status		
16.3.4.3.2. After the FTS is armed, the software shall retain the FTS in the armed state.	Select Status		
16.3.4.3.3. When the FTS receiver is on internal power, the software shall maintain the FTS receiver on internal power.	Select Status		
16.3.4.3.4. During flight, all detected FTS-related system errors shall be transmitted to the range.	Select Status		
16.3.5. Computer System Testing and Maintenance	I		
16.3.5.1. Non-operational hardware and software required for testing or maintenance shall be clearly identified.	Select Status		
16.3.5.2. Systems shall include interlocks, as necessary, to mitigate hazards when performing maintenance or testing.	Select Status		
16.3.5.3. Interlocks shall be designed to prevent an inadvertent override.	Select Status		
16.3.5.4. Interlocks that are required to be overridden shall not be autonomously controlled by a computer system, unless dictated by a timing requirement.	Select Status		
16.3.5.5. Interlocks that are required to be overridden and are autonomously controlled by a computer system shall be designed to prevent an inadvertent override.	Select Status		
16.3.5.6. The status of overridden interlocks shall be displayed on the appropriate operator console(s).	Select Status		
16.3.5.7. A positive indication of interlock(s) restoration shall be provided and verified on the appropriate operator console(s) before restoring a system to its operational state.	Select Status		
16.3.5.8. Compilers	Select Status		
16.3.5.8.1. Existing code compiled with a new compiler or new release of a compiler shall be regression tested.	Select Status		
16.3.5.8.2. Beta test versions of language compilers shall not be used for safety critical functions.	Select Status		
16.4. Software Requirements	I		

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16.4.1. Software Design, Development, and Test Requirements. NPR 7150.2 NASA Software Engineering Requirements provides requirements for software design, development, and testing. Additionally, software shall be designed, developed, and tested in accordance with NASA-STD-8739.8, Software Assurance and Software Safety Standard, and commercial software development standard IEEE/EIA 12207, Standard for Information Technology.	Select Status		
NASA-GB-8719.13, NASA Software Safety Guidebook, is recommended for guidance in ensuring software safety.	I		
16.4.1.1. SCF software test documentation shall be coordinated with SLD 30/SE and SLD 45/SE. SCF software testing shall be conducted IAW the approved test plan and include the following:	Select Status		
16.4.1.1.1. Reaction of software to system (hardware, software, or combination of hardware and software) errors or failures.	Select Status		
16.4.1.1.2. Boundary conditions (in, out, crossing).	Select Status		
16.4.1.1.3. Critical values (e.g., singularities and behavior around singularities such as crossing over a singularity or approaching a singularity from either direction).	Select Status		
For example, zero is a special case of a more general issue in that certain numeric representations may cause a fault (e.g., floating point exception).	I		
16.4.1.1.4. Minimum and maximum input data rates in worse case configurations.	Select Status		
16.4.1.1.5. Regression testing for changes to SCF software code.	Select Status		
16.4.1.1.6. Operator interface/human errors during SCF operations.	Select Status		
16.4.1.1.7. Error handling.	Select Status		
16.4.1.1.8. Special features such as partitioning upon which the protection of SCF features is based.	Select Status		
16.4.1.1.9. Formal testing for software to include analysis and documentation (software analysis, test plan, and test report).	Select Status		
16.4.1.1.10. Test coverage for all execution paths; with all statements executed at least once and every branch tested at least once.	Select Status		
16.4.1.1.11. A revised inventory, relative to software CDR, of safety critical data (local and configuration) and non-safety critical data along with justification for the partitioning. Justification should be based on safety analysis performed and defined system engineering processes.	Select Status		

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16.4.1.1.12. Revised analysis results, relative to software CDR, for safety critical data analysis performed, including verification of data items between and within software modules, reaction of the software system to faults and transformation of fault types between system elements, and the progression of data through the system. Software analysis tools should be used to the greatest extent practical.	Select Status		
16.4.2. Software Coding Practices. The payload project's software developers should develop or adopt software coding practices applicable to the programming languages used.	I		
Some examples include Appendixes D and E of the Joint Software Safety Committee, Software System Safety Handbook; Code Conventions for the Java Programming Language by Sun Microsystems; and C++ Coding Standards by Herb Sutter and Andrei Alexandrescu.	I		
Experience has indicated that computer systems architectures that contain separate instruction and data memory and buses, or separate program memory and data memory through memory protection hardware, segment protection, or page protection prove useful for risk mitigation.	I		
16.4.3. Human-Computer Interface	I		
16.4.3.1. General human-computer interface requirements are found in the Global Information Grid (GIG) Technical Guidance Federation.	Select Status		
MIL-STD-1472, Human Engineering, provides requirements for displays and controls designated specifically for government operator use.	I		
16.4.3.2. The system shall be designed such that the operator may exit current processing to a known stable state with a single action.	Select Status		
Care should be taken to prevent the operator from inadvertently initiating a hazardous operation; therefore, the "single action" should be designed to minimize that possibility. That action may include pressing two keys at the same time.	I		
16.4.3.3. Computer systems shall minimize the potential for inadvertent actuation of hazardous operations.	Select Status		
16.4.3.4. Only one operator at a time shall control safety critical computer system functions.	Select Status		
16.4.3.5. Operator-initiated hazardous functions shall require two or more independent operator actions.	Select Status		

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Table 16.6. Examples of acceptable actions to initiate a hazardous operation are: ***(1) Pressing a key which produces an alert to notify the operator of the impending hazardous operation, followed by a second keystroke to invoke the operation.*** ***(2) Removal of a physical block such as a switch cover followed by flipping the switch.*** ***(3) Moving a cursor on a display monitor to a desired position to highlight a selection, followed by clicking to confirm and accept the highlighted selection.***	**I**		
16.4.3.6. Software shall provide confirmation of valid command and/or data entry to the operator.	**Select Status**		
16.4.3.7. Software shall provide two different sensory feedback methods to the operator that indicates command receipt and status of the operation commanded.	**Select Status**		
The system should provide both visual and aural feedback to ensure the operator knows that the system has accepted the action and is processing it.	**I**		
16.4.3.8. Software shall provide the operator with real-time status reports of operations.	**Select Status**		
16.4.3.9. Error messages that distinguish safety critical states/errors from non-safety critical states/errors shall be provided.	**Select Status**		
16.4.3.10. The system shall ensure that a single failure or error cannot prevent the operator from taking safing actions.	**Select Status**		
16.4.4. Software Data Standards	**I**		
16.4.4.1. Software shall not use a bit pattern of all 1s or all 0s to denote the safe and arm (potentially hazardous) states.	**Select Status**		
16.4.4.2. The arm and safe states shall be represented by unique bit patterns of length at least 4 bits in such a way that the safe state pattern cannot represent the arm pattern as a result of a 1 or 2-bit error.	**Select Status**		
16.4.5. Configuration Control	**I**		
16.4.5.1. The payload project shall provide a software configuration management (SCM) plan in accordance with NPR 7150.2, Software Engineering Requirements, to the PSWG for PSWG and Range Safety review.	**Select Status**		
The system should be designed to prevent or minimize the chance for inadvertent or unauthorized access to and modification of system software by system operators.	**I**		
16.4.5.2. Software and firmware shall be put under formal configuration control as soon as a software baseline is established.	**Select Status**		
16.4.5.3. A Software Configuration Control Board (SCCB) shall be established to approve changes to configuration-controlled software before implementation.	**Select Status**		

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16.4.5.4. A member from the system safety engineering team shall be a member of the SCCB and tasked with the responsibility of evaluating all software changes for their potential safety impact.	Select Status		
16.4.5.5. A member of the hardware Configuration Control Board (CCB) shall be a member of the SCCB and vice versa to keep members apprised of hardware/software changes and to ensure that hardware/software changes do not conflict with or introduce potential safety hazards due to hardware/software incompatibilities.	Select Status		
16.4.5.6. Object code patches shall not be performed unless the SCCB and the PSWG and Range Safety give specific approval.	Select Status		
16.5. Computer System and Software Data Requirements	Select Status		
16.5.1 Computer system and software data shall be provided in accordance with Attachment 1, A1.2.4.14 and A1.2.5.18 of this volume.	Select Status		
16.6. Independent Verification and Validation (IV&V) Analysis Support	I		
Table 16.7. Independent Verification and Validation (IV&V) Analysis Support. IV&V analysis support should be considered for SCFs with a serious SwCI or high risk SwCI. This determination should be based on the tailored application of the software safety standards as contained in the Range User's program specific SSP and further defined in the software safety plan.	I		
16.6.1. IV&V Support.	I		
16.6.1.1. The payload project shall ensure appropriate V&V requirements are established at the beginning of the program to ensure proper implementation of software safety requirements. This includes an assessment of the scope and level of IV&V to be planned and implemented based on the level of criticality and risk of the software application.	Select Status		
16.6.1.2. IV&V shall be performed by an independent third (3rd) party. The assessor shall not be part of the developer's company or its subsidiaries unless specifically approved by SLD 30/SE and SLD 45/SE , given sufficient separation exists and can be demonstrated.	Select Status		
16.6.1.3. The IV&V process shall begin during the definition phase and encompass the requirements, design, development, operational evaluation and test, and life cycle program phases.	Select Status		
16.6.1.4. Efforts of V&V used to identify where IV&V is required shall encompass:	Select Status		
16.6.1.4.1. Validation that software-to-software interfaces and software-to-hardware interfaces have been correctly implemented.	Select Status		
16.6.1.4.2. Independent analysis program to evaluate selected hardware, software, firmware and interfaces to demonstrate the algorithms and logic are correctly implemented.	Select Status		

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16.6.1.4.3. Model and simulation of selected hardware, software, firmware and interfaces to demonstrate compliance to system and operational requirements.	Select Status		
16.6.1.5. IV&V shall report and track through closure all anomalies throughout the development and operational implementation process.	Select Status		
16.6.1.6. All serious and high risk SwCI anomalies shall be closed with PSWG and Range Safety approval prior to use of SwCI at the range. Unverifiable failures that cannot be tracked to a specific piece of hardware or software shall be documented as such. Unverifiable failures shall be documented with any analysis done, special testing performed, configuration of the system at the time of the failure, and any other applicable information for the future.	Select Status		

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CHAPTER 17 WESTERN RANGE SEISMIC DESIGN	Select Status		
The probability of the WR being exposed to a severe earthquake is great enough to require taking specific mitigating measures in design. This chapter identifies equipment seismic design requirements. Equipment includes aerospace ground equipment (AGE), ground support equipment (GSE), flight hardware integrated with GSE, and ground support systems (GSS). For simplification, the terms equipment and/or GSE are used in this chapter to include AGE, GSE, and GSS. Seismic requirements do not apply to the spacecraft itself but do apply to spacecraft integrated with GSE. For example, a spacecraft mounted on a support stand would be analyzed as a unit and protected accordingly.	I		
17.1. Applicability of Design and/or Anchorage or Restraint Requirements	I		
17.1.1. Equipment needed/required for post-earthquake recovery, essential equipment (per code definition), or safety critical equipment, shall be designed to remain operational or revert to a "safe mode" during a seismic event, and to be operational immediately following a seismic event. This equipment shall be designed with an importance factor of 1.5 (I = 1.5). If the payload project, PSWG and Range Safety determine that the equipment is not essential to life safety, an importance factor of 1 may be used.	Select Status		
17.1.2. Equipment whose failure or excessive deflections during a seismic event could propagate to a catastrophic event or endanger personnel, high-pressure systems, or systems used to store hazardous or toxic materials shall be designed and anchored to withstand a seismic event. The equipment need not remain operational after the seismic event as long as personnel and environmental safety are preserved; however, equipment whose failure could result in a catastrophic event or endanger personnel shall be designed to revert to an established "safe mode" in the event of a seismic event.	Select Status		
17.1.3. Equipment whose movement could propagate to a catastrophic event, block personnel egress avenues, or injure personnel shall be secured to prevent movement.	Select Status		
17.1.4. Transportation equipment shall be stored with the casters or wheels locked or blocked. Transportation equipment shall be stored in open areas so that if movement occurs during an earthquake, the equipment shall not impact adjoining structures (for example, building columns) and propagate into a facility failure.	Select Status		
17.1.5. Gravity friction shall not be used as the only means to anchor or restrain equipment.	Select Status		
17.2. Basis for Design	I		
17.2.1. Seismic design of equipment, supports and/or anchorages shall be in accordance with the International Building Code (IBC), American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-10), and the additional requirements specified in this publication.	Select Status		
17.2.2. Local Geotechnical shall be used to determine site soil classification. Data may be available within 300 ft of the equipment or facility and can be used to determine the site soil classification. If a geotechnical report is too costly and not available, a site soil classification D shall be used if deemed appropriate by the payload project, PSWG and Range Safety.	Select Status		

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17.2.3. Appropriate seismic hazard mitigation shall be implemented for high cost computer or electronic equipment.	Select Status		
Where it is cost-effective, high-cost computer or electronic equipment should be mounted on seismic isolation bearings to mitigate damage during an earthquake. FEMA 74, Reducing the Risks of Non-Structural Earthquake Damage, A Practical Guide, should be used as a guide to reduce the risk of earthquake non-structural damage.	I		
17.2.4. Seismic Loading and Loads Combinations	I		
17.2.4.1. Seismic loads for AGE/GSE shall be calculated in accordance with the IBC and ASCE/SEI 7-10.	Select Status		
17.2.4.2. Seismic loading shall include vertical component in addition to the horizontal component to evaluate the total earthquake load. This is accomplished per ASCE/SEI 7-10 by multiplying 0.2 by the spectral response and the dead load ($0.2*S_{DS}*D$).	Select Status		
17.2.4.3. Calculation of the seismic loads shall consider dynamic amplification and the dynamic characteristics of the GSE and their supports and anchorage to ensure the proper seismic response factor is selected.	Select Status		
17.2.4.5. Loads combinations shall be in accordance with IBC and ASCE/SEI 7-10, American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures.	Select Status		
17.2.5. Exemptions. GSE that meets any of the following criteria shall be exempt from seismic design and/or restraint requirements:	Select Status		
17.2.5.1. Internal operational elements of GSE that are confined within the GSE structure.	Select Status		
17.2.5.2. Man-handled GSE physically attached to flight hardware or GSE.	Select Status		
17.2.5.3. GSE categorized as hand tools.	Select Status		
17.2.5.4. GSE temporarily positioned in support of operations, on a case-by-case basis, those items may be ruled exempt by the PSWG, and Range Safety based on the results of a risk analysis. The analysis shall address risk for catastrophic failure of the equipment, or any potential catastrophic event the equipment may precipitate. These include but are not limited to: excessive movement that may impact another hazardous system, movement that may block and egress routes, release of stored energy or hazardous commodity, whether the identified equipment may be needed for post-earthquake recovery, or a tipping hazard which may present a crushing or pinching hazard.	Select Status		
17.2.6. Existing Equipment. For programs and/or projects planning to reuse existing GSE that does not meet the requirements in this publication, payload project safety and engineering shall assess that equipment for potential risk. The payload project shall coordinate the risk assessment with the PSWG and Range Safety and formulate risk mitigation plans for the GSE in question.	Select Status		
17.3. WR Seismic Data Requirements	Select Status		

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The GSE data package shall be submitted in accordance with the requirements in Attachment 1, A1.2.5.19 of this volume and shall identify the equipment and potential for seismic hazard and risk.	Select Status		
17.4. Earthquake Emergency Planning and Post Recovery Response	Select Status		
The payload project shall develop emergency and recovery procedures for a seismic event. These procedures shall detail emergency shutdown and inspections of critical systems to ensure operation of safety controls were not compromised during the seismic event. An assessment of the facility and its components shall be completed before resuming normal operations.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 18 SOLID ROCKET MOTORS, ROCKET MOTOR SEGMENTS, AND ROCKET MOTOR COMPONENTS	I		
18.1. General	Select Status		
In addition to the requirements in Chapter 6 and Chapter 13 of this volume, the following data and analysis shall be provided for solid rocket motors and rocket motor segments:	Select Status		
18.1.1. Structural analyses for all aerospace ground equipment used to handle rocket motors and segments. This includes items such as handling rings, special breakover fixtures, air pallets, segment and motor stands, special lifting fixtures, and critical motor component installation fixtures.	Select Status		
18.1.2. Initial and periodic NDE plans for the aerospace ground equipment, as required in 6.1.1.3.2.1. Single failure items and SFP welds shall be clearly identified.	Select Status		
18.2. Failure Modes, Effects, and Criticality Analysis (FMECA) and Operating & Support Hazards Analysis (O&SHA)	Select Status		
FMECA and operational hazard analysis (O&SHA) for all aspects of solid rocket segment and/or motor handling and buildup. This analysis shall include the following:	Select Status		
18.2.1. An assessment of the probability of the motor, segment, or component igniting and possibly becoming propulsive upon mechanical, electrical, or thermal shock.	Select Status		
18.2.2. An assessment of the requirements for onsite NDE testing of rocket motor segment, motors, and/or components. X-ray or ultrasonic testing equipment failure modes, and their effect on the rocket motor/segment shall be analyzed. This analysis is particularly important for equipment used to inspect rocket motor bore.	Select Status		
18.3. Lightning Effects Hazard Analysis	I		
18.3.1. A lightning effects hazard analysis shall be performed on each facility used to store and process solid rocket segments/motors.	Select Status		
18.3.2 An induced effects lightning hazard analysis shall be performed to determine the effects on each solid rocket motor/segment undergoing storage and/or processing operations in a facility should the facility experience a direct lightning strike.	Select Status		
18.3.3 These analyses shall specify any operational restrictions needed to ensure lightning safety during storage and processing.	Select Status		
18.4. Solid Rocket Motor and Motor Segment Data Requirements	Select Status		
The data requirements found in Attachment 1, A1.2.4.9.6 of this volume shall be submitted for solid rocket motors, motor segments, and components.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 1 SAFETY DATA PACKAGE	I		
A1.1. INTRODUCTION	I		
A1.1.1. Purpose. The Safety Data Package (SDP) or equivalent of the Missile System Prelaunch Safety Package (MSPSP) is a documentation data submittal that provides a detailed description of hazardous and safety critical ground support and flight hardware equipment, systems, and materials and their interfaces used in the launch of launch vehicles and payloads. It is one of the media through which missile system prelaunch safety approval is obtained. NPR 8715.7 provides the payload safety review and approval process including required safety documentation and SDP submittal time line for the Payload Safety Introduction Briefing, Safety Review I (project's mission PDR time frame), Safety Review II (project's mission CDR time frame) and Safety Review III (prior to payload shipping reviews).	Select Status		
A1.1.2. Content. This attachment contains the content preparation instructions for the data generated by the requirements specified in Volume 3.	I		
A1.1.3. Applicability. The requirements in this attachment are applicable to all NASA Payloads, and related ground support systems, including AGE, GSE, and facilities.	Select Status		
A1.1.4. Submittal Process. A Safety Data Package (SDP) (MSPSP) shall be submitted to the PSWG in conjunction with Range Safety by the payload project with overall responsibility for the payload systems for review and approval by the PSWG and Range Safety.	Select Status		
A1.1.5. Final Approval. A final SDP (MSPSP) that satisfies all PSWG and Range Safety concerns addressed at the project's mission CDR shall be submitted to the PSWG for review and approval by the PSWG and Range Safety at least 45 calendar days prior to payload (spacecraft) shipment or as determined by the PSWG.	Select Status		
A1.2. PREPARATION INSTRUCTIONS	I		
A1.2.1. Content	I		
A1.2.1.1. The SDP (MSPSP) contains technical information concerning hazardous and safety critical equipment, systems, and materials and their interfaces used in the pre-launch processing and launch of payloads.	Select Status		
A1.2.1.2. The SDP (MSPSP) is a detailed description of the design, test, and inspection requirements for all ground support systems and flight hardware and materials and their interfaces used in the pre-launch and launch of payloads. Hazard Analyses and Hazard Reports shall be contained in the SDP or provided separately and submitted with the SDPs (see A1.2.4.1.9 and A3.2.4.4). All schematics, functional diagrams, and operational manuals shall have well defined, standard IEEE or Mil-Spec terminology and symbols.	Select Status		
A1.2.1.3. The payload project shall develop the SDP and submit it in three phases (SDP I, II, and III) unless agreed to otherwise by the PSWG and Range Safety.	Select Status		

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A1.2.1.3.1. SDP I is due no later than 30 days prior to the project's mission PDR (see NPR 8715.7). SDP I shall contain technical information, hazard analysis and hazard reports commensurate with PDR-level design and operations. For a project utilizing a previously launched payload bus SDP I shall include identification and description of any payload safety-related problems, mishaps, or failures that occurred during fabrication, testing, processing, or integration that could affect the safety of the flight hardware or software, ground support equipment, personnel, or other NASA concerns.	**Select Status**		
A1.2.1.3.2. SDP II is due no later than 30 days prior to the project's mission CDR (see NPR 8715.7). SDP II shall contain updated technical information from SDP I commensurate with CDR-level design and operations. A cross-reference shall be provided identifying the disposition of review comments of SDP I indicating where changes were made.	**Select Status**		
A1.2.1.3.3. SDP III is the Final SDP and is due no later than 90 days prior to the payload shipment to the processing site (see NPR 8715.7). SDP III shall address all comments and incorporate all changes reflecting the as-built configuration and planned processing activities. A cross-reference shall be provided identifying the disposition of review comments since the last SDP submittal to indicate where incorporated changes to the SDP were made. SDP III shall contain final hazard reports, the Final GOP (in SDP III or as a stand-alone document), and a signed copy of any approved safety waivers (with attachments provided upon request). SDP III shall also contain a record of test failures, anomalies and mishaps involving qualification hardware, flight hardware, ground support equipment, and software (if used for hazard control), and an assessment of the resolution and safety implications of these events.	**Select Status**		
A1.2.2. Format. The payload project format is acceptable provided the information described below is provided. Suggested formats are shown as applicable. The format presented in this attachment provides two distinct sections: Flight Hardware Systems and Ground Support Systems.	**Select Status**		
A1.2.2.1. Table of Contents and Glossary. The SDP (MSPSP) shall contain a table of contents and a glossary.	**Select Status**		
A1.2.2.2. Introduction. The "introduction" section shall address the scope and purpose of the SDP (MSPSP).	**Select Status**		
A1.2.3. General Description. The "general description" section provides an overview of the payload or ground support system as a prologue to the subsystem descriptions. The following information is included in this section:	**Select Status**		
A1.2.3.1. Physical dimensions and weight.	**Select Status**		
A1.2.3.2. Nomenclature and description of major subsystems.	**Select Status**		
A1.2.3.3. Types of motors and propellants to be used.	**Select Status**		
A1.2.3.4. Sketches and/or photographs of the launch vehicle, payload, or ground support system.	**Select Status**		
A1.2.3.5. Synopsis of each hazardous and safety critical subsystem.	**Select Status**		
A1.2.3.6. A list of hazardous subsystems addressed in Volume 3 of this publication that are not present in the launch vehicle or payload system.	**Select Status**		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4. Flight Hardware Subsystems	I		
A1.2.4.1. At a minimum, the "flight hardware subsystems" section shall include the following information and the specific data requirements listed in A1.2.4.6 through A1.2.4.14 below:	Select Status		
A1.2.4.1.1. Subsystem overview.	Select Status		
A1.2.4.1.2. Nomenclature of major subsystems.	Select Status		
A1.2.4.1.3. Function of the subsystem.	Select Status		
A1.2.4.1.4. Location of the subsystem.	Select Status		
A1.2.4.1.5. Operation of the subsystem.	Select Status		
A1.2.4.1.6. Subsystem design parameters.	Select Status		
A1.2.4.1.7. Subsystem test requirements.	Select Status		
A1.2.4.1.8. Subsystem operating parameters.	Select Status		
A1.2.4.1.9. Summaries of any PSWG and Range Safety required hazard analyses conducted.	Select Status		
A1.2.4.2. Supporting data shall be included or summarized and referenced as appropriate with availability to the PSWG and Range Safety upon request.	Select Status		
A1.2.4.3. Tables, matrixes, and sketches are required for systems and component data. (See A1.2.4.7.2 and A1.2.4.7.3 below for suggestions.)	Select Status		
A1.2.4.4. Required analyses, test plans, and test results may be included in the SDP as appendixes or submitted separately. At a minimum, analyses, test plans, and test reports shall be listed, referenced, and summarized in the SDP.	Select Status		
A1.2.4.5. A list of all the PSWG and Range Safety approved noncompliances.	Select Status		
A1.2.4.6. Flight Hardware Structures and Mechanisms	I		
A1.2.4.6.1. Flight Hardware Structures and Mechanisms General Requirements. In addition to the information required in A3.2.4.1, the material properties of the main structures, mechanisms, and deployable' s used on launch vehicles and payloads shall be included in the SDP .	Select Status		
A1.2.4.6.2. Flight Hardware Used in Lifting Critical Loads. At a minimum, the following documentation is required:	Select Status		
A1.2.4.6.2.1. SFP analysis.	Select Status		
A1.2.4.6.2.2. NDE plan and test results for SFP components and SFP welds.	Select Status		
A1.2.4.6.2.3. Initial proof load test plan and test results.	Select Status		

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A1.2.4.6.2.4. Stress analysis.	Select Status		
A1.2.4.7. Flight Hardware Pressure, Propellant, and Propulsion Systems	I		
A1.2.4.7.1. General Data. A detailed description of the pressure, propellant, and propulsion systems of the payload shall be provided. The description shall include the information identified in A1.2.4.1 plus the following:	Select Status		
A1.2.4.7.1.1. Material compatibility analysis.	Select Status		
A1.2.4.7.1.2. Physical and chemical properties and general characteristics of the propellant, test fluid, and gases.	Select Status		
A1.2.4.7.1.3. For hazardous propellants, fluids, and gases, the following shall be submitted:	Select Status		
A1.2.4.7.1.3.1. Specific health hazards such as toxicity and physiological effects.	Select Status		
A1.2.4.7.1.3.2. Threshold limit value (TLV) and maximum allowable concentration (MAC) for eight-hour day, five-day week of continuous exposure.	Select Status		
A1.2.4.7.1.3.3. Emergency tolerance limits including length of time of exposure and authority for limits (for example, Surgeon General, National Institute for Occupational Safety and Health [NIOSH], independent study).	Select Status		
A1.2.4.7.1.3.4. Maximum credible spill size including volume and surface area and supporting analyses.	Select Status		
A1.2.4.7.1.3.5. Description of hazards other than toxicity such as flammability and reactivity.	Select Status		
A1.2.4.7.1.3.6. Personal protective equipment to be used in handling and using the propellants when this equipment will be used during an operation, and the manufacturer, model number, and other identifying data.	Select Status		
A1.2.4.7.1.3.7. Manufacturer, model number, specifications, operating limits, type of certification, and general description of vapor detecting equipment.	Select Status		
A1.2.4.7.1.3.8. Identification of material incompatibility problems in the event of a spill.	Select Status		
A1.2.4.7.1.3.9. Recommended methods and techniques for decontamination of areas affected by spills or vapor clouds and hazardous waste disposal procedures.	Select Status		
A1.2.4.7.2. Flight Hardware Pressure, Propellant, and Propulsion System Data. A schematic diagram shall be submitted for all systems: The schematic shall present the system in a clear and easily readable form with complete subsystems grouped and labeled accordingly. The schematic or a corresponding data sheet shall provide the following information:	Select Status		
Nomenclature of each element should be made adjacent to or in the vicinity of each element.	I		
A1.2.4.7.2.1. Identification of all pressure system components such as valves, regulator, tubes, hoses, vessels, and gauges using standard symbols.	Select Status		

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A legend is recommended. The original mechanical drawings should be referenced.	I		
A1.2.4.7.2.2. MOP of all systems and subsystems at expected operating temperatures.	Select Status		
A1.2.4.7.2.3. Identification of expected source pressures and expected delivery pressures.	Select Status		
A1.2.4.7.2.4. All relief valve pressure settings and flow rates.	Select Status		
A1.2.4.7.2.5. System fluid and maximum expected temperature.	Select Status		
A1.2.4.7.2.6. Pressure ranges of all pressure transducers.	Select Status		
A1.2.4.7.2.7. Pressure settings of pressure regulators.	Select Status		
A1.2.4.7.2.8. Charging pressure of reservoirs and vessels, their nominal capacities, and wall thickness.	Select Status		
A1.2.4.7.2.9. Pressure setting of all pressure switches.	Select Status		
A1.2.4.7.2.10. The nominal outside diameter and wall thickness of all tubing and piping.	Select Status		
A1.2.4.7.2.11. Flow path through all components.	Select Status		
When the system is to be used in several operating modes, it is easier to provide a separate schematic that depicts flow paths for each operating mode.	I		
A1.2.4.7.2.12. Reference designations for each component so that a cross-reference between schematics and drawings and a pressure system component list or other documentation is possible.	Select Status		
A1.2.4.7.2.13. End-to-end electrical schematics of electrical and electronic components giving full functional data and current loads.	Select Status		
A1.2.4.7.2.14. Connections for testing or servicing.	Select Status		
A1.2.4.7.2.15. A narrative description of the system or subsystem and its operating modes, including a discussion of operational hazards and accessibility of components.	Select Status		
A1.2.4.7.2.16. A sketch or drawing of the system that shows physical layout and dimensions.	Select Status		
A1.2.4.7.2.17. System information shall be placed in tabular form; suggested format is shown below.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Table A3.1. Example Systems Data Format ***System ID Number*** ***System Title*** ***Location*** ***MOP*** ***Commodity*** ***Responsible Organization*** ***Number of Vessels*** ***Recertification Date (GSE only)*** ***Recertification Period (GSE only)*** ***Material(s)*** ***Inspection Results*** ***ISI Requirements (GSE only)***	I		
A1.2.4.7.3. Flight Hardware Pressure, Propellant, and Propulsion Component Design Data. The following information shall be submitted for each component:	Select Status		
A1.2.4.7.3.1. Identification of each component by a reference designation permitting cross reference with the system schematic.	Select Status		
A1.2.4.7.3.2. The MAWP for all pressure system components.	Select Status		
A1.2.4.7.3.3. The MOP at which the component shall operate when installed in the system.	Select Status		
A1.2.4.7.3.4. Safety factors or design burst pressure for all pressure system components.	Select Status		
A1.2.4.7.3.5. Actual burst pressures, if available.	Select Status		
A1.2.4.7.3.6. Pre-assembly hydrostatic test proof pressure for each system component.	Select Status		
A1.2.4.7.3.7. If applicable, the proof pressure the component will be tested to after installation in the system.	Select Status		
A1.2.4.7.3.8. Materials used in the fabrication of each element in the component, including soft goods and other internal elements.	Select Status		
A1.2.4.7.3.9. Cycle limits if fatigue is a factor of the component.	Select Status		
A1.2.4.7.3.10. Temperature limits of each system component.	Select Status		

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Table A1.2. Example Vessels Data Format: ***Vessel ID Number*** ***System ID Number*** ***Manufacturer Name*** ***Manufacturer Serial No.*** ***Manufacturer Drawing No.*** ***Commodity*** ***Original MAWP*** ***Burst Pressure*** ***Volume*** ***Location*** ***DOT Specification (GSE only)*** ***Year of Manufacture*** ***National Board No. (GSE only)*** ***Code Stamps (GSE only)*** ***Recertification MAWP (GSE only)*** ***Recertification Date (GSE only)*** ***Recertification Period (GSE only)*** ***Cyclic Limit*** ***Test Pressure*** ***Vessel Design*** ***Material*** ***Temperature Limits*** ***Maximum Stress*** ***Inside Radius*** ***Thickness*** ***Dimensions*** ISI Information and ISI Results (GSE only)	**I**		

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Table A1.3. Example Relief Devices Data Format: ***ID Number*** ***System Number*** ***Type*** ***Manufacturer*** ***Manufacturer Part No.*** ***Code Stamps (GSE only)*** ***Manufacturer Date*** ***Inlet Size*** ***Outlet Size*** ***Set or Burst Pressure*** ***System MOP*** ***System Commodity*** ***Flow Capacity*** ***Material*** ***Temperature Limits*** ***Test Pressure*** ***ISI Requirements and ISI Results (GSE only)***	**I**		
Table A1.4. Example Pressure Gauges and Sensors Data Format: ***ID Number*** ***System Number*** ***Manufacturer*** ***Manufacturer Date*** ***Manufacturer Part No.*** ***Pressure Range*** ***Material*** ***System Commodity*** ***MAWP*** ***Burst Pressure*** ***System MOP*** ***Inlet Size*** ***ISI Requirements and ISI Results (GSE only)***	**I**		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Table A1.5. Example Flexible Hoses Data Format: ***ID Number*** ***System Number*** ***Manufacturer*** ***Manufacturer Part No.*** ***Manufacturer Date*** ***Materials*** ***Temperature Limits*** ***MAWP/Manufacturer Rated Working Pressure*** ***Size (diameter, length)*** ***Burst Pressure*** ***Cyclic Limit*** ***Test Pressure*** ***Shelf Life*** ***ISI Requirements and ISI Results (GSE only)***	I		
A1.2.4.7.4. Flight Hardware Pressure, Propellant, and Propulsion Initial Test Plans and Procedures. A list and summary of all initial test plans, test procedures, and test results for all flight hardware pneumatic, hydraulic, hypergolic, and cryogenic fluid and propellant systems, as applicable in accordance with Chapter 12.	Select Status		
A1.2.4.8. Flight Hardware Electrical and Electronic Subsystems	I		
A1.2.4.8.1. General Data. A detailed description of the electrical and electronic subsystems of the launch vehicle or payload shall be provided. The description shall include the information identified in A3.2.4.1.	Select Status		
A1.2.4.8.2. Flight Hardware Battery Design Data. The following information shall be submitted for flight hardware batteries:	Select Status		
A1.2.4.8.2.1. Design versus actual operating parameters of cells and battery.	Select Status		
A1.2.4.8.2.2. Cell chemistry and physical construction.	Select Status		
A1.2.4.8.2.3. Cell vent parameters.	Select Status		
A1.2.4.8.2.4. Toxic chemical emission of cells and evaluation of hazards.	Select Status		
A1.2.4.8.2.5. EPA classification of the battery.	Select Status		
A1.2.4.8.2.6. DOT classification of the battery.	Select Status		
A1.2.4.8.2.7. Physical and electrical integration of cells to form the battery.	Select Status		

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A1.2.4.8.2.8. Description of safety devices.	Select Status		
A1.2.4.8.2.9. Case design including vent operation and cell and battery case housing yield point.	Select Status		
A1.2.4.8.2.10. A description of all operations to include packing, transportation, and storage configuration; activation; installation; checkout; charging; usage; removal; and disposal.	Select Status		
A1.2.4.8.2.11. Identification of the hazards associated with each activity in A3.2.4.8.2.10 above and the safety controls that shall be in effect.	Select Status		
A1.2.4.8.2.12. Manufacturing qualification and acceptance testing results that are considered safety critical.	Select Status		
A1.2.4.8.2.13. Battery size and weight.	Select Status		
A1.2.4.8.2.14. Specification of the system that uses the battery.	Select Status		
A1.2.4.8.2.15. A description of the EGSE used for packing, transportation, and storage; activation; installation; checkout; analysis; charging; usage; removal; and disposal of the battery.	Select Status		
A1.2.4.8.2.16. A list and summary of test plans, test procedures, and test results in accordance with 14.4.	Select Status		
A1.2.4.8.3. Flight Hardware Electrical and Electronic Subsystem Data. The following information shall be submitted for electrical and electronic subsystems operating in hazardous atmospheres:	Select Status		
A1.2.4.8.3.1. A brief description of power sources and the power distribution network, including schematics and line drawings of the distribution network.	Select Status		
A1.2.4.8.3.2. A description of how faults in electrical circuitry are prevented from propagating into hazardous subsystems, including such information as dedicated power sources and buses, use of fuses, and wiring sizing.	Select Status		
A1.2.4.8.3.3. A description of how inadvertent commands that can cause a hazardous condition are prevented.	Select Status		
A1.2.4.8.3.4. Identification of potential shock hazards.	Select Status		
A1.2.4.8.3.5. A description of how the intent of hazard proofing is met for electrical and electronic systems.	Select Status		
A1.2.4.8.3.6. Complete grounding and bonding methodology.	Select Status		
A1.2.4.8.3.7. A bent pin analysis for all connectors for safety critical or hazardous systems that have spare pins.	Select Status		
A1.2.4.9. Flight Hardware Ordnance Subsystems	I		
A1.2.4.9.1. General Data. A detailed description of the ordnance subsystems of the launch vehicle or space craft shall be provided. The description shall include the information identified in A1.2.4.1.	Select Status		
A1.2.4.9.2. Flight Hardware Ordnance Hazard Classifications and Categories. The following ordnance hazard classification data shall be submitted:	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.9.2.1. UNO classifications and DOD hazard classifications, including class, division, and compatibility group, in accordance with DESR 6055.09_AFMAN 91-201, Explosive Safety Standards, and NASA-STD-8719.12 respectively.	Select Status		
A1.2.4.9.2.2. DOT classification.	Select Status		
A1.2.4.9.2.3. The ordnance device and system hazard classification for each ordnance item and system; test results and/or analysis used to classify the ordnance devices and systems.	Select Status		
A1.2.4.9.3. Flight Hardware Ordnance System Data. The following ordnance system data shall be submitted:	Select Status		
A1.2.4.9.3.1. A block diagram of the entire ordnance system.	Select Status		
A1.2.4.9.3.2. A complete line schematic of the entire ordnance system from the power source to the receptor ordnance, including telemetry pick-off points and ground (umbilical) interfaces.	Select Status		
A1.2.4.9.3.3. Diagrams showing the location of all ordnance components on the vehicle.	Select Status		
A1.2.4.9.3.4. A description of wiring, ETS, and FOC routing.	Select Status		
A1.2.4.9.3.5. A description of electrical, ETS, and optical connections and connectors.	Select Status		
A1.2.4.9.3.6. Detailed, complete schematics of the entire ordnance system showing component values such as resistance and capacitance, tolerances, shields, grounds, connectors, and pin outs.	Select Status		
A1.2.4.9.3.6.1. The schematics shall include all other vehicle components and elements that interface or share common usage with the ordnance system.	Select Status		
A1.2.4.9.3.6.2. All pin assignments shall be accounted for.	Select Status		
A1.2.4.9.3.7. Detailed narrative description and functional schematic of the operation of the ordnance system. The narrative description and functional schematic shall be capable of being used to determine the configuration and resulting failure tolerance of the vehicle and ground ordnance systems at any time during prelaunch processing, launch countdown, or launch, including all credible failure scenarios.	Select Status		
A1.2.4.9.3.8. The FMECA for each ordnance system.	Select Status		
A1.2.4.9.3.9. An operational flow of the ordnance system processing and checkout, including timelines and summaries of each procedure to be used.	Select Status		
A1.2.4.9.3.10. A sketch showing the accessibility of manual arming and safing devices.	Select Status		
A1.2.4.9.3.11. Specification drawings and documents for all airborne and ground ordnance systems.	Select Status		
A1.2.4.9.4. Flight Hardware Ordnance Component Design Data. The following ordnance component design data shall be submitted:	Select Status		

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A1.2.4.9.4.1. A complete and detailed description of each ordnance system component and how it functions.	Select Status		
A1.2.4.9.4.2. Specification drawings and documents for all airborne and ground ordnance components.	Select Status		
A1.2.4.9.4.3. Illustrated breakdown of all mechanically operated ordnance components.	Select Status		
A1.2.4.9.4.4. Part number, manufacturer, and net explosive weight for each ordnance item.	Select Status		
A1.2.4.9.4.5. Temperature and humidity requirements for each ordnance item.	Select Status		
A1.2.4.9.4.6. Bridgewire resistance, maximum safe no-fire current, and minimum all-fire current for each low voltage EED.	Select Status		
A1.2.4.9.4.7. Maximum no-fire voltage and minimum all-fire voltage for each EBW.	Select Status		
A1.2.4.9.4.8. Maximum no-fire energy and minimum all-fire energy for each LID and PAD.	Select Status		
A1.2.4.9.4.9. A list and summary of test plans procedures, and results, as required.	Select Status		
A1.2.4.9.4.10. 8 x 10 inch color photographs or electronic copies of all ordnance items.	Select Status		
The photographs or electronic copies should be of sufficient detail to identify individual ordnance items as well as to show the ordnance item(s) in installed configuration on the payload. These photographs are intended to ensure the safety of Explosive Ordnance Disposal personnel who may be directed to render the ordnance safe.	I		
A1.2.4.9.5. Flight Hardware Ordnance Component Handling and Storage Data. Specific requirements for handling and storing the flight ordnance shall be submitted.	Select Status		
A1.2.4.9.6. Solid Rocket Motors, Rocket Motor Segments, and Associated Components. In addition to the requirements listed for ordnance, the following data shall be provided for solid rocket motors, rocket motor segments, and associated components:	Select Status		
A1.2.4.9.6.1. Propellant Properties.	Select Status		
A1.2.4.9.6.1.1. Propellant explosive hazard classification (DoD, UNO, DOT, including test results), if not previously addressed by A3.2.4.9.2.1.	Select Status		
A1.2.4.9.6.1.2. Propellant formulation (composition).	Select Status		
A1.2.4.9.6.1.3. Propellant auto-ignition température.	Select Status		
A1.2.4.9.6.1.4. Propellant static sensitivity (energy in Joules required to ignite the propellant).	Select Status		
A1.2.4.9.6.1.5. Propellant conductivity.	Select Status		
A1.2.4.9.6.2. Propellant Reactions to Impact on Hard Surface.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.9.6.2.1. Ignition thresh hold drop height.	**Select Status**		
A1.2.4.9.6.2.2. Low order detonation threshold drop height.	**Select Status**		
A1.2.4.9.6.2.3. Critical impact velocity (threshold velocity required to break up propellant sufficiently so that it will transit from deflagration to detonation in a 1 inch diameter schedule 40 steel pipe).	**Select Status**		
A1.2.4.9.6.3. Igniter data	**Select Status**		
A1.2.4.9.6.3.1. Type of propellant and propellant properties data as specified in A3.2.4.9.6.1 and A3.2.4.9.6.2 above.	**Select Status**		
A1.2.4.9.6.3.2. Data on each igniter initiator, such as a through bulkhead initiator (TBI).	**Select Status**		
A1.2.4.9.6.3.3. Igniter weight.	**Select Status**		
A1.2.4.9.6.3.4. Igniter grounding provisions.	**Select Status**		
A1.2.4.9.6.3.5. Igniter storage requirements.	**Select Status**		
A1.2.4.9.6.3.6. Igniter handling requirements.	**Select Status**		
A1.2.4.9.6.3.7. Igniter testing and inspection requirements.	**Select Status**		
A1.2.4.9.6.3.8. Igniter packaging requirements (if shipped separately).	**Select Status**		
A1.2.4.9.6.3.9. Igniter case description, including design safety factors.	**Select Status**		
A1.2.4.9.6.4. Rocket Motor/Segment Data.	**Select Status**		
A1.2.4.9.6.4.1. Motor/segment case description, including design safety factors.	**Select Status**		
A1.2.4.9.6.4.2. Method of proof testing the rocket motor/segment case before propellant loading.	**Select Status**		
A1.2.4.9.6.4.3. Weight of propellant.	**Select Status**		
A1.2.4.9.6.4.4. Cross-section drawings showing propellant grain design details, case insulation, including physical dimensions, and joint details for segmented rocket motors.	**Select Status**		
A1.2.4.9.6.4.5. Motor/segment nondestructive testing requirements.	**Select Status**		
A1.2.4.9.6.4.6. Motor/segment storage requirements.	**Select Status**		
A1.2.4.9.6.4.7. Motor/segment handling requirements.	**Select Status**		
A1.2.4.9.6.4.8. Motor/segment grounding requirements.	**Select Status**		
A1.2.4.9.6.4.9. Description of structural, mechanical, and electrical subsystems.	**Select Status**		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.9.6.4.10. Description of materials and properties of seals and O-rings.	Select Status		
A1.2.4.9.6.5. Data submission and analysis, as described in Chapter 18. If these data and analysis are submitted as part of another section of the SDP (MSPSP), shall cross-reference that analysis here.	Select Status		
A1.2.4.10. Flight Hardware Non-Ionizing Radiation Sources	I		
A1.2.4.10.1. General Data. A detailed description of the non-ionizing radiation sources shall be provided. The description shall include the information identified in A3.2.4.1.	Select Status		
A1.2.4.10.2. Flight Hardware RF Emitter Data. The following information shall be submitted for RF emitters:	Select Status		
A1.2.4.10.2.1. Site Plans. Site plans shall be submitted to Range Safety and the RPO/RSO for all RF generating equipment. The site plan shall include the following information:	Select Status		
A1.2.4.10.2.1.1. Location of generating equipment.	Select Status		
A1.2.4.10.2.1.2. RF hazard areas.	Select Status		
A1.2.4.10.2.1.3. Description and use of nearby facilities and operating areas.	Select Status		
A1.2.4.10.2.2. Design and Test Data. At a minimum, the following RF emitter design and test data shall be submitted:	Select Status		
A1.2.4.10.2.2.1. Emitter peak and average power.	Select Status		
A1.2.4.10.2.2.2. Pulse widths.	Select Status		
A1.2.4.10.2.2.3. Pulse repetition frequencies.	Select Status		
A1.2.4.10.2.2.4. Pulse codes.	Select Status		
A1.2.4.10.2.2.5. Maximum rated duty cycle.	Select Status		
A1.2.4.10.2.2.6. Type and size of antenna.	Select Status		
A1.2.4.10.2.2.7. Antenna gain and illumination.	Select Status		
A1.2.4.10.2.2.8. Beam width and beam skew.	Select Status		
A1.2.4.10.2.2.9. Operating frequency in MHz.	Select Status		
A1.2.4.10.2.2.10. Insertion loss between transmitter and antenna.	Select Status		
A1.2.4.10.2.2.11. Polarization of transmitted wave hardware.	Select Status		
A1.2.4.10.2.2.12. An analysis of the RF hazard area with and without antenna hats/dummy load, and results of any testing.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.10.2.2.13. A table that lists all of the RF emitters aboard a launch vehicle, payload, and ground support systems and their hazard areas (distances).	Select Status		
A1.2.4.10.2.2.14. A description of interlocks, inhibits, and other safety features that prevent inadvertent exposures.	Select Status		
A1.2.4.10.2.2.15. A copy of the RPO/RSO approved Radiation Protection Program RF Use Request Authorization.	Select Status		
A1.2.4.10.2.2.16. A copy of the PSWG and Range Safety and RPO/RSO (appropriate local safety authority) approved site plan.	Select Status		
A1.2.4.10.2.2.17. A list and summary of test plans, test procedures, and test results in accordance with 8.1.3.	Select Status		
A1.2.4.10.3. Flight Hardware Laser System (Class 1M, 2M, 3B, and 4) Data. At a minimum, the following laser system data shall be submitted:	Select Status		
A1.2.4.10.3.1. A general description of the system and its operation including how, where, why, and by whom the laser will be used; the laser system also includes calibration equipment.	Select Status		
A1.2.4.10.3.2. Drawings of the system that identify and show the location and operation of all components, interfaces, safety interlocks, and stops.	Select Status		
A1.2.4.10.3.3. For lasers that generate or use hazardous or corrosive materials, the data required for hazardous materials as described in A1.2.4.13.2 of this attachment.	Select Status		
A1.2.4.10.3.4. For lasers that use cryogenic fluids for cooling or operational enhancement, the data required for cryogenic systems and hazardous materials as described in A1.2.4.13.2 of this attachment.	Select Status		
A1.2.4.10.3.5. For laser systems using high voltages and/or high capacitance, the data required for electrical ground support equipment as described in A1.2.5.10 of this attachment.	Select Status		
A1.2.4.10.3.6. Laser System Performance Data.	Select Status		
A1.2.4.10.3.6.1. Type, class, nomenclature, manufacturer model number, general identification, and other pertinent information.	Select Status		
A1.2.4.10.3.6.2. General description of the test, pertinent drawing of the operation site, and associated equipment.	Select Status		
A1.2.4.10.3.6.3. Lasing material.	Select Status		
A1.2.4.10.3.6.4. Continuous wave (CW) or pulse identification.	Select Status		
A1.2.4.10.3.6.5. Wavelength.	Select Status		
A1.2.4.10.3.6.6. Bandwidth.	Select Status		
A1.2.4.10.3.6.7. Average power and/or energy per pulse and/or maximum output energy.	Select Status		

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A1.2.4.10.3.6.8. Pulse duration and pulse rate.	Select Status		
A1.2.4.10.3.6.9. Beam width at 1/e point for both axes.	Select Status		
A1.2.4.10.3.6.10. A sketch of the beam pattern and location and energy density of hot spots and effects of weather and reflectivity.	Select Status		
A1.2.4.10.3.6.11. Beam divergence at 1/e point for both axes.	Select Status		
A1.2.4.10.3.6.12. Emergent beam diameter.	Select Status		
A1.2.4.10.3.6.13. Coolant.	Select Status		
A1.2.4.10.3.6.14. Amount of energy reflected back through the eyepiece or pointing device.	Select Status		
A1.2.4.10.3.6.15. Electrical voltage applied to the system.	Select Status		
A1.2.4.10.3.6.16. Any other pertinent laser parameter such as distribution of energy on-beam and scan rate as determined by the payload project or the PSWG and Range Safety.	Select Status		
A1.2.4.10.3.6.17. Composition, color, and specularly or diffusely reflected surface characteristics of intended targets.	Select Status		
A1.2.4.10.3.6.18. Maximum incident energy on targets.	Select Status		
A1.2.4.10.3.6.19. Target characteristics including secondary hazards that may be affected by the laser, including fuels and other flammables, sensitive electronic components, FTSs (as applicable), and others.	Select Status		
A1.2.4.10.3.6.20. Intended method (such as binoculars or spotter scope) of viewing the beam and/or its reflections.	Select Status		
A1.2.4.10.3.6.21. Safety devices such as interlocks, filters, shutters, and aiming devices.	Select Status		
A1.2.4.10.3.6.22. Azimuth and elevation and/or electrical and mechanical elevation stops.	Select Status		
A1.2.4.10.3.7. Hazard Evaluation Data. Analysis and supporting data outlining possible laser system failures for all phases of laser system uses shall be submitted. Such data includes the following:	Select Status		
A1.2.4.10.3.7.1. All critical failure modes, failure mode effects, and failure probabilities including possible effects on secondary hazards and the subsequent results.	Select Status		
A1.2.4.10.3.7.2. Routine occupational hazard exposure that has been experienced in the past with the system or similar systems along with recommended methods for reducing or eliminating the hazards.	Select Status		
A1.2.4.10.3.8. Biophysiological Data	Select Status		
A1.2.4.10.3.8.1. Safe eye and skin distances based on occupational exposure limits.	Select Status		
A1.2.4.10.3.8.2. Safety clearance and hazard zones.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.10.3.8.3. Personal protective equipment required for personnel remaining inside clearance zones.	Select Status		
A1.2.4.10.3.9. A copy of the RPO/RSO approved Radiation Protection Plan Laser Use Request Authorization.	Select Status		
A1.2.4.10.3.10. A list and summary of test plans, test procedures, and test results in accordance with 8.2.3.	Select Status		
A1.2.4.11. Flight Hardware Ionizing Radiation Sources	I		
A1.2.4.11.1. General Data. A detailed description of the ionizing radiation sources shall be provided. The description shall include the information identified in A1.2.4.1.	Select Status		
A1.2.4.11.2. Flight Hardware Ionizing Radiation Subsystem Data. The following data shall be submitted:	Select Status		
A1.2.4.11.2.1. The final SAS (Safety Analysis Summary) as required by NPR 8715.26, Nuclear Flight Safety, and DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems, Attachment 3, Launch Forecast Report. The SAS shall be referenced in the SDP (MSPSP) and submitted as an accompanying document.	Select Status		
A1.2.4.11.2.1.1. Status reports on the SAS approval.	Select Status		
A1.2.4.11.2.1.2 Verification of approval for launch by separate correspondence in accordance with the requirements of NPR 8715.26, Nuclear Flight Safety and DAFMAN 91-110 Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems, or the equivalent.	Select Status		
A1.2.4.11.2.2. Manufacturer of the source.	Select Status		
A1.2.4.11.2.3. Date of source preparation.	Select Status		
A1.2.4.11.2.4. Source identification number.	Select Status		
A1.2.4.11.2.5. Cross-sectional sketch showing dimensions of the source.	Select Status		
A1.2.4.11.2.6. Source container or holder construction material.	Select Status		
A1.2.4.11.2.7. Physical source form such as powder or plate.	Select Status		
A1.2.4.11.2.8. Chemical source form such as metal or oxide.	Select Status		
A1.2.4.11.2.9. Strength in curies.	Select Status		
A1.2.4.11.2.10. Type of protective cover material over the source.	Select Status		
A1.2.4.11.2.11. Date and result of last wipe test.	Select Status		
A1.2.4.11.2.12. Method of sealing against leakage.	Select Status		
A1.2.4.11.2.13. Radionuclide solubility in sea water.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.11.2.14. Description, including diagrams, showing exact placement of the source in the vehicle or payload.	Select Status		
A1.2.4.11.2.15. A brief description of intended use.	Select Status		
A1.2.4.11.2.16. Radiation levels in millirem per hour for all modes of operation and all radiation container surfaces accessible to personnel.	Select Status		
A1.2.4.11.2.17. Description of potential accidents that would cause release of radioactive material including potential personnel exposure and ground contamination.	Select Status		
A1.2.4.11.2.18. A summary of the possible consequences of a release of radioactive material at the payload processing facility and launch site area including the maximum credible release and recommendations for methods to reduce or eliminate the resulting hazards.	Select Status		
A1.2.4.11.2.19. Description of recovery plans for land and sea launch abort scenarios.	Select Status		
A1.2.4.11.2.20. Location and name of responsible organization and licensed individual assigned to supervise handling of this material.	Select Status		
A1.2.4.11.2.21. Detailed nuclear system design.	Select Status		
A1.2.4.11.2.22. Normal and potentially abnormal environments and failure modes that can affect the processing, launch, and flight of a nuclear system.	Select Status		
A1.2.4.11.2.23. The predicted responses of the nuclear system to processing, launch, and flight environments and failures.	Select Status		
A1.2.4.11.2.24. The predicted resulting nuclear risk.	Select Status		
A1.2.4.11.2.25. Ground support systems design data as required by the appropriate sections of this publication.	Select Status		
A1.2.4.11.2.26. Detailed ground processing flow.	Select Status		
A1.2.4.11.2.27. A copy of the RPO/RSO approved Use Authorization or Radiation Protection Plan, as required by local Radiation Protection Program [i.e., KNPR 1860.1, KSC Ionizing Radiation Protection Program; *AFI 40-201, 45TH Space Wing Supplement Radioactive Material (RAM) Management* (ER only)].	Select Status		
A1.2.4.11.2.28. A copy of the Radiation Protection Plan as required by the (SLD30)30th SW RADSAFCOM (WR only).	Select Status		
A1.2.4.11.2.29. A list and summary of test plans, test procedures, and test results in accordance with 9.2.2.	Select Status		
A1.2.4.11.3. Flight Hardware Ionizing Radiation Producing Equipment and Devices. The following data shall be submitted:	Select Status		
A1.2.4.11.3.1. Manufacturer and model number.	Select Status		

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A1.2.4.11.3.2. A description of the system and its operation.	Select Status		
A1.2.4.11.3.3. A description of the interlocks, inhibits, and other safety features.	Select Status		
A1.2.4.11.3.4. If installed on a flight system, a diagram showing the location of the equipment or devices.	Select Status		
A1.2.4.11.3.5. A description of the radiation levels, in millirems per hour, accessible to personnel for all modes of operation and all surfaces accessible to personnel; levels with doors and access panels removed shall be included.	Select Status		
A1.2.4.11.3.6. A copy of the RPO/RSO approved Use Authorization or Radiation Protection Plan, as directed by the PSWG and required by local Radiation Protection Programs [i.e., KNPR 1860.1, KSC Ionizing Radiation Protection Program; *AFI 40-201, 45TH Space Wing Supplement Radioactive Material (RAM) Management* , (ER only), etc.], allowing the use of these radiation sources during ground processing activities.	Select Status		
A1.2.4.11.3.7. A copy of the Radiation Protection Plan as required by the (SLD30) 30th SW RADSAFCOM (WR only).	Select Status		
A1.2.4.12. Flight Hardware Acoustical Subsystems	**I**		
A1.2.4.12.1. General Data. A detailed description of acoustical hazard sources shall be provided. The description shall include the information identified in A1.2.4.1.	Select Status		
A1.2.4.12.2. Flight Hardware Acoustics Hazards Data. The following data requirements shall be submitted for acoustic hazards:	Select Status		
A1.2.4.12.2.1. The location of all sources generating noise levels that may result in hazardous noise exposure for personnel and the sound level in decibels on the A scale (dBA) for that noise.	Select Status		
A1.2.4.12.2.2. The anticipated operating schedules of these noise sources.	Select Status		
A1.2.4.12.2.3. Methods of protection for personnel who may be exposed to sound pressure levels above 85 dBA (8-hour time weighted average).	Select Status		
A1.2.4.12.2.4. A copy of the Bioenvironmental Engineering approval, as applicable, stating the equipment and controls used are satisfactory.	Select Status		
A1.2.4.13. Flight Hardware Hazardous Materials Subsystems	**I**		
A1.2.4.13.1. General Data. A detailed description of the hazardous materials shall be provided. The description shall include the information identified in A1.2.4.1.	Select Status		
A1.2.4.13.2. Flight Hardware Hazardous Materials Data. At a minimum, the following hazardous materials data shall be submitted:	Select Status		
A1.2.4.13.2.1. A list of all hazardous materials on the flight system and used in ground processing.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.13.2.2. A description of how each of these materials and liquids is used and in what quantity.	Select Status		
A1.2.4.13.2.3. A description of flammability and, if applicable, explosive characteristics.	Select Status		
A1.2.4.13.2.4. A description of toxicity including TLV and other exposure limits, if available.	Select Status		
A1.2.4.13.2.5. A description of compatibility including a list of all materials that may come in contact with a hazardous liquid or vapor with test results provided or referenced.	Select Status		
A1.2.4.13.2.6. A description of electrostatic characteristics with test results provided or referenced, including bleed-off capability of the as used configuration.	Select Status		
A1.2.4.13.2.7. A description of personal protective equipment to be used with the hazardous material and liquid.	Select Status		
A1.2.4.13.2.8. A summary of decontamination, neutralization, and disposal procedures.	Select Status		
A1.2.4.13.2.9. A Safety Data Sheet (SDS) for each hazardous material and liquid on flight hardware or used in ground processing; the SDS shall be available for review at each location in which the material is stored or used.	Select Status		
A1.2.4.13.2.10. Description of any detection equipment, location, and proposed use.	Select Status		
A1.2.4.13.2.11. Additional Data for Plastic Materials	Select Status		
A1.2.4.13.2.11.1. Identification of the cleaning methods to be used to maintain surface cleanliness and conductivity, if applicable.	Select Status		
A1.2.4.13.2.11.2. Identification of the minimum acceptable voltage accumulation levels for the plastic materials or operations.	Select Status		
A1.2.4.13.2.11.3. Identification of the method for ensuring conductivity between adjoining pieces of the plastic materials.	Select Status		
A1.2.4.13.2.11.4. Assessment of the environmental effects on plastic materials such as humidity, ultraviolet light, and temperature that could cause degradation of conductivity flammability or electrostatic properties.	Select Status		
A1.2.4.13.2.12. A list and summary of test plans, test procedures, and test results in accordance with Volume 3 section 10.2.	Select Status		
A1.2.4.14. Computing Systems Data. The payload project shall provide the following information to the PSWG and Range Safety in the SDP (MSPSP):	Select Status		
A1.2.4.14.1. System description including hardware, software, and layout of operator console and displays.	Select Status		
A1.2.4.14.2. Flow charts or diagrams showing hardware data busses, hardware interfaces, software interfaces, data flow, and power systems.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.14.3. Logic diagrams, Software Design Descriptions (SDDs).	Select Status		
A1.2.4.14.4. Operator user manuals and documentation.	Select Status		
A1.2.4.14.5. List and description of all safety critical computer system functions, including interfaces.	Select Status		
A1.2.4.14.6. Software hazard analyses. ***Note: "Software hazard analysis" is a subsystem hazard analysis of a hazardous or safety-critical system and is synonymous with the term "software safety analysis" covered in NASA-STD-8739.8 and NASA-GB-8719.13.***	Select Status		
A1.2.4.14.7. Software Test Plans (STPs), Software Test Descriptions (STDs), and Software Test Results (STRs) in accordance with IEEE/EIA 12207, NPR 7150.2 NASA Software Engineering Requirements and NASA-STD-8739.8, NASA Software Assurance and Software Safety Standard.	Select Status		
A1.2.4.14.8. Software Development Plan (SDP) that includes discussions on conformance with applicable coding standards, configuration control, PLCs, COTS, and software reuse. (for example, see Space and Missile Systems Center (SMC) Standard SMC-S-012, *Software Development*)	Select Status		
A1.2.4.14.9. Documentation describing Independent Validation & Verification (IV&V) process used to ensure safety requirements have been correctly and completely implemented.	Select Status		
A1.2.4.14.10. Software Safety Plan identifying software safety activities, data, and documentation created in development of software in a safety-critical system.	Select Status		
A1.2.5. Ground Support Systems	I		
A1.2.5.1. At a minimum, the "ground support system" section shall include the following information and the specific data requirements listed in A1.2.5.6 through A1.2.5.19 below:	Select Status		
A1.2.5.1.1. Subsystem overview.	Select Status		
A1.2.5.1.2. Nomenclature of major subsystems.	Select Status		
A1.2.5.1.3. Function of the subsystem.	Select Status		
A1.2.5.1.4. Location of the subsystem.	Select Status		
A1.2.5.1.5. Operation of the subsystem.	Select Status		
A1.2.5.1.6. Subsystem design parameters.	Select Status		
A1.2.5.1.7. Subsystem test requirements.	Select Status		
A1.2.5.1.8. Subsystem operating parameters.	Select Status		
A1.2.5.1.9. Summaries of any PSWG and Range Safety required hazard analyses conducted.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.2. Supporting data shall be included or summarized and referenced as appropriate with availability to Range Safety upon request.	Select Status		
A1.2.5.3. Tables, matrixes, and sketches are required for systems and component data. (See A1.2.4.7.2 and A1.2.4.7.3 for suggestions.)	Select Status		
A1.2.5.4. Required analyses, test plans, and test results may be included in the SDP (MSPSP) as appendixes or submitted separately. At a minimum, analyses, test plans, and test reports shall be listed, referenced, and summarized in the SDP (MSPSP).	Select Status		
A1.2.5.5. A list of all PSWG and Range Safety approved noncompliances.	Select Status		
A1.2.5.6. Ground Support Material Handling Equipment. Design and test plan data for the following government payload processing facility contractor and payload project furnished material handling equipment (MHE) shall be provided.	Select Status		
A1.2.5.6.1. General Data. A detailed description of MHE shall be provided. The description shall include the information identified in A1.2.5.1.	Select Status		
A1.2.5.6.2. Ground Support Slings Used to Handle Critical Hardware. At a minimum, the following data is required:	Select Status		
A1.2.5.6.2.1. SFP analysis.	Select Status		
A1.2.5.6.2.2. NDE plan and test results for SFP components.	Select Status		
A1.2.5.6.2.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.6.2.4. Stress analysis.	Select Status		
A1.2.5.6.3. Ground Support Below-the-Hook Lifting Devices. At a minimum, the following documentation is required:	Select Status		
A1.2.5.6.3.1. SFP analysis.	Select Status		
A1.2.5.6.3.2. NDE plan and test results for SFP components.	Select Status		
A1.2.5.6.3.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.6.3.4. Stress analysis.	Select Status		
A1.2.5.6.4. Ground Support Handling Structures Used to Handle Critical Hardware. At a minimum, the following documentation is required:	Select Status		
A1.2.5.6.4.1. SFP analysis.	Select Status		
A1.2.5.6.4.2. NDE plan and test results for SFP and non-SFP components and SFP and non-SFP welds.	Select Status		

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A1.2.5.6.4.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.6.4.4. Stress analysis for structures.	Select Status		
A1.2.5.6.4.6. O&SHA and FMECA analyses for structural mechanisms like spin tables, rotating structures, and portable launch support frames.	Select Status		
A1.2.5.6.5. Support Structures Used to Handle Critical Hardware. At a minimum, the following documentation is required:	Select Status		
A1.2.5.6.5.1. SFP analysis.	Select Status		
A1.2.5.6.5.2. NDE plan and test results for SFP and non-SFP components and SFP and non-SFP welds.	Select Status		
A1.2.5.6.5.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.6.5.4. Stress analysis for structures.	Select Status		
A1.2.5.6.6. Ground Support LPDs and Load Measuring/Indicating Devices Used to Handle Critical Hardware. At a minimum, the following documentation is required:	Select Status		
A1.2.5.6.6.1. SFP analysis.	Select Status		
A1.2.5.6.6.2. NDE plan and test results for SFP components and SFP welds.	Select Status		
A1.2.5.6.6.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.6.6.4. Stress analysis.	Select Status		
A1.2.5.6.7. Ground Support Rigging Hardware Used to Handle Critical Hardware. At a minimum, the following documentation is required:	Select Status		
A1.2.5.6.7.1. SFP analysis.	Select Status		
A1.2.5.6.7.2. NDE plan and test results for SFP components.	Select Status		
A1.2.5.6.7.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.6.8. Flight Hardware Used to Lift Critical Hardware. At a minimum, the following documentation is required:	Select Status		
A1.2.5.6.8.1. SFP analysis.	Select Status		
A1.2.5.6.8.2. NDE plan and test results for SFP components and SFP welds.	Select Status		
A1.2.5.6.8.3. Initial proof test plan and test results.	Select Status		
A1.2.5.6.8.4. Stress analysis.	Select Status		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.6.9. MHE Used to Handle Non-Critical Hardware. At a minimum, the initial proof load test plan and results shall be documented and be made available upon request.	Select Status		
A1.2.5.8. Removable, Extendible, and Hinged Personnel Work Platforms. At a minimum, the following documentation is required:	Select Status		
A1.2.5.8.1. SFP analysis.	Select Status		
A1.2.5.8.2. NDE plan and test results for SFP and non-SFP components and SFP and non-SFP welds.	Select Status		
A1.2.5.8.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.8.4. Stress analysis.	Select Status		
A1.2.5.9. Ground Support Pressure and Propellant Systems	I		
A1.2.5.9.1. General Data. A detailed description of the pressure and propellant systems shall be provided. The description shall include the information identified in A3.2.5.1, A3.2.4.7.1.1, A3.2.4.7.1.2, A3.2.4.7.1.3 as well as the in-service operating, maintenance, and ISI plan.	Select Status		
A1.2.5.9.2. Ground Support Pressure and Propellant System Data. The system data as identified in A3.2.4.7.2 shall be submitted in addition to a copy of any DOT approved exemptions for mobile and portable hazardous pressure systems.	Select Status		
A1.2.5.9.3. Ground Support Pressure and Propellant System Component Design Data. At a minimum, the information identified in A1.2.4.7.3 shall be submitted for ground support pressure system components.	Select Status		
A1.2.5.10. Ground Support Electrical and Electronic Subsystems	I		
A1.2.5.10.1. General Data. A detailed description of electrical and electronic subsystems shall be provided. The description shall include the information identified in A3.2.2.5.1.	Select Status		
A1.2.5.10.2. EGSE Battery Design Data. At a minimum, the battery design data identified in A3.2.4.8.2 shall be provided for EGSE batteries.	Select Status		
A1.2.5.10.3. EGSE Design Data. The following EGSE design data is required:	Select Status		
A1.2.5.10.3.1. Identification of EGSE and its use.	Select Status		
A1.2.5.10.3.2. A description of how faults in the EGSE circuitry that can create a hazardous condition are prevented from propagating into the flight system.	Select Status		
A1.2.5.10.3.3. A description of how inadvertent commands that can cause a hazardous condition are prevented.	Select Status		
A1.2.5.10.3.4. Identification of potential shock hazards.	Select Status		
A1.2.5.10.3.5. A description of how the intent of the NFPA is met with respect to hazardous atmospheres.	Select Status		

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A1.2.5.10.3.6. Identification of all non-explosion proof equipment powered up during and after propellant loading.	Select Status		
A1.2.5.10.3.7. For explosion proof and intrinsically safe equipment approved by a nationally recognized testing laboratory, the following information shall be provided:	Select Status		
A1.2.5.10.3.7.1. Manufacturer.	Select Status		
A1.2.5.10.3.7.2. Model number.	Select Status		
A1.2.5.10.3.7.3. Hazardous location class and group.	Select Status		
A1.2.5.10.3.7.4. Operating temperature.	Select Status		
A1.2.5.10.3.8. For any explosion proof equipment or components not having a fixed label from a nationally recognized testing laboratory, the data and certification shall be available for inspection in the facility of use.	Select Status		
A1.2.5.10.3.9. Test data and certification on custom or modified equipment that cannot be certified by a nationally recognized testing laboratory for explosion proof equipment.	Select Status		
A1.2.5.10.3.10. Test results for all payload project designed, built, or modified intrinsically safe apparatus as required by a nationally recognized testing laboratory in accordance with UL 913.	Select Status		
A1.2.5.10.3.11. A bent pin analysis for all connectors for safety critical or hazardous systems that have spare pins.	Select Status		
A1.2.5.11. Ground Support Ordnance Subsystems	**I**		
A1.2.5.11.1. General Data. A detailed description of ordnance subsystems shall be provided. The description shall include the information identified in A1.2.5.1.	Select Status		
A1.2.5.11.2. Ordnance Ground Systems Design Data. The following ordnance ground systems design data is required:	Select Status		
A1.2.5.11.2.1. A complete description of the ground test equipment that will be used in the checkout of ordnance devices and systems, including general specifications and schematics for all test equipment.	Select Status		
A1.2.5.11.2.2. Specifications, schematics, and a complete functional description of the low voltage stray current monitor.	Select Status		
A1.2.5.11.2.3. Schematics of all ordnance system monitor circuits from the ordnance component pick-off points to the PSC termination.	Select Status		
A1.2.5.11.2.4. Calibration data for all monitor circuit terminations that will be provided to the PSC.	Select Status		
A1.2.5.11.2.5. A complete and detailed description of the airborne and ground ordnance telemetry system and how it functions, including general specifications and schematics.	Select Status		

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A1.2.5.11.2.6. The following information is required for ordnance continuity and bridgewire resistance measurement devices:	Select Status		
A1.2.5.11.2.6.1. Maximum safe no-fire energy of the ordnance being tested.	Select Status		
A1.2.5.11.2.6.2. A declaration of any certification currently in effect for the instrument along with the manufacturer specifications including:	Select Status		
A1.2.5.11.2.6.2.1. Range.	Select Status		
A1.2.5.11.2.6.2.2. Accuracy.	Select Status		
A1.2.5.11.2.6.2.3. Power supply and recharge capability.	Select Status		
A1.2.5.11.2.6.2.4. Self-test features.	Select Status		
A1.2.5.11.2.6.2.5. Schematics.	Select Status		
A1.2.5.11.2.6.3. Failure analysis including the outcome of the energy analysis (open circuit or maximum terminal voltage) and current limit analysis (short circuit or maximum output current).	Select Status		
A1.2.5.11.2.6.4. Instrument description including any modifications required for operational use and details of safety design features such as interlocks.	Select Status		
A1.2.5.11.2.6.5. Description of intended operations.	Select Status		
A1.2.5.11.2.7. The following information is required for monitor circuit outputs:	Select Status		
A1.2.5.11.2.7.1. Tolerances.	Select Status		
A1.2.5.11.2.7.2. Maximum and minimum values.	Select Status		
A1.2.5.11.2.8. For high voltage exploding bridgewires, the nominal gap breakdown voltage tolerance.	Select Status		
A1.2.5.11.2.9. For laser initiated devices, the following information is required:	Select Status		
A1.2.5.11.2.9.1. If modified secondary (composition) explosives are used, test requirements and reports.	Select Status		
A1.2.5.11.2.9.2. Heat dissipation analysis.	Select Status		
A1.2.5.11.2.10. Ordnance Hazard Classifications and Categories.	Select Status		
A1.2.5.11.2.10.1. DoD/UN hazard classifications (class, division, and compatibility group) in accordance with DESR 6055.09_AFMAN 91-201, Explosive Safety Standards.	Select Status		
A1.2.5.11.2.10.2. DOT classification.	Select Status		

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A1.2.5.11.2.10.3. The ordnance device and system hazard category for each ordnance item and system.	Select Status		
A1.2.5.11.2.10.4. Test results and/or analysis used to classify the ordnance devices and systems.	Select Status		
A1.2.5.11.2.11. A list and summary of test plans, test procedures, and test results, as required.	Select Status		
A1.2.5.11.3. Ground Support Ordnance Handling and Storage Data. Specific requirements for handling and storing the ground support ordnance shall be submitted.	Select Status		
A1.2.5.12. Ground Support Non-Ionizing Radiation Source Data	I		
A1.2.5.12.1. General Data. A detailed description of non-ionizing subsystems shall be provided. The description shall include the information identified in A1.2.5.1.	Select Status		
A1.2.5.12.2. Ground Support RF Emitter Data. The information identified in A1.2.4.10.2 shall be submitted for RF emitters.	Select Status		
A1.2.5.12.3. Ground Support Laser Systems. At a minimum, the laser system data requirements identified in A1.2.4.10.3 shall be submitted.	Select Status		
A1.2.5.13. Ground Support Ionizing Radiation Source Data	I		
A1.2.5.13.1. General Data. A detailed description of ionizing subsystems shall be provided. The description shall include the information identified in A1.2.5.1.	Select Status		
A1.2.5.13.2. Ionizing Radiation Sources Data. At a minimum, the data identified in A1.2.4.11.3 shall be provided for all ground radiation producing sources.	Select Status		
A1.2.5.14. Ground Support Acoustic Hazards	I		
A1.2.5.14.1. General Data. A detailed description of acoustical hazards and subsystems shall be provided. The description shall include the information identified in A1.2.5.1.	Select Status		
A1.2.5.14.2. Acoustic Hazards Data. The data identified in A1.2.4.12.2 shall be submitted for acoustic hazards.	Select Status		
A1.2.5.15. Ground Support Hazardous Materials	I		
A1.2.5.15.1. General Data. A detailed description of hazardous materials and subsystems shall be provided. The description shall include the information identified in A1.2.5.1.	Select Status		
A1.2.5.15.2. Ground Support Hazardous Materials Data. The hazardous materials data identified in A1.2.4.13.2 shall be submitted.	Select Status		
A1.2.5.17. Motor Vehicle Data. At a minimum, the following data shall be provided for motor vehicles:	Select Status		
A1.2.5.17.1. General Vehicle Data	I		

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A1.2.5.17.1.1. Documentation certifying that vehicles used to transport bulk hazardous material on the range comply with DOT requirements or are formally exempted by DOT.	Select Status		
A1.2.5.17.1.2. If DOT certification or exemption documentation is not available, the following information is required:	Select Status		
A1.2.5.17.1.2.1. Design, test, and inspection requirements.	Select Status		
A1.2.5.17.1.2.2. Stress analysis.	Select Status		
A1.2.5.17.1.2.3. SFP analysis.	Select Status		
A1.2.5.17.1.2.4. FMECA.	Select Status		
A1.2.5.17.1.2.5. Comparison analysis with similar DOT approved vehicle.	Select Status		
A13.2.5.17.1.2.6. “Equivalent safety” (meets DOT intent) analysis.	Select Status		
A1.2.5.17.2. Special-Purpose Trailer Data	**I**		
A1.2.5.17.2.1. Stress analysis.	Select Status		
A1.2.5.17.2.2. SFP analysis.	Select Status		
A1.2.5.17.2.3. Initial proof load test plan and test results.	Select Status		
A1.2.5.17.2.4. Initial road test plan and test results.	Select Status		
A1.2.5.17.2.5. NDE plan and test results for SFPs.	Select Status		
A1.2.5.17.3. Lift Trucks Data	**I**		
A1.2.5.17.3.1. Certification that the lift truck meets applicable national standards such as ASME B56 Series Safety Standards.	Select Status		
A1.2.5.17.3.2. For personnel platforms on lift trucks.	Select Status		
A1.2.5.17.3.2.1. Stress analysis.	Select Status		
A1.2.5.17.3.2.2. SFP analysis.	Select Status		
A1.2.5.17.3.2.3. NDE plan and test results for SFP components and SFP welds.	Select Status		
A1.2.5.17.3.2.4. Proof load test plan and test results.	Select Status		
A.2.5.17.3.3. For lift trucks used to lift or move critical loads; maintenance plans shall be submitted for review and approval.	Select Status		

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A1.2.5.18. Computing Systems Data. The payload project shall provide the information identified in A1.2.4.14 to the PSWG in conjunction with Range Safety in the SDP (MSPSP).	Select Status		
A1.2.5.19. WR Seismic Data Requirements. The GSE data package shall identify the equipment and potential for seismic hazard and risk and shall include:	Select Status		
A1.2.5.19.1. GSE designation and applicable drawing numbers.	Select Status		
A1.2.5.19.2. Whether the equipment is new or existing.	Select Status		
A1.2.5.19.3. GSE description; for example, weight, materials, structural system.	Select Status		
A1.2.5.19.4. How the GSE is used and where and how it is stored.	Select Status		
A1.2.5.19.5. The length of time the GSE is used and stored.	Select Status		
A1.2.5.19.6. Estimate of potential for seismic hazard (for example, propagation to catastrophic event, personnel injury, blocking emergency egress routes, or hitting something) due to equipment failure or movement during a seismic event.	Select Status		
A1.2.5.19.7. Whether the equipment is required to be designed to meet seismic design requirements.	Select Status		
A1.2.5.19.8. Whether the equipment is required to be anchored.	Select Status		
A1.2.5.19.9. Design margin of safety under seismic loading (if applicable).	Select Status		
A1.2.5.19.10. Engineering analysis addressing how the launch vehicle, in typical configurations, will respond to a pre-defined seismic event.	Select Status		
A1.2.5.19.11. Risk analysis of items exempt from the seismic design requirements.	Select Status		
A1.2.5.19.12. Detailed description of the “safe mode” for both safety-critical equipment and equipment whose failure could result in a catastrophic event or a potential for endangering personnel.	Select Status		
A1.2.6. Compliance Checklist. A compliance checklist of all design, test, analysis, and data submittal requirements in this chapter shall be provided. The checklist shall indicate for each requirement if the proposed design is compliant, non-compliant but meets intent, non-compliant (waiver required) or non-applicable.	Select Status		
A1.2.6.1. Criteria/requirement.	Select Status		
A1.2.6.2. System.	Select Status		
A1.2.6.3. Compliance.	Select Status		
A1.2.6.4. Noncompliance.	Select Status		
A1.2.6.5. Not applicable.	Select Status		

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A1.2.6.6. Resolution.	Select Status		
A1.2.6.7. Reference.	Select Status		
A1.2.6.8. Copies of all Range Safety approved noncompliances including waivers and equivalent levels of safety certifications.	Select Status		
A1.3. MODIFICATIONS TO THE SAFETY DATA PACKAGE (SDP)	Select Status		
The change section contains a summary of all changes to the last edition of the SDP (MSPSP). All changes shall be highlighted using change bars or similar means of identification.	Select Status		

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS AND MATERIAL, GROUND OPERATIONS SAFETY REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
VOLUME 6 INTRODUCTION	**I**		
Volume 6 Contains NASA and USSF Range Safety User Requirements applicable for NASA Payload projects and related personnel and equipment, systems, and material operations on NASA contracted facilities being conducted on USSF ranges, primarily, the Eastern Range (ER) operated by USSF SLD45, and the Western Range (WR), operated by SLD30. This volume, as does this publication, applies to all NASA Payload projects, payload project related operations, payload project related personnel (NASA, contractors, or persons with other agencies) whether involved directly on the project, a payload instrument, GSE or the facility. Like the rest of this publication, this requires tailoring to accommodate NASA Payload projects processing and launching from USSF ranges. This publication may be tailored for other ranges and launch facilities however local range and safety requirements must be included and coordinated in the tailoring.	**I**		

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CHAPTER 1 INTRODUCTION	I		
1.1. Applicability	I		
All NASA Payload projects are subject to the requirements of this volume to ensure that operations are conducted safely.	I		
1.2. Organization of the Volume	I		
1.2.1. Main Chapters. The main chapters of this volume include common requirements for all payload risk classifications. Appendixes include additional requirements to supplement the main chapters.	I		
1.2.2. Open Text. The open text contains the actual mandatory performance-based requirements. The only tailoring expected for these requirements would be the deletion of non-applicable requirements. For example, solid rocket motor performance requirements would be deleted for launch systems that do not use solid rocket motors.	I		
1.2.3. Bordered Paragraphs	I		
1.2.3.1. Bordered paragraphs are non-mandatory and are used to identify some of the potential detailed technical solutions that meet the performance requirements. In addition, the bordered paragraphs contain lessons learned from previous applications of the performance requirement, where a certain design may have been found successful, or have been tried and failed to meet the requirement. These technical solutions are provided for the following reasons:	I		
1.2.3.1.1. To aid the tailoring process between the PSWG, Range Safety and the payload project in evaluating a potential system against all the performance requirements.	I		
1.2.3.1.2. To aid the PSWG, Range Safety and the payload project in implementing lessons learned.	I		
1.2.3.1.3. To provide benchmarks that demonstrate what the PSWG and Range Safety considers an acceptable technical solution/implementation of the performance requirement and to help convey the level of safety the performance requirement is intended to achieve.	I		
1.2.3.2. The technical solutions in the bordered paragraphs may be adopted into the tailored version of the requirements for a specific program when the payload project intends to use that solution to meet the performance requirement. At this point, they become mandatory requirements to obtain the PSWG and Range Safety approval. This process is done to:	I		
1.2.3.2.1. Provide an appropriate level of detail necessary for contractual efforts and to promote efficiency in the design process.	I		
1.2.3.2.2. Avoid contractual misunderstandings that experience has shown often occur if an appropriate level of detail is not agreed to. The level of detail in the bordered paragraphs is necessary to avoid costly out-of-scope contractual changes and to prevent inadvertently overlooking a critical technical requirement.	I		

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1.2.3.3. The payload project always has the option to propose alternatives to the bordered paragraph solutions. Payload project proposed solutions shall be evaluated against requirements in this standard. Payload project proposed alternative solutions shall achieve an equivalent level of Safety and be approved by the PSWG and Range Safety. After meeting these two requirements, the payload project proposed solutions become part of the tailored requirements from this publication for that specific project.	**I**		
1.2.3.4. The PSWG and Range Safety determines whether the payload project proposed detailed technical solutions meet the intent of this document.	**I**		
1.3. Compliance Documents	**I**		
Occupational Safety and Health Administration (OSHA) (29 CFR), Environmental Protection Agency (EPA) (40 CFR), Department of Transportation (DOT) (49 CFR), FAA (see V1, § 2.4), and NASA procedural requirements (NPRs) documents including NPR 8715.7, NASA Standards, Air Force and Space Force manuals, instructions, and directives along with industry standards are specified as compliance documents throughout this volume. When there is a conflict between federal regulations, industry standards, local requirements, and other requirements, the more stringent requirement shall be used.	**Select Status**		

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CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES	I		
2.1. Payload Safety Working Group	I		
The PSWG consists of safety engineers and personnel from the NASA payload project (NASA and contractor), NASA Launch Services SMA as applicable, launch site range safety, the launch services provider contractor organization, the payload processing facility safety representative, the payload or sample recovery organization (as needed), subject matter experts, others as needed, and with participation from the Launch Site Integration Manager (LISM) as required. The PSWG is responsible for ensuring the review and approval of all safety deliverables required by this document. Specific responsibilities of the PSWG are provided in NPR 8715.7 and include the following:	I		
2.1.1. Review and Approval	I		
2.1.1.2. Ground Operations Plans (GOPs).	I		
2.1.1.6. Other documents as specified in this publication and NPR 8715.7.	I		
2.1.1.7. During the review and approval process, both the PSWG and the payload project shall assure timely coordination with other authorities as appropriate. Other authorities include, but are not limited to, appropriate Radiation Officer (RPO), Environmental Health, Institutional Safety, Pad Safety, Occupational Health/Medical, Civil Engineering, and the Fire Department.	Select Status		
2.1.2. General	I		
2.1.2.1. Ensuring that hazardous and safety critical facilities are periodically inspected as required.	I		
2.1.2.2. Monitoring hazardous and safety critical operations.	I		
2.1.2.3. Defining the threat envelopes of all hazardous operations that may affect public safety or launch base safety and establishing safety clearance zones.	I		
2.1.3. Pad Safety. Although the following are not payload project requirements, it is intended that the payload project be familiar with some of the key responsibilities of the Pad Safety function as they relate to the payload project's safety requirements. Pad Safety functions are performed by the local launch pad Ground Safety organization, referred to as Pad Safety. ***Note: The payload project should also be familiar with the Payload Processing Facility (PPF) safety requirements, facility features and facility personnel responsibilities and functions as they relate to the payload project's operations and safety.***	I		
2.1.3.1. General Responsibilities. Pad Safety shall participate in meetings and events as directed by Range Safety, including the following.	Select Status		

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2.1.3.1.1. All personnel shall observe, evaluate, and enforce compliance of Range Safety requirements within the launch complexes, assembly and checkout areas, propellant and ordnance storage areas, and other areas as deemed appropriate by Range Safety. ***Note: Pad Safety personnel shall not be denied access to any range area where hazardous operations are conducted.***	**Select Status**		
2.1.3.1.2. Review and provide comments on hazardous procedures to Range Safety.	**Select Status**		
2.1.3.1.3. Review and provide comments on system design data and operating procedures.	**Select Status**		
2.1.3.1.4. Implement specified safety precautions and impose safety holds, when necessary, during ground operations, as required by procedures or OSP.	**Select Status**		
2.1.3.1.5. Assist in the resolution of safety problems in areas where Pad Safety has jurisdiction.	**Select Status**		
2.1.3.1.6. Attend meetings and conferences that involve safety working groups and facility working groups, technical interchange meetings, etc., as necessary.	**Select Status**		
2.1.3.1.7. Coordinate with the RPO/RSO to ensure enforcement of the Radiation Control Program in all areas where launch vehicles, payloads, and their related hazards are located.	**Select Status**		
2.1.3.1.8. Coordinate with Bioenvironmental Engineering and Environmental Health (both Health Physics and Industrial Hygiene) on environmental health hazards.	**Select Status**		
2.1.3.1.9. Notify Environmental Health, Range Safety, Range Scheduling (SLD 30), and Cape Support (SLD 45), the installation Fire Department and the Command Post immediately anytime an incident involves an environmental health hazard.	**Select Status**		
2.1.3.1.10. When present, Pad Safety shall ensure the evacuation of personnel from launch complexes and facilities and operations are halted when a lightning hazard is imminent in accordance with the various safety plans.	**Select Status**		
2.1.3.1.11. Respond to mishaps and/or incidents in accordance with the SLD Installation Emergency Management Plan (IEMP).and the AFI 10-2501, Emergency Management Program.	**Select Status**		
2.1.3.1.12. Assist payload projects on safety related issues.	**Select Status**		
2.1.3.2. Hazardous and Safety Critical Pad Support. Pad Safety shall provide oversight of the payload project when the hazards of the activity are unique and not covered by OSHA, and when hazardous operations have the potential to endanger beyond the boundaries of the launch complex, as follows:	**Select Status**		
2.1.3.2.1. Ensure compliance with established directives and procedures during hazardous and safety critical operations.	**Select Status**		
2.1.3.2.2. Assess procedure deviations and resolve with Range Safety, as necessary.	**Select Status**		

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2.1.3.2.3. Ensure the number of personnel is kept to a minimum in designated safety clearance zones in accordance with Range Safety approved procedures. ***Note: Pad Safety shall be included in the maximum allowable manning level, unless Range Safety determines that adequate support can be provided from a remote location.***	**Select Status**		
2.1.3.2.4. Ensure a comprehensive safety briefing is conducted and understood by participants prior to the start of a hazardous operation.	**Select Status**		
2.1.3.2.5. Control personnel access into safety clearance zones during hazardous operations.	**Select Status**		
2.1.3.2.6. Advise the operation control authority on whether or not to stop operations when a hazardous condition or a safety compromise exists.	**Select Status**		
2.1.3.2.7. Allow operations to resume only after the imminent danger no longer exists and safety requirements are met.	**Select Status**		
2.1.3.3. Notifications	**I**		
2.1.3.3.1. Immediately notify the appropriate agency (Command Post at the SLD 30 and Range Safety at SLD 45) of any launch vehicle or payload mishap, hazard, handling malfunction, or other incident creating or contributing to an unsafe condition for personnel or critical hardware.	**Select Status**		
2.1.3.3.2. Verbally notify Range Safety of any violation of this document as soon as possible. If requested by Range Safety, a written report shall be provided to Range Safety within five calendar days of the violation.	**Select Status**		
2.1.3.4. Flight Termination System (FTS) Installation, Checkout, and Status. Monitor and verify the installation, checkout, and status of the FTS in accordance with Range Safety instructions at locations designated by Range Safety.	**Select Status**		
2.1.3.5. Inspections	**I**		
2.1.3.5.1. Inspect all explosive areas and facilities at least annually to determine compliance with the requirements of this document and DESR 6055.09_AFMAN 91-201, Explosives Safety Standards. These duties are performed by Weapons Safety Office (SEW).	**Select Status**		
2.1.3.5.2. Inspect critical facilities prior to the start of a hazardous operation or as directed by Range Safety.	**Select Status**		
2.1.3.5.3. Inspect new and modified critical facilities prior to the initial startup operation, prepare inspection reports on these facilities, and submit the reports to Range Safety within 15 calendar days of the inspection.	**Select Status**		
2.1.3.5.4. Audit the execution of procedures for handling ordnance, propellant material, and high pressure gases performed on CCSFS and VSFB at least quarterly.	**Select Status**		
2.2. Payload Project Responsibilities	**I**		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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Payload projects are responsible for the following:	I		
2.2.1. Conduct of Operations	I		
2.2.2.1. Planning and conducting hazardous and safety critical operations in accordance with procedures approved by the appropriate local safety authority.	Select Status		
2.2.2.2. Planning and conducting operations in accordance with the current edition of the applicable OSP for the launch complex, facility, or area in use, including ordnance and propellant operations and areas.	Select Status		
2.2.2.3. Planning and conducting other operations in accordance with the current edition of other safety plans, as applicable.	Select Status		
2.2.3. Notification of Hazardous and Safety Critical Operations to Range Agencies	I		
2.2.3.1. Notifying Cape Support (321-853-5211) for the ER and Range Scheduling (805-606-8825) for the WR at least 24 hours before the start of any hazardous system operation while on the Range. The following information shall be provided: date, time, nature of the operation, location, and procedure or task number.	Select Status		
2.2.3.2. Notifying Range Safety and Pad Safety of all hazardous and safety critical operations and tests that are planned to take place at the Range.	Select Status		
2.2.3.3. Notifying Range Safety and Pad Safety at least 30 calendar days before the scheduled erection of a launch vehicle and/or payload.	Select Status		
2.2.4. Document Preparation and Maintenance	I		
2.2.4.1. Developing and implementing a Ground Operations Plan (GOP) in accordance with Attachment 1 of this volume to cover operations conducted on the payload processing facility and launch site area.	Select Status		
2.2.4.2. Developing and implementing procedures and general instructions to cover all operations conducted at the payload processing facility and launch site area.	Select Status		
2.2.4.3. Developing, obtaining appropriate safety approval as determined by the PSWG and Range Safety, and implementing procedures related to hazardous and safety critical operations.	Select Status		
The designation of a procedure as "Hazardous" or "Non-Hazardous" is evaluated on a case-by-case basis and does not necessarily result in mandatory Pad Safety coverage of the operation. The requirements for hazardous procedures may be found in Attachment 2 of this volume.	I		
2.2.4.4. Obtaining appropriate safety authority approval of new procedures or revisions to previously approved procedures when there is an impact to the safe conduct of the procedure.	Select Status		

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2.2.4.5. Developing and implementing a program to control hazardous energy sources by locking and tagging in accordance with lockout/tagout approved procedures.	Select Status		
2.2.4.6. Developing, obtaining appropriate safety approval as determined by the PSWG and Range Safety, and implementing a propellant off-load plan and procedure.	Select Status		
2.2.4.7. Developing, obtaining the PSWG and Range Safety approval, and implementing an Emergency Response Plan (ERP) for graphite/epoxy composite overwrapped and Kevlar-wrapped pressure vessels.	Select Status		
2.2.4.8. Developing, implementing, and maintaining records for an In-Service Inspection (ISI) Plan in accordance with the requirements of this volume and Volume 3.	Select Status		
2.2.4.9. Developing, implementing, and maintaining records for a Nondestructive Examination (NDE) Plan in accordance with the requirements of this volume and Volume 3.	Select Status		
2.2.4.14. Obtaining appropriate approval for procedures in accordance with KNPR 8715.3, Kennedy NASA Procedural Requirements; *AFI 40-201, 45TH Space Wing Supplement Radioactive Material (RAM) Management*, DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems; or other local safety authorities and respective safety requirements, as required.	Select Status		
2.2.4.17. Developing and implementing a training plan for all payload project personnel performing hazardous and safety critical procedures and operations and submitting an outline of this training plan to the PSWG for the PSWG and Range Safety for approval.	Select Status		
The local safety authority responsible for review and approval of hazardous procedures should evaluate the training plan for areas that could lead to a mishap caused by inadequate training and could affect workers of other employers, range assets, and the general public.	I		
2.2.4.18. Developing pathfinder requirements in coordination with the PSWG and Range Safety.	Select Status		
2.2.4.19. At the WR, developing, obtaining SLD30/SE Range Safety approval and PSWG concurrence, and implementing a SLD/SE 30 First Use Tag Program for lifting hardware at the WR.	Select Status		
2.2.5. Operational Duties	I		
2.2.5.1. Ensuring required support and emergency elements approved by the appropriate local safety authority have continuous access to any area where hazardous conditions could occur.	Select Status		
2.2.5.2. Obtaining concurrence to proceed from the appropriate local safety authority before starting any hazardous and safety critical operations and before resuming any operation that has been interrupted resumes.	Select Status		
Interruptions include such events as a safety hold, shift change, evacuation, or breaks.	I		

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2.2.5.3. Before initiating hazardous or safety critical operations, the following shall be accomplished:	Select Status		
2.2.5.3.1. Pre-operation and shift change briefings.	Select Status		
2.2.5.3.2. Pre-operation and shift change inspections to verify proper system, facility, and area configuration; personnel and equipment support; and use of an approved procedure.	Select Status		
2.2.5.5. Observing, evaluating, and enforcing compliance with applicable safety requirements by all personnel within launch complexes, assembly, and checkout areas, propellant and ordnance storage areas, and other areas as deemed appropriate by Range Safety or the appropriate local safety authority.	Select Status		
2.2.5.6. Reviewing and providing comments on hazardous and safety critical procedures to Range Safety or the appropriate local safety authority.	Select Status		

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CHAPTER 3 GROUND OPERATIONS POLICIES	I		
3.1. Personnel Safety	I		
3.1.1. All personnel shall be protected during the performance of operations.	Select Status		
3.2. Stopping Unsafe Operations	I		
3.2.1. All personnel shall have authority to stop immediately operations or practices that, if allowed to continue, could reasonably be expected to result in death or serious physical harm to personnel or major system damage.	Select Status		
3.2.2. All personnel are authorized to stop operations or practices when imminent danger cannot be eliminated through regular channels. Personnel observing an unsafe operation or practice shall report their observations to a safety representative, an operational supervisor, or any other appropriate authority.	Select Status		
3.2.3. Notification of Action. Any action taken to stop an unsafe operation where imminent danger is involved shall be followed by direct verbal, telephone, or radio communication and notification to the appropriate safety authority. For Space Force Ranges notifications, include Pad Safety at the ER and Range Safety at the WR, the Squadron Commander, the Group Commander, or their designated representative.	Select Status		
3.2.4. Notification of Work Stoppage. The Contracting Officer or Administrator for a USSF Construction Contract shall be immediately notified of any work stoppage of their respective construction contract.	Select Status		

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CHAPTER 4 DOCUMENTATION REQUIREMENTS	I		
4.1. Ground Operations Plans	Select Status		
GOPs shall be developed in accordance with the requirements in Attachment 1 of this volume and submitted to the PSWG for PSWG and Range Safety review and approval.	Select Status		
4.1.1. The GOP provides a detailed description of hazardous and safety critical operations for processing aerospace systems and their associated ground support equipment (GSE). Along with the Safety Data Package (Missile System Prelaunch Safety Package (MSPSP)), the GOP is the medium from which payload safety approval is obtained.	Select Status		
4.1.2. A high level Ground Operations Flow Overview shall be provided at the Payload Safety Introduction Briefing. The preliminary Draft GOP is due 30 days prior to project's mission CDR for Safety Review II per NPR 8715.7. The Final GOP shall be submitted 90 days prior to the payload shipment to the processing site per NPR 8715.7. The information from a GOP may be part of the respective Safety Data Packages as an inclusion or may be a separate document. The level of detail provided in the GOP data shall be commensurate with the level of data available at the time of submission.	Select Status		
4.1.3. The final GOP shall be submitted no later than 60 days prior to the Safety Review III meeting and at least 90 days prior to intended shipment of hardware to the prelaunch payload processing site per NPR 8715.7.	Select Status		
4.1.4. The GOP shall be approved before the start of any hazardous operations.	Select Status		
4.2. Test and Inspection Plans	Select Status		
Test and inspection plans shall be developed to document the initial and recurring validation of component compliance and assessment of hazards. Test and inspection plans shall be developed for the following items that include, but are not limited to, material handling equipment, ground support pressure vessels, and ground support propellant systems. Specific requirements for each of these systems are discussed in this volume.	Select Status		
4.2.1. Equipment and System Logs and Test Records.	I		
4.2.1.1. Unless otherwise specified in a separate part of this volume that addresses a particular class of system or equipment, logs and test records shall be maintained on critical ground support systems and major fixed equipment. Logs and test records shall comply with the following:	Select Status		
4.2.1.1.1. Logs and test records shall contain chronological entries including:	Select Status		
4.2.1.1.1.1. Records of use or running time.	Select Status		
4.2.1.1.1.2. Maintenance.	Select Status		
4.2.1.1.1.3. Modifications.	Select Status		
4.2.1.1.1.4. Tests, inspections, acceptable parameters, and results.	Select Status		

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4.2.1.1.2. Discrepancies and out of specification results shall be clearly identified.	Select Status		
4.2.1.1.3. Resolution of discrepancies and out of specification results shall be noted.	Select Status		
4.2.1.2. Logs and test records shall be maintained for the life of the system/equipment.	Select Status		
4.2.1.3. Logs and test records shall be available to the PSWG and Range Safety upon request.	Select Status		
4.3. Safety and Emergency Plans	I		
4.3.1. Operations Safety Plans and Danger Area Information Plans	Select Status		
4.3.1.1. Payload project shall comply with and implement in their operations, applicable OSPs, and emergency plans.	Select Status		
4.3.3. Emergency Evacuation Plans	I		
4.3.3.1. EEPs detailing safety and emergency actions shall be developed by facility operators and posted in every building, facility, and area.	I		
4.3.3.2. EEPs shall include the following information:	I		
4.3.3.2.1. Identification of exit/egress routes.	I		
4.3.3.2.2. Identification of primary and alternate Emergency Evacuation Assembly Points (EEAPs); EEAPs shall be designated by signs.	I		
4.3.3.2.3. Responsibilities of supervisors and personnel for duties assigned in an emergency.	I		
4.3.3.2.4. Actions to be taken to safe an operation.	I		
4.3.3.2.5. Methods of communication including aural warning systems and public address (PA) announcements.	I		
4.3.3.2.6. Location of fire alarm boxes and other emergency activation devices.	I		
4.3.3.2.7. Required emergency equipment and PPE.	I		
4.3.3.2.8. Required personnel training.	I		
4.3.3.2.9. Reporting requirements such as, but not limited to, Squadron Commander or Command Post.	I		
4.4. Procedures	I		
4.4.1. General Requirements for Procedures	I		
4.4.1.1. Procedures and general operating instructions for all operations shall be developed by the payload project and reviewed by the appropriate local safety authority.	Select Status		

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4.4.1.2. All procedures shall be written in accordance with the requirements provided in Attachment 2 of this volume and local safety requirements.	Select Status		
When a procedure references another source (e.g., technical order, another procedure), it should be made available for review upon request.	I		
4.4.1.3. Brief summaries of all procedures shall be submitted as part of the GOP review and approval process. At that time, the operating procedure summaries shall be designated as "Hazardous," "Non-Hazardous," or "Safety Critical." These designations shall be justified in the operating procedure summaries. Local safety authorities may designate additional processes and operations as "Hazardous" or "Safety Critical."	Select Status		
4.4.1.4. Revisions to any procedures shall be submitted to the appropriate local safety authorities for review and approval when there is a potential impact on the safe conduct of an operation.	Select Status		
4.4.2. Hazardous and Safety Critical Procedures	I		
4.4.2.1. Procedures for hazardous and safety critical operations shall be developed in accordance with the requirements in Attachment 2 of this volume. Emergency actions shall be included in the procedures. Hazardous and safety critical procedures shall be reviewed and approved by the appropriate local safety authority. Approval of hazardous and safety critical procedures shall not be given until the pertinent data sections of the SDP (MSPSP) and GOP have been reviewed and approved.	Select Status		
4.4.2.2. Disapproval of a formally submitted procedure may result in an additional 30 calendar day review time submittal and possible delay of operations. The payload projects are encouraged to provide a draft of a typical procedure for early review by all appropriate local safety authorities.	Select Status		
4.5. Range User Training Plan	Select Status		
A training plan listing all training courses used for personnel involved with hazardous or safety critical operations and procedures shall be submitted to the PSWG in conjunction with Range Safety as part of the GOP.	Select Status		
4.6. Mishap Reporting	Select Status		
Mishap reporting shall be in accordance with NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, and in accordance with local safety authorities' procedures.	I		
4.6.1. Mishaps Involving Space Force Personnel and Property. Reporting criteria for mishaps involving Space Force personnel and property are established in DAFI 91-204, Safety Investigations and Reports. Mishaps involving radioactive materials shall be reported in accordance with DAFMAN 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems.	Select Status		

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4.6.2. Accident Notification Plan. An Accident Notification Process complying with NPR 8621.1 and the Project's Mishap Preparedness and Contingency Plan, as well as local requirements, shall be included in the GOP to ensure proper notification of personnel at the various stages and locations of payload processing. The PSWG Chairperson shall be notified immediately of any payload project mishap (accident) or close call.	Select Status		
4.6.3. Support to Investigations. The payload project will provide reasonable support for mishap investigations, including providing access to all pertinent documents and personnel who may have relevant information.	Select Status		
4.7. Safety for Return-to Earth Payloads or Sample Returns	I		
4.7.1. Payload or Sample Return Recovery Safety Plan	I		
4.7.1.1. The payload project shall prepare and implement a comprehensive Payload or Sample Return Recovery Safety Plan to ensure safety during return-to-Earth payload or sample recovery.	Select Status		
4.7.1.2. The Payload or Sample Return Recovery Safety Plan shall:	Select Status		
4.7.1.2.1. Identify each organizational unit involved in the payload or sample recovery operations.	Select Status		
4.7.1.2.2. Define in detail the roles, responsibilities, and authorities of each organizational unit, field team, and key personnel for each task.	Select Status		
4.7.1.2.3. Describe interfaces and communications between all organizational units and field teams to be used in payload or sample recovery and transportation for both nominal and off-nominal recovery scenarios.	Select Status		
4.7.1.3. A Recovery Command System similar to the Incident Command System process used by departments, agencies, and private sector organizations shall be used in the execution of recovery operations.	Select Status		
4.7.1.4. The local safety authority's plan for safe recovery operations shall be reviewed for adequacy as applicable. Modifications for a particular mission or for a set of planned missions will be jointly coordinated and approved before the scheduled launch date.	Select Status		
4.7.1.5. Changes to the Recovery Safety Plan subsequent to the "final" edition will be expediently coordinated with the local safety authorities.	Select Status		
4.7.2. Recovery Hazard Analysis	I		
4.7.2.1. The payload project shall perform and document an operations hazard analysis identifying and assessing hazards associated with payload or sample recovery operations, nominal and off-nominal.	Select Status		
4.7.2.2. Hazards identified shall be documented on the NF 1825 NASA Payload Safety Hazard Report found on the NASA Payload Safety Program website at https://sma.nasa.gov/sma-disciplines/elv-payload-safety or an equivalent form that contains all information required on NF 1825.	Select Status		
4.7.2.3. Hazard controls or elimination activities shall be incorporated into the payload, operations involving payload or sample recovery, and related support equipment.	Select Status		
4.7.3. Recovery Hazardous Operations	I		

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4.7.3.1. Hazardous recovery operations shall be performed in accordance with existing institutional and local safety standards, national consensus standards (e.g., ANSI, NFPA), or special supplemental alternative standards when there are no known suitable existing standards.	Select Status		
4.7.3.2. Written procedures approved by the local safety authorities shall be provided in accordance with Attachment 2, Hazardous and Safety Critical Procedures, of this Volume.	Select Status		
4.7.4. Payload or Sample Return Recovery Operations Safety Training	I		
4.7.4.1. The payload project shall develop safety training courses for personnel involved with hazardous or safety critical operations during the payload or sample recovery operations. The training shall cover applicable local requirements, various roles, responsibilities, and authorities.	Select Status		
4.7.4.2. Safety training courses shall include information on hazards and preventing injury during payload or sample recovery operations.	Select Status		
4.7.5. Mishap Preparedness and Contingency Plan. The payload project is required by NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping, to ensure the project's Mishap Preparedness and Contingency Plan includes payload return or sample return contingencies.	Select Status		
4.7.6. Safety Data Submittal, Schedule, Review, and Approval	I		
4.7.6.1. Payload or Sample Recovery Safety Plan.	I		
4.7.6.1.1. A draft Payload or Sample Recovery Safety Plan shall be submitted to appropriate local safety authorities and the NASA project safety management for review prior to the project's Preliminary Design Review (PDR).	Select Status		
4.7.6.1.2. A baselined Payload or Sample Recovery Safety Plan shall be submitted to appropriate local safety authorities and the NASA project safety management for review and approval prior to the project's Critical Design Review (CDR).	Select Status		
4.7.6.1.3. The Payload or Sample Recovery Safety Plan is a living document and shall be updated as design or operational changes impact recovery operations.	Select Status		
4.7.6.1.4. The final Payload or Sample Recovery Safety Plan shall be submitted for review and approval to the appropriate local safety authorities and the NASA project safety management at least 180 days prior to payload or sample recovery.	Select Status		
4.7.6.2. Recovery Hazard Reports	I		
4.7.6.2.1. Preliminary Hazard Reports shall be submitted for review and approval to the appropriate local safety authorities and the NASA project safety management prior to the project's PDR.	Select Status		
4.7.6.2.2. Updated Hazard Reports shall be submitted for review and approval to the local safety authorities and the NASA project safety management prior to the project's CDR.	Select Status		
4.7.6.2.3. Updated Hazard Reports shall be submitted to the appropriate local safety authorities and the NASA project safety management for review and approval prior to the project's Operational Readiness Review (ORR).	Select Status		
4.7.6.2.4. Final Hazard Reports shall be submitted for review and approval to the local safety authorities and the NASA project safety management at least 180 days prior to payload or sample recovery.	Select Status		
4.7.6.3. Hazardous Operations	I		

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4.7.6.3.1. Documented procedures for all hazardous operations shall be provided to the appropriate local safety authorities and NASA project safety management for review and approval at least 180 days prior to payload or sample recovery.	**Select Status**		
4.7.6.3.2. Finalized documented procedures for hazardous operations shall be made available to the local safety authorities, the Recovery System Incident Commander, and all those performing and managing hazardous operations during payload or sample recovery at least 60 days prior to payload or sample recovery.	**Select Status**		

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CHAPTER 5 GROUND OPERATIONS SAFETY REQUIREMENTS	I		
5.1. Ground Operations Personnel Requirements	I		
5.1.1. Personnel Training, Certification and Experience. A list of personnel training, certification, and experience requirements shall be available as part of the payload project's training plan.	Select Status		
5.1.2. Ground Operations Safety Orientation and Training	I		
5.1.2.1. All payload projects shall ensure that their personnel receive formal safety, fire prevention, medical surveillance, and occupational health orientation and training before receiving a controlled area badge. The employer is responsible to ensure the training is adequate and complete.	Select Status		
5.1.2.2. Unique personnel training and certification requirements for hazardous operations such as ordnance, crane operations, forklift operations, PPE, and SCAPE shall be specified in the appropriate procedures.	Select Status		
5.1.3. Personnel Conduct	Select Status		
5.1.3.1. Food, Beverage, and Cigarette Consumption. The payload project shall ensure that eating, drinking, or smoking, including the use of e-cigarettes, is authorized only in designated areas.	Select Status		
5.1.3.2. Alcoholic Beverages and Narcotics	Select Status		
5.1.3.2.1. The payload project shall ensure that the use of alcoholic beverages and narcotics while on duty is prohibited.	Select Status		
5.1.3.2.2. The payload project shall require that their personnel taking prescription or non-prescription medications that could affect performance notify their supervisor.	Select Status		
5.1.3.3. Mischief. The payload project shall ensure that their personnel are prevented from indulgence in practical jokes, horseplay, scuffling, and wrestling.	Select Status		
5.1.4. Work Time Restrictions	I		
5.1.4.1. The payload project supervisors at all levels shall ensure their personnel will not be assigned to, and will not participate in, critical operations if it is evident that their physiological or psychological wellbeing is, or is likely to be, adversely affected by immunizations, fatigue, blood donations, use of drugs, illness, consumption of alcohol, or other stress conditions. For payload operations on NASA or NASA contracted facilities, the payload project or contractor shall adhere to the requirements in NPR 1800.1, paragraph 2.14, and their Center's or organizations maximum work time policies and requirements but in no case shall an employee work in excess of 16 consecutive hours. For payload and launch operations on Space Force property the following shall apply:	Select Status		
5.1.4.2. Each duty period for mission ready (Category A) and mission support (Category B) personnel, including participation in a launch or launch attempt activity, shall be preceded by an available rest period.	Select Status		

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5.1.4.3. Planned duty for personnel in either mission ready or mission support should normally be 8 hours, starting when the individual reports for duty. Those personnel identified to support operational tests shall not be scheduled for duty during the planned rest period.	**Select Status**		
5.1.4.4. Hazardous Operations and Prelaunch Attempts. The following criteria shall be used for determining hours worked versus rest time for all personnel who work with hazardous systems, materials, or components, or who accomplish prelaunch functions that require a high degree of concentration:	**Select Status**		
5.1.4.4.1. Maximum 12-hour shift, unless approved by Range Safety or a USAF Squadron Commander, with at least 8 hours of rest after 12 hours of work.	**Select Status**		
5.1.4.4.2. A maximum of 60 hours per week.	**Select Status**		
5.1.4.4.3. A maximum of 14 consecutive days.	**Select Status**		
5.1.4.5. Consecutive Launch Attempts	**Select Status**		
5.1.4.5.1. When 12-hour shifts are required and launches are rescheduled on a 24-hour basis, consideration shall be given for a 48-hour launch delay after 3 consecutive back-to-back launch attempts.	**Select Status**		
5.1.4.5.2. In the event mission impacts or operational requirements necessitate 12-hour shifts, mission ready personnel shall not be scheduled for more than 5 consecutive shifts without a 48-hour break and mission support personnel shall not be scheduled for more than 6 consecutive shifts without a 24-hour break.	**Select Status**		
5.1.4.6. SLD 30 Additional Work Restrictions	**Select Status**		
5.1.4.6.1. In the event of a missile accident, emergency, or operational necessity, the duty time limits defined in this volume may be exceeded with the expressed knowledge of the SLD 30 Commander or Vice Commander, commanders of tenant organizations, or the SLD 30 Chief of Safety for personnel under their respective control.	**Select Status**		
5.1.4.6.2. When mission requirements dictate, the duty period may be extended to 12 hours by the first level supervisor. Rest periods and break periods shall be provided according to appropriate regulations and negotiated agreements.	**Select Status**		
5.1.4.6.3. If, after a complete evaluation of the potential hazards involved, mission requirements dictate a duty period in excess of 12 hours, the following criteria shall apply:	**Select Status**		
5.1.4.6.3.1. For mission ready (Category A) personnel, the duty periods may be increased to 14 hours or rest periods may be waived with the express knowledge of the SLD 30 Commander or Vice Commander, WR Commander, Operations Groups Commander, or the Chief of Safety.	**Select Status**		
5.1.4.6.3.2. For mission support (Category B) personnel, the duty period may be increased to 14 hours with the expressed knowledge of the applicable division chief or equivalent level supervisor.	**Select Status**		

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5.2. Hazardous Ground Operations General Requirements	I		
5.2.1. Pathfinder Requirements	I		
5.2.1.1. The PSWG, Range Safety and payload project shall determine which procedures require a pathfinder and its necessary fidelity.	Select Status		
5.2.1.2. Before the first use of applicable hazardous procedures, including contingency, such as operations with live ordnance, pressure systems, or propellant, pathfinder operations shall be conducted at the payload processing facility and launch site area in a nonhazardous fashion by using inert or dummy ordnance, non-pressurized systems, or non-fueled systems.	Select Status		
5.2.1.2.1. Handling operations shall be performed with inert or dummy equipment that simulates the flight unit in form, fit, function, weight, and center of gravity.	Select Status		
5.2.1.2.2. Pressure and propellant system operations shall be performed with equipment that simulates flight equipment valve connections and operations.	Select Status		
5.2.1.2.3. Pathfinder operations shall use GSE that will be used for flight operations.	Select Status		
5.2.1.2.4. The project shall work with the local safety authority (who is responsible for the safety operations in the area) to develop acceptance criteria for pathfinder operations and evaluate whether the acceptance criteria have been met.	Select Status		
5.2.2. Control of Access to Hazardous Operations. A control area shall be established for each hazardous operation in accordance with local safety requirements for the hazard(s). Man-loading shall be determined and implemented for each hazardous control area. The appropriate safety authority as identified by the PSWG and Range Safety shall establish personnel limits, entry control, and control areas for all hazardous operations.	Select Status		
5.2.2.1. Personnel Limits for Hazardous Ground Operations	I		
5.2.2.1.1. Personnel limits shall be established for all hazardous operations and tasks. Deviation from approved access list numbers requires approval from the local safety authority.	Select Status		
5.2.2.1.2. The supervisor in charge of the building or operation is responsible for maintaining personnel load limits for that building or operation.	I		
5.2.2.2. Control of Access to All Hazardous Operations	I		
5.2.2.2.1. Hazardous areas shall be fenced, barricaded, or cordoned off and personnel access control maintained at a central control point.	Select Status		
5.2.2.2.2. Access roads shall be closed by barricades, guards, or signs during hazardous operations for positive control of personnel and vehicles. Emergency vehicles shall not traverse the controlled area if another route is available.	Select Status		

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5.2.2.2.3. When hazardous operations are covered by Pad Safety, Pad Safety shall control access. When hazardous operations are not covered by Pad Safety, the operation test conductor shall control access.	Select Status		
5.2.2.3. Personnel Restrictions for Hazardous Ground Operations	I		
5.2.2.3.1. Non-essential personnel shall leave hazardous areas (safety clearance zones) before the start of operations.	Select Status		
5.2.2.3.2. Whenever a warning light status is changed or an audible signal is sounded, a PA announcement shall precede it and identify the reason for the change.	Select Status		
5.2.2.3.3. Each facility and/or area shall have instruction signs informing personnel of the area aural and warning light scheme before entry.	Select Status		
5.2.2.3.4. The buddy system shall be used in all hazardous operations.	Select Status		
5.2.2.3.5. Area Warning Lights. Personnel with the appropriate badge and security clearance have access to areas in accordance with the following:	Select Status		
5.2.2.3.5.1. A flashing green light indicates the controlled area is open to normal work. Hazardous commodities may be present in the area, but no hazardous operations are in progress. Access is controlled by Security/Hazardous Support Operations (HOS).	Select Status		
5.2.2.3.5.2. A flashing amber light indicates a hazardous operation is in progress in the controlled area. Non-essential personnel shall be cleared from the controlled area. Personnel shall not enter without permission from Pad Safety or, in the absence of Pad Safety, the entry control authority.	Select Status		
5.2.2.3.5.3. A flashing red light indicates an emergency situation in the controlled area. All personnel shall evacuate the controlled area to the EEAP. This signal shall be accompanied by the sounding of an audible alarm and a PA announcement. This signal is also used to clear all personnel from a launch complex before a launch or for a hazardous operation that requires clearing the complex, such as wet dress rehearsal or static fire. At the WR, a flashing red light also designates a dangerous operation for ballistic missile operations [e.g., follow-on test and evaluation (FOT&E) where work is performed under the strict control of technical orders (TOs)].	Select Status		
5.2.3. Hot Work Operations	I		
5.2.3.1. Hot Work Operating Standards. Hot work (open flame) operations including welding, soldering, cutting, brazing, grinding, or heating of materials in such a manner as to cause a source of ignition shall be conducted in accordance with 29 CFR 1910.252, (Subpart Q, Welding, Cutting and Brazing), General Requirements, and American National Standards Institute (ANSI) Z49.1, Safety in Welding, Cutting, and Allied Processes as well as local safety requirements. DAFMAN 91-203 (Chapter 27, Welding, Cutting, and Brazing) applies for hot work operations on USAF properties.	Select Status		
5.2.3.2. Hot Work Operations Training and Certification. All welders shall be trained and certified by competent authority to standards no less than those established by the American Welding Society (AWS).	Select Status		

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5.2.3.3. Hot Work General Operating Requirements	I		
5.2.3.3.1. A written permit shall be obtained from the Fire Marshall before performing hot work.	Select Status		
5.2.3.3.2. Locations where hot work will be routinely performed may operate on an indefinite permit if that area is subject to periodic Fire Department inspections.	Select Status		
5.2.3.3.3. A fire watch shall be maintained during and after the hot work until such time the fire watch determines that the combustion hazard no longer exists.	Select Status		
5.2.3.3.4. The requirement for the Fire Department to perform the fire watch shall be determined on a case-by-case basis by the Fire Marshall and the appropriate local safety authority.	Select Status		
5.2.3.3.5. Proper housekeeping and protective shields and barriers shall be used to prevent inadvertent combustion.	Select Status		
5.2.3.3.6. Combustibles shall be kept at least 35 feet away from the operation.	Select Status		
5.2.3.3.7. A suitable fire extinguisher shall be available.	Select Status		
5.2.3.4. Hot Work Within Ordnance or Propellant Areas. Hot work within ordnance or propellant areas shall be coordinated with the local safety authority as well as the range Fire Department.	Select Status		
Normally, fire watches are conducted by the Range User; however, there may be instances when, after consultation with Range Safety on any unique hazards or operating environment considerations (such as a nearby fueled spacecraft, ordnance, hypergolic propellants), the Fire Marshall determines a Fire Department engine crew on-site is warranted.	I		
5.2.3.3.5. Proper housekeeping and protective shields and barriers shall be used to prevent inadvertent combustion.	Select Status		
5.2.3.3.6. Combustibles shall be kept at least 35 feet away from the operation.	Select Status		
5.2.3.3.7. A suitable fire extinguisher shall be available.	Select Status		
5.2.3.5. Hot Work on Containers and Lines That May Have Contained Explosives or Flammables. Hot work shall not be performed on containers and lines that may have contained explosives or flammables and that have not been properly cleaned and purged.	Select Status		
5.2.4. Control of Hazardous Energy Sources	I		
5.2.4.1. Hazardous energy sources shall be controlled through a lockout/tagout program that complies with the requirements of 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout), DAFMAN 91-203 (Chapter 21, Hazardous Energy Control), and ANSI Z244.1, Control of Hazardous Energy Lockout/Tagout and Alternative Methods, as well as local safety requirements.	Select Status		

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5.2.4.2. Lockout/tagout procedures shall be developed by the payload project and approved by the appropriate local safety authority.	Select Status		
5.2.5. Confined Space, Tank Entry, and Tank Cleaning	I		
5.2.5.1. Personnel who enter and work within permit-required confined spaces shall comply with appropriate controls as defined in 29 CFR 1910.146, Permit-Required Confined Spaces; ANSI Z117.1, Safety Requirements for Entering Confined Spaces, DAFMAN 91-203 (Chapter 23, Confined Spaces), and local safety requirements.	Select Status		
5.2.5.2. The payload projects, contractors, and subcontractors who will be entering confined spaces other than the contractor's equipment and flight hardware shall contact the appropriate local safety authority at the start of the project to obtain information about the confined space.	Select Status		
5.2.6. Tethering of Equipment	I		
5.2.6.1. Hand-held tools, equipment, and personal belongings shall be tethered in any area where dropped objects could pose a hazard to personnel.	Select Status		
5.2.6.2. Falling Object Hazards to be considered in determining tethering requirements include direct contact with personnel or the consequences of damaging critical hardware providing the potential of latent or immediate hazards to personnel from damaged hardware.	Select Status		
5.3. Personal Protective Equipment	I		
5.3.1. Payload Project Responsibilities. The payload project shall provide the applicable PPE required for the work location that meets the requirements established by 29 CFR 1910.132, (Subpart I-Personal Protective Equipment), General Requirements; 29 CFR 1910.133, Eye and Face Protection; 29 CFR 1910.134, Respiratory Protection; 29 CFR 1910.135, Head Protection; 29 CFR 1910.136, Foot Protection; California Occupational Safety and Health (CAL-OSHA) (WR only); ANSI; and National Institute of Occupational Safety and Health (NIOSH). The PPE selected shall have been approved for the planned usage by the appropriate local safety authorities, occupational health authorities, and other applicable approving authorities as identified by the PSWG and Range Safety.	Select Status		
5.3.2. PPE Compatibility. All PPE shall be compatible with the hazardous materials involved and shall be subject to approval by the safety and occupational health authorities and other applicable approving authorities as identified by the PSWG and Range Safety.	Select Status		
5.3.2.1. Protective gear including coveralls shall be compatible with propellants involved and shall be fire resistant and non-static producing as well.	Select Status		
5.3.3. Clothing Requirements in Payload Processing Facility and Launch Site Areas	I		
5.3.3.1. Complete upper and lower body attire shall be worn in industrial and missile operating areas. Lower arms, hands, and head do not have to be covered unless otherwise stated.	Select Status		

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5.3.3.2. Open-toed and high-heeled shoes are prohibited.	Select Status		
5.3.3.3. Canvas shoes are not permitted where liquid propellants or cryogenics are handled.	Select Status		
5.3.3.4. Dresses and shorts shall not be worn on towers.	Select Status		
5.3.3.5. The appropriate attire for hazardous and safety critical operations shall be identified in the operating procedure.	Select Status		
5.3.3.6. Coveralls or other work clothes designated to be worn in toxic propellant areas shall not be worn in eating areas or other facilities off site.	Select Status		
5.3.3.7. Expended work clothes shall be clearly segregated from work clothes ready for use.	Select Status		
5.3.3.8. Work clothes exposed to an oxygen-rich atmosphere shall be thoroughly aired before smoking is allowed.	Select Status		
5.3.4. The operating procedure shall include a check for PPE training.	Select Status		
5.4. Fall Protection	Select Status		
The payload project shall observe and implement fall protection requirements in accordance with 29 CFR 1910.28 and NPR 8715.1, NASA Safety and Health Programs. Specific criteria for the equipment listed above can be found in ANSI Z359.1, Personnel Fall Arrest Systems, Subsystems, and Components; (such as guard rails, lanyard anchorages, lanyards, snap hooks, ladders, inspections) and 29 CFR 1910 Sub Part D.	Select Status		

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Fall Hazards: All open-sided floors or fall hazards 4 feet above the next lower level or any height where falls into hazards such as moving machinery, impaling, or drowning hazards exist should be guarded by standard guard rails with mid-rails and toe boards. *Fall protective PPE should be used when installing guardrails, safety nets, and other fall protection.* *Hazard Guards: If standard guard rails are not installed, PPE, in the order of preference listed below, should be used to protect personnel if they are within 6 feet of the hazard:* *(1) Full body harness (ANSI Class III).* *(2) Chest harness (ANSI Class II).* *(3) Safety nets (29 CFR 1926.105).* *PPE Lanyards: PPE should be attached to anchorages by a lanyard that limits the length of a fall to no more than 6 feet. The order of preference is as follows:* *(1) Self-retracting lanyard (inertia reel).* *(2) Shock absorbing lanyard.* *(3) Nylon rope lanyard.* *(4) Wire rope lanyard (for welders).* *Lanyard Anchorages:* *(1) Handrails should not be used for anchorages or lanyard tie-off points.* *(2) Life-line (dog-run) style anchorages for lanyards require appropriate justification with analysis to be submitted and specific approval by the PSWG, Range Safety or local safety authority for each application. Dog-runs are not an acceptable alternative to installed platforms or walkways.* *Installation of Permanent Anchorage Connectors:* *(1) Visual inspection of installed permanently fixed anchorage connections and dog-runs should be accomplished annually by the payload project. Documentation should be available for review by the PSWG and Range Safety.* *(2) Suspect connections or anchorages should receive NDE as determined by the PSWG, Range Safety or local safety authority and should be repaired or replaced as required.* *Fall Protection Snap Hooks. Fall protection snap hooks used in fall protection systems should be sized to ensure proper connection.* *Fall Protection Equipment Inspections:* *(1) Each article of PPE should be visually inspected by the user before use.* *(2) All PPE should be thoroughly inspected at least twice a year by a qualified person of the organization that owns the PPE.* *Inspection Tags: Each piece of PPE should have a visible tag or other indication of inspection permanently attached with the following information:* *(1) The date inspected.* *(2) The next inspection due date.* *(3) The stamp or signature of the quality inspector.* *Ladder Fall Protection:* *(1) Ladder fall protection should be installed on all fixed ladders with a fall hazard of 20 feet or more.* Ladder safety devices with a full body harnesses shall be the preferred method of fall protection.	I		
5.5. Smoking Areas	I		

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5.5.1. The payload project shall observe and use applicable industry standards for smoking areas. No smoking signs shall be posted as directed by the local safety authority or Fire Department.	Select Status		
Selection of designated smoking areas, their ash receptacles, and ventilation systems is subject to the review and approval of the Fire Department. No smoking and smoking areas in the complex should be clearly designated by lines painted on the concrete or asphalt surfaces and appropriately marked by signs.	I		
5.5.2. Designated Non-Smoking Areas. Smoking, matches, open flames, e-cigarettes and spark-producing devices shall be prohibited at all times within the following areas:	Select Status		
5.5.2.1. Within 100 feet of any propellant storage tank.	Select Status		
5.5.2.2. On gantries or service towers.	Select Status		
5.5.2.3. Within 100 feet of the test stand while propellants are being transferred or during the time propellants are aboard the launch vehicle and/or payload.	Select Status		
5.5.2.4. Within 50Ft of the launch vehicle and/or payload during and after ordnance installation.	Select Status		
5.5.2.5. In missile impact areas where radioactive contamination, ordnance, or fuels are present.	Select Status		
5.5.2.6. In any area displaying NO SMOKING signs.	Select Status		
5.5.2.7. In all propellant operating and storage areas except in specifically designated smoking areas.	Select Status		
5.6. Operating Restrictions Due to Adverse Weather	I		
5.6.1. General. Local adverse weather requirements for NASA, NASA contractors, Space Force Range Safety, and other facilities where payload project operations take place shall be adhered to and specified in the OSP. The payload project shall comply with OSP. Adverse weather conditions include but are not limited to lightning and thunderstorms, hurricanes, and high wind conditions.	Select Status		
5.6.2. ER Lightning Hazard Watches and Hazard Warnings	I		
5.6.2.1. Operations that will be allowed during lightning watches and warnings shall be coordinated, reviewed, and approved by SLD 45/SEA and documented in the specific OSP.	Select Status		
5.6.2.2. Phase I Lightning Watch. For the five nautical miles lightning watch (Forecast for lightning within five nautical miles of centroid of a specific lightning alert area, [Space Launch Complex (SLC) and/or facility], expected within some time, usually 30 minutes), the following actions shall be taken:	I		
5.6.2.2.1. SCAPE operations, propellant tanking and de-tanking, hoisting hazardous materials or 1.1 to 1.4 class ordnance, and other hazardous operations that take 30 minutes or longer to secure shall not be started.	Select Status		

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5.6.2.2.2. If an operation is in progress, personnel shall begin safing the system so as to have the area secured and evacuated, if required, before the forecasted five nautical miles lightning warning start time.	Select Status		
5.6.2.3. Phase II Lightning Warning. For the lightning warning, lightning is imminent or occurring within the five nautical mile boundary of a centroid of a specific lightning alert area (SLC and/or facility), the following actions shall be taken:	Select Status		
5.6.2.3.1. All operations shall cease unless they are performed remotely and have been approved by either Range Safety or are authorized in the specific OSP.	Select Status		
5.6.2.3.2. If the Phase I lightning watch has not been previously announced or the five nautical mile lightning warning start time is earlier than forecast, the operation shall be terminated at the safest step and the area secured and evacuated in accordance with the specific OSP.	Select Status		
5.6.2.4. Due to the differences between launch vehicle configurations and SLCs, evacuation requirements shall be specified in each specific OSP. In general, the complex shall be cleared before the 5 nautical mile lightning warning start time whenever a launch vehicle with payload, propellants, solid rocket motors, or Class 1.1 to 1.4 ordnance is present or EEDs are electrically connected.	I		
5.6.2.5. Additional information regarding lightning hazard watches and warnings may be found in the 45 SWI 15-101, Weather Support instruction.	I		
5.6.3. WR Lightning/Thunderstorm Watches and Warnings. The 30th Force Support Squadron (FSS) issues two messages related to lightning/thunderstorms: A watch and a warning.	I		
5.6.3.1. A Lightning/Thunderstorm Watch is a forecast issued when the potential for lightning/thunderstorms is expected to occur within ten nautical miles of any location on VSFB. The desired lead time for this watch is two hours. The watch is forecast for a period of time (valid time) that lightning/ thunderstorms are expected to be within ten nautical miles.	I		
5.6.3.2. A Lightning/Thunderstorm Warning is issued when lightning is observed within 10 nautical miles of VSFB.	I		
5.6.3.3. Meteorological and weather warning notification procedures are provided in 30SWI 15-101, Weather Support instruction.	I		
5.6.3.4. Upon issuance of the Lightning/Thunderstorm Watch, all operations involving propellant or ordnance activities shall be completed before the start of the Lightning/Thunderstorm Watch "valid time." All propellant or ordnance activities not completed before the watch "valid time," may continue if the facility has a certified lightning protection system and the organization's commander grants approval to continue. All other non-propellant or non-ordnance activities may continue in the facility during the Lightning/Thunderstorm Watch.	Select Status		

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5.6.3.5. Upon issuance of the Lightning/Thunderstorm Warning, a space launch complex, explosive/missile processing facility, launch facility, storage facility, or any other hazardous operating location that has a certified lightning protection system does not require evacuation; and all non-propellant or non-ordnance activities may continue in the facility during the Lightning/Thunderstorm Warning. ***Exception: If either of the following conditions apply, all personnel shall evacuate to at least the public transportation route (PTR) distance regardless of the lightning protection system: Condition 1: There is exposed solid propellant. Condition 2: There is an explosive initiation device that cannot be placed in a safe configuration.***	**Select Status**		
The intent of 5.6.3.4 and 5.6.3.5 is to allow all non-ordnance and non-propellant activities to continue in facilities with certified lightning protection systems during a Lightning/ Thunderstorm Watch or Warning. A "certified" lightning protection system is inspected and maintained in accordance with the National Fire Protection Association Standard 780. These are the minimum lightning protection requirements imposed by SLD 30 Safety, Payload projects may be more conservative at their own discretion.	**I**		
5.6.3.6. Upon issuance of the Lightning/Thunderstorm Warning, any operation involving propellant or ordnance activities in a space launch complex, explosive/missile processing facility, launch facility, storage facility, or any other hazardous operating location that does not have a certified lightning protection system shall evacuate to at least the PTR distance.	**Select Status**		
5.6.3.7. If a Lightning/Thunderstorm Watch or Warning has not been previously issued or the Lightning/Thunderstorm Watch or Warning "valid time" is earlier than forecast, the propellant or ordnance activities shall be terminated at the safest point and the area secured.	**Select Status**		
5.6.3.8. Lightning/Thunderstorm Watch and Warning notifications and payload project action requirements for propellant or ordnance activities apply to both day-to-day and day-of-launch operations.	**I**		
5.6.3.9. Range Users working an approved operation involving propellant or ordnance activities during a Lightning/ Thunderstorm Watch can call SLD 30th WS (x6-8022) to get an update of the status of the watch. To ensure the consistent and accurate relay of information, payload projects should designate a single point of contact to make these calls, preferably the individual in charge of the operation.	**I**		
Examples of approved activities are installation of electrical cables, mechanical components, flight hardware, stud standoff, and wing installation. Examples of unapproved activities are handling of rocket motors or launch vehicles by lifting, mating, or roll transfer; fuel transfer and pressurization; and ordnance installation and connection.	**I**		
5.7. Operating Restrictions Due to High Winds	**I**		
5.7.1. For Winds of 18-29 Knots as Measured on or Closest to Specific Facilities. No work shall be performed on the exterior surface of umbilical or mobile service towers or other tall structures unless spider staging, or similar suspended work devices are safely secured to the structure.	**Select Status**		
5.7.2. For Winds of 30 Knots or More as Measured on or Closest to Specific Facilities	**I**		

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5.7.2.1. No work shall be performed on the exterior surfaces of umbilical or mobile service towers or other tall structures except for emergency tasks.	Select Status		
5.7.2.2. Work performed during emergency conditions shall be approved by Pad Safety or Range Safety and all suspended work devices shall be secured to the structure.	Select Status		
5.8. Facility Use	I		
5.8.1. Facility Use General Requirements	I		
5.8.1.1. Facilities shall be used within the limits of their design. If facilities are leased from the USAF, the payload project shall coordinate with Range Safety and Civil Engineering for proper use within the limits of their design.	Select Status		
5.8.1.2. Only those operations that are consistent with facility design, materials, equipment, and personnel shall be performed in the facility.	Select Status		
5.8.2. Hazardous Facility Use General Requirements	I		
5.8.2.1. The use of facilities for hazardous storage or processing operations shall be approved by the appropriate local safety authority.	Select Status		
5.8.2.2. The OSP shall be developed by the facility operator in coordination with the appropriate safety authorities. Payload projects will review and be familiar with the OSP as needed.	Select Status		
5.8.2.3. Facilities used for hazardous activities shall have an FEOP and an Evacuation Plan developed by facility operators.	Select Status		
5.8.2.4. Simultaneous hazardous operations within the same control area are prohibited.	Select Status		
5.8.2.5. Non-hazardous operations within the same control area as an ongoing hazardous operation are prohibited unless a safe distance approved by the appropriate safety authority can be maintained.	Select Status		
5.8.3. Hazardous Facility Inspection	I		
5.8.3.1. Facility Inspections ***Note: These requirements are for the facility personnel and owners that potentially impact and involve the payload project.***	I		
5.8.3.1.1. Facilities shall be inspected before first use, upon modification, before operations, and at least annually, as determined by the payload project and local safety authorities.	Select Status		
5.8.3.1.2. Inspection reports shall be maintained in accordance with local safety requirements (NPR 8715.1 NASA Safety and Health Programs for NASA facilities or for Space Force facilities in accordance with DESR 6055.09_AFMAN 91-201, Explosive Safety Standards, and AFI 91-202, The US Air Force Mishap Prevention Program.	Select Status		

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5.8.3.1.3. Actions shall be taken to correct discrepancies identified during inspections. Records of discrepancies and discrepancy corrections shall be maintained for three years.	Select Status		
5.8.3.1.4. A verbal report shall be made to the appropriate local authority within the same day of the inspection if discrepancies are found that may delay a planned operation or endanger personnel or material handling equipment (MHE) used to handle critical hardware, or the critical hardware itself.	Select Status		
5.8.3.1.5. Written reports describing actions taken to correct discrepancies identified during inspections shall be submitted to the local safety authority within 15 calendar days or less if deemed necessary by either group.	Select Status		
5.8.3.2. Operations Safety Facility, Complex, and Area Inspections	I		
5.8.3.2.1. A systematic visual examination of facilities, related GSE, and any work in progress that could cause accidental damage to property or injury to people or affect the launch schedule shall be performed by the appropriate safety authority. This inspection deals primarily with aerospace ground equipment (AGE), launch critical associated equipment, maintenance, associated hardware, fire hazards, fall protection, and equipment on the complex.	Select Status		
5.8.3.2.2. A safety inspection shall be performed on launch complexes, explosives storage and processing facilities and areas, and in hazardous processing and checkout facilities according to the following schedule:	Select Status		
5.8.3.2.2.1. At least two weeks before a launch vehicle or payload being brought to the pad or facility.	Select Status		
5.8.3.2.2.2. Within 48 hours of the pad erection day.	Select Status		
5.8.3.2.2.3. Immediately before the start of any hazardous or safety critical operation.	Select Status		
5.8.3.2.2.4. After any major or safety-related modification has been made to facilities or equipment.	Select Status		
5.8.3.2.3. Explosives storage and operating areas and facilities shall be inspected by the appropriate authority at least annually to ensure compliance with explosives safety criteria. Area monthly records shall be reviewed during the annual inspection.	Select Status		
5.8.3.3. Facility Operator Inspections. The facility operator shall inspect explosive storage and operating areas and facilities at least once a month.	Select Status		
5.8.3.4. Facility Spot-Checks. Spot-checks of processing facilities shall be performed to ensure compliance with this publication.	Select Status		
5.9. Hazardous Operation Support Requirements	I		
5.9.1. Communication and Television Support	I		
5.9.1.1. All hazardous operations shall require primary and backup communications between the operation's control point and the operation.	Select Status		

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5.9.1.2. Recorded voice communication and Operation Television (OTV) coverage shall be used for Self-Contained Atmospheric Protective Ensemble (SCAPE) operations and whenever required by the safety authority or local safety authorities.	Select Status		
5.9.2. Safety Radio Net	I		
5.9.2.1. Emergency forces supporting hazardous operations shall be required to maintain continuous monitoring on a safety radio net. Verification of operational status shall be accomplished prior to each hazardous operation. Use of RT (Radio Telephone) devices on USAF property shall conform to the requirements of DESR 6055.09_AFMAN 91-201, Explosive Safety Standards, Volume 3, Chapter 8 and Volume 6, Chapter 8 of this standard.	Select Status		
5.9.2.2. Safety Net shall be used during transit and when SCAPE personnel are off Operational Intercommunications System (OIS).	Select Status		
5.9.2.3. Telephones or other means of radio communications shall be available for summoning assistance in emergencies in areas where hazardous operation are conducted.	I		
5.9.3. Loss of support and equipment during any phase of the operation shall be reported immediately to the appropriate payload project office authorities for assessment of necessary actions.	I		

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CHAPTER 6 MATERIAL HANDLING EQUIPMENT, CRANE, HOIST, PERSONNEL PLATFORM, POWERED INDUSTRIAL TRUCK, AND ELEVATOR OPERATIONS	I		
This chapter is applicable to the equipment that falls under the payload project's responsibility. In addition to the requirements listed herein, the requirements of NASA-STD-8719.9, Lifting Standard, apply in their entirety. Any local lifting equipment requirements shall be adhered to when operating material handling equipment (MHE) related to or involving payload testing, processing or integration. This chapter is divided into the following: 6.1. Material Handling Equipment (MHE) Operations; 6.2. Crane and Hoist Operations; 6.3. Personnel Platform Operations; 6.4. Powered Industrial Trucks (see ASME B56); and 6.5. Elevator Usage. Requirements for vehicles used to transport hardware onto and off of NASA facilities or ranges are not governed by this chapter.	I		
6.1. Material Handling Equipment Operations	Select Status		
The operations requirements for material handling equipment (MHE) used for handling (lifting, supporting, or manipulating) critical and non-critical hardware are described below. These requirements are applicable to new or modified MHE. The requirements are also applicable to permanent or short-term use MHE and apply whether the equipment is owned, rented, or leased by the government, contractors, or commercial operators.	Select Status		
MHE is comprised of below-the-hook lifting devices (BTHLD), handling structures, support structures, slings, load cells, (Hydra Sets ®), load indicating devices (LID), and rigging hardware. Slings, BTHLDs, lifting assemblies, rigging hardware, and LIDs are governed by industry standards, e.g., OSHA, ASME.	I		
6.1.1. MHE Operating Standards	I		
6.1.1.1. Existing equipment shall not be used in operations unless it meets all the requirements in Volume 3, Chapter 6 unless otherwise agreed to by the appropriate local safety authority.	Select Status		
6.1.1.2. All MHE shall be operated, tested, and maintained in accordance with the requirements of this publication, NASA-STD-8719.9, Lifting Standard; OSHA; DAFMAN 91-203; and applicable military and industry standards including, but not limited to, ANSI, the American Society of Mechanical Engineers (ASME), and the National Fire Protection Association (NFPA).	Select Status		
6.1.1.4. All users of MHE used to handle the critical hardware covered in this publication shall have written and approved procedures that cover selection, operation, maintenance, and testing of the MHE used.	Select Status		

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Operations that include maintenance of the MHE and use of these items with no safety critical or hazardous loads shall not be considered safety critical operations. Those operations that involve MHE and safety critical or hazardous loads including direct contact, such as supporting the load, or within the immediate vicinity, such as moving the MHE without a load over a hazardous commodity, shall be considered hazardous operations. Moving or parking an empty hook over a hazardous/critical commodity shall not be considered a hazardous operation.	I		
6.1.2. MHE Operator Qualification and Training	I		
6.1.2.1. MHE Operator Qualification Requirements	I		
6.1.2.1.1. Operators shall be mentally and physically capable of safely operating the MHE.	Select Status		
6.1.2.1.2. Operators shall be physically tested for vision and hearing before being assigned to operator duty and annually thereafter.	Select Status		
6.1.2.2. MHE Operator Training and Certification	I		
6.1.2.2.1. Operators shall be trained in the safe operation of the MHE used and the hazards to which they are exposed.	Select Status		
6.1.2.2.2. Operator training shall include, but not be limited to, the following topics:	Select Status		
6.1.2.2.2.1. The requirements of the operator manual.	Select Status		
6.1.2.2.2.2. The requirements of NASA-STD-8719.9, Lifting Standard; applicable parts of DAFMAN 91-203, and ASME B30 series, Material Handling Equipment.	Select Status		
6.1.2.2.2.3. The parts of 29 CFR 1910, Subpart N, Material Handling and Storage.	Select Status		
6.1.2.2.2.4. The parts of ASME B30 and other industry standards.	Select Status		
6.1.3. MHE Periodic Test and Inspection Requirements	I		
6.1.3.1. MHE Test and Inspection General Requirements	I		
6.1.3.1.1. MHE shall be tested initially and periodically in accordance with Volume 3, 6.2.1.3.	Select Status		
6.1.3.1.2. All damaged MHE shall be removed from service until all discrepancies are corrected.	Select Status		
6.1.3.1.3. All MHE shall be marked with the due date of next inspection.	Select Status		

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6.1.3.2. MHE General Data Requirements. All MHE data requirements and documentation (inspection, test, maintenance, and modification reports, commercial-off-the-shelf (COTS) operating and maintenance manuals, etc.) shall be provided in accordance with requirements of SSCMAN 91-710, Volume 3, Chapter 4, and Volume 3, Attachment A3.1 of this publication and other standards referenced herein. This documentation shall be made available to PSWG and Range Safety for audit upon request.	**Select Status**		
6.1.4. MHE General Operations	**I**		
6.1.4.1. All MHE to be used for hazardous operations and/or safety critical operations shall be identified to the appropriate local safety authority as determined by the PSWG, Range Safety, and the center LDEM (NASA only).	**Select Status**		
6.1.4.2. All MHE shall be verified as safe for its intended use by the payload project.	**Select Status**		
6.1.4.3. MHE documentation (inspections, tests, maintenance, and modifications) shall be maintained by the payload project for the life of the MHE. This documentation shall be made available to the PSWG, Range Safety, and local safety authority.	**Select Status**		
6.1.5. Sling Operations	**I**		
6.1.5.1. Sling Operating Standards. The NASA-STD-8719.9, Lifting Standard, requires all slings shall be operated, maintained, and tested in accordance with; ASME B30.9, Slings; and ASME B30.26, Rigging Hardware.	**Select Status**		
Synthetic web/rope slings should have an overload indicating device when used for safety critical operations.	**I**		
6.1.5.1.1. For identification and onsite assurance purposes, sling assemblies shall have a periodic recertification tag containing equipment identification, next required test date, and quality control stamp.	**Select Status**		
6.1.5.1.2. Sling assemblies which have components that are normally disassembled shall be either marked, coded, or tethered to assure proper assembly of verified hardware.	**Select Status**		
6.1.5.1.3. Removable lifting lugs used on flight hardware or GSE shall be identified to ensure the lugs can be reinstalled in the proper location if necessary. *Note: Components not marked, coded, or tethered will invalidate the proof or periodic load/certification of the whole assembly.*	**Select Status**		
6.1.5.2. Sling Periodic Test and Inspection Requirements.	**Select Status**		

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6.1.5.2.1 Periodic Test Requirements. Slings used to support critical operations shall be Periodic Load tested to 100% of the manufacturer's rated load within one year of intended use, unless the range user has proposed, with supporting risk analysis, in accordance with PSWG and Range Safety approval, an alternate test interval. Following modifications and repairs, critical slings shall be Proof load tested to the same level as new slings, in accordance with this standard Volume 3, Table 6.1, ASME B30.9 and 29 CFR 1910.184. NDE shall be performed on load tested critical slings per, Volume 3, paragraph 6.2.1.3.2. MHE NDE, requirements following a PSWG and Range Safety approved NDE plan.	**Select Status**		
6.1.5.2.2 Periodic and Frequent Inspection Requirements. Sling assemblies used for critical lifts shall be periodically inspected and inspected before each use. Sling assembly inspection shall be in accordance with periodic and frequent inspection methodologies described in ASME B30.9 and ASME B30.26. Any sling or rigging hardware shall be removed from service if any conditions are present, that are listed in ASME B30.9/ASME B30.26 Removal Criteria, for each sling/rigging hardware type. Slings and rigging hardware shall not be returned to service until approved by a qualified person, the PSWG and Range Safety.	**Select Status**		
6.1.5.3. Sling Recurring Data Requirements. Recurring data is required in accordance with Volume 3, Chapter 4.	**Select Status**		
6.1.6. Load Positioning and Load Measuring/Indicating Device Operations	**I**		
6.1.6.1. Operator Training. LPD and LID operators shall be trained and certified in accordance with manufacturer recommendations and NASA-STD-8719.9, Lifting Standard.	**Select Status**		
6.1.6.2. LPD and LID Operating Standards. LPD and LID shall be operated, maintained, and tested in accordance with the manufacturer instructions; NASA-STD-8719.9, Lifting Standard; and the additional requirements described below.	**Select Status**		
6.1.6.3. LPD and LID Inspection and Periodic Test Requirements. LPD and LID shall be inspected and tested in accordance with Volume 3, Section 6.2.6.2 of this publication and NASA-STD-8719.9, Lifting Standard.	**Select Status**		
6.1.6.4. LPD and Recurring Data Requirements. Recurring data is required in accordance with Volume 3, Chapter 4.	**Select Status**		
6.1.6.4.1. Before every use, LPDs and LIDs shall be inspected. LPDs and LIDs showing evidence of damage or rejectable criteria shall not be used in operations.	**Select Status**		
6.1.6.4.2. LIDs used to support critical operations shall be properly calibrated before use. If a wireless remote readout control is used with the LID, it shall be calibrated and display the same weight as the LID.	**Select Status**		
Remote control display devices are often used with LIDs when the LID is too high off the ground to be able to read its weight display.	**I**		

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6.1.6.4.3. LPDs and LIDs used to support critical operations shall be inspected and periodic load tested to 100% of the rated load within one year of intended use, unless the payload project has proposed, with supporting risk analysis, and PSWG and Range Safety has approved, an alternate test interval. Following any modifications or repairs, critical LPDs and LIDs shall be proof load tested to the same level as new LPDs or LIDs, to include calibration in accordance with manufacturer instructions. After the proof load test, NDE shall be performed on critical LPDs or LIDs per a PSWG and Range Safety approved NDE plan.	Select Status		
6.1.7. Handling Structure Operations	I		
6.1.7.1. Handling Structure Operating Standards. All structural lifting beam operations shall meet NASA-STD-8719.9 and ASME B30.20, Below Hook Lifting Devices, for range operations.	Select Status		
6.1.7.2. Handling Structure Inspection and Periodic Test Requirements. Handling structures shall be inspected and tested in accordance with Volume 3, 6.2.4.2.	Select Status		
6.1.7.2.1. Before every use, handling structures shall be visually inspected in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan. Structures showing evidence of damage or rejectable criteria shall not be used in operations	Select Status		
6.1.7.2.2. Handling structures used to support critical operations shall be inspected and load tested to 100% of the rated load within one year of intended use, unless the payload project has proposed, with supporting risk analysis, and the PSWG and Range Safety has approved, an alternate test interval. Following any modifications or repairs, critical handling structures shall be proof load tested to the same level as new handling structures. After the proof load test, NDE shall be performed on critical handling structures in accordance with a PSWG and Range Safety approved NDE plan.	Select Status		
6.1.7.2.3. Handling structures fabricated (including fittings and attachment hardware) of ductile materials and exhibiting ductile failure mode at the operating environmental conditions may be exempted by the PSWG and Range Safety from periodic load testing on a case-by-case basis. Subject to PSWG and Range Safety review and approval, such structures may be verified using an alternate approach, based on fracture mechanics and proof-test logic.	Select Status		
6.1.7.3. Handling Structure Recurring Data Requirements. Recurring data is required in accordance with Volume 3, Chapter 4.	Select Status		
6.1.8. BTHLD Operations.	I		
6.1.8.1. BTHLD Operating Standards. BTHLDs shall be inspected, operated, maintained, and tested in accordance with NASA-STD-8719.9, NASA Lifting Standard, ASME B30.20 and 29 CFR 1910.	Select Status		
6.1.8.2. BTHLD Periodic Test and Inspection Requirements.	I		

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6.1.8.2.1. BTHLDs shall be visually inspected in accordance with frequent and periodic inspection methodologies described in ASME B30.20 and shall follow the PSWG and Range Safety approved NDE plan. See volume 3 of this standard, paragraph 4.4.1 Nondestructive Examination Plan test requirements. BTHLDs showing evidence of damage or rejectable criteria shall be removed from operational use.	Select Status		
6.1.8.2.2. BTHLD’s, and associated rigging hardware, used to support critical operations shall be inspected and Periodic Load tested to 100% of the rated load within one year of intended use in accordance with V3, Table 6.1 (5) and Note 2.	Select Status		
6.1.8.2.3. BTHLD’s Proof Load tested to 125% of the rated load performed after modification or repairs, in accordance with ASME B30.20 methodology, shall satisfy the Periodic Load test requirement for that interval periodic load test cycle in accordance with V3, Table 6.1. After the Proof Load test, volumetric and surface NDE shall be performed on all SFP components and welds on critical BTHLDs in accordance with a PSWG and Range Safety approved NDE plan.	Select Status		
6.1.8.2.4. BTHLDs fabricated (including fittings and attachment hardware) of ductile materials and exhibiting ductile failure mode at the operating environmental conditions may be exempted from periodic load testing by the LDEM (when on center), the PSWG and Range Safety. on a case-by-case basis. Subject to PSWG and Range Safety review and approval, such structures may be verified using an alternate approach based on fracture mechanics and proof-test logic.	Select Status		
6.1.8.2.5. Periodic load test intervals may be extended by no more than 90 days from the original lifting device expiration date due to programmatic or institutional needs, subject to the center LDEM, PSWG and Range approval. To extend the periodic load test interval, the following conditions shall be met: a. The payload project provides documented rationale to the LDEM, PSWG and Range Safety. b. The LDEM, PSWG and Range Safety determines there is no increase in risk.	Select Status		
6.1.8.2.6. The payload project can implement, with supporting risk analysis, an alternate test interval plan for critical BHTLD’s, and associated rigging hardware, performed in accordance with test criteria in V3, Table 6.1, with the center LDEM, the PSWG and Range Safety concurrence.	Select Status		
6.1.9. Support Structure Operations	I		
6.1.9.1. Support Structure Periodic Test and Inspection Requirements.	I		
6.1.9.1.1. Before every use, support structures shall be visually inspected in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan. Structures showing evidence of damage or rejectable criteria shall not be used in operations.	Select Status		
6.1.9.1.2. Support structures used to support critical operations shall be inspected and tested to 100% of the rated load within one year of intended use, unless the payload project has proposed, with supporting risk analysis, and PSWG and Range Safety has approved, an alternate test interval. Following any modifications or repairs, critical support structures shall be proof load tested to the same levels as new critical support structures. After the proof load test, NDE shall be performed on critical support structures in accordance with a PSWG and Range Safety approved NDE plan.	Select Status		

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6.1.9.1.3. Support structures fabricated (including fittings and attachment hardware) of ductile materials at the operating environmental conditions may be exempted by the PSWG and Safety from periodic load testing on a case-by-case basis.	Select Status		
6.1.10. Rigging Hardware Operations.	I		
6.1.10.1. Rigging Hardware Operating Standards. All rigging hardware shall be operated, maintained, and tested in accordance with ASME B30.26.	Select Status		
6.1.10.2. Rigging Hardware Periodic Test and Inspection Requirements.	I		
6.1.10.2.1. Before every use, rigging hardware shall be visually inspected in accordance with ASME B30.26. Any rigging hardware showing evidence of damage and meeting removal criteria as outlined in ASME B30.26 shall be removed from service.	Select Status		
6.1.10.2.2. Rigging hardware used to support critical operations shall be inspected and load tested to 100% of the rated load within one year of use. Following any modifications or repairs, critical rigging hardware shall be proof load tested to the same level as new critical rigging hardware in accordance with ASME B30.26. After the proof load test, NDE shall be performed on critical rigging hardware in accordance with a PSWG and Range Safety approved NDE plan.	Select Status		
6.2. Crane and Hoist Operations	I		
6.2.1. Crane and Hoist Operating Standards. In addition to the requirements in 6.1, all cranes and hoists shall be operated in accordance with ASME B30 series, CMAA 70, Specifications for Electric Overhead Traveling Cranes; and CMAA 74, Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist, MHI Standards, NASA-STD-8719.9, Lifting Standard; and NFPA 70; and DAFMAN 91-203. The requirements are also applicable to permanent or short-term use equipment and apply whether the equipment is owned, rented, or leased by the government, contractors, or commercial operators.	Select Status		
At VSFB, cranes not on VSFB exclusive federal jurisdiction property also require inspection, testing, and certification in accordance with CAL-OSHA requirements.	Select Status		
6.2.2. Crane Operator Training and Certification	I		
6.2.2.1. All operators of cranes shall be trained in accordance with NASA-STD-8719.9, Lifting Standard; Materials Handling and Storage Equipment; DAFMAN 91-203 (Chapter 12, Material Handling Equipment) and the qualifications stated in the ASME B30 series, 29 CFR 1910.179, and 29 CFR 1910.180, as applicable.	Select Status		
6.2.2.2. All operators of hoisting apparatus of over 1,000 pound capacity [hoists (fixed or traveling) or cranes (overhead or mobile)] shall be trained and certified.	Select Status		
6.2.2.3. All operators of cranes that are used to lift critical loads are subject to the requirements stated in ASME B30 series.	Select Status		

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6.2.2.4. Annual Crane Operator Certification. Annual crane operator certification is required and shall be conducted in three parts:	Select Status		
6.2.2.4.1. Classroom Training and Testing. Employers shall ensure their personnel receive classroom training as evidenced by testing. Employers shall maintain records for each operator they employ. For the WR, the requirements in 6.2.2.1, 6.2.2.2, and 6.2.2.3 apply.	Select Status		
6.2.2.4.2. Physical Examination. The employer is responsible for obtaining a physical examination of the operator as required by NPR 1800.1 NASA Occupational Health Program Procedures, DAFMAN 91-203, ASME B30 series, and the local requirements of the crane owner.	Select Status		
6.2.2.4.3. Hands-On Training and Certification. The employer shall document hands-on training, evaluation, and certification in the form of a card that includes the following:	Select Status		
6.2.2.4.3.1. Name of operator.	Select Status		
6.2.2.4.3.2. Certifying agency and certification expiration date.	Select Status		
6.2.2.4.3.3. Other pertinent information such as the types of equipment the operator is certified to operate.	Select Status		
6.2.2.5. Types of Operator Certification	I		
6.2.2.5.1. Critical load (except for proof load) hands-on training and certification shall be conducted on the specific device to be used for the lift.	Select Status		
6.2.2.5.2. Non-critical load hands-on training and certification shall be conducted on a crane of the same type for which personnel are to be certified such as mobile hydraulic, mobile mechanical (friction), overhead bridge, and overhead monorail.	Select Status		
6.2.3. Crane and Hoist Inspection and Periodic Test Requirements	I		
6.2.3.1. Daily Inspections	I		
6.2.3.1.1. Using a pre-operational checklist, daily, or otherwise before first use, inspections shall be conducted as required by OSHA and recommended by the manufacturer on the equipment to be used at the beginning of each shift.	Select Status		
6.2.3.1.2. Daily inspections shall cover the following items:	Select Status		
6.2.3.1.2.1. The function of all controls, brakes, and operating mechanisms for maladjustment interfering with proper operations.	Select Status		

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6.2.3.1.2.2. The condition of all components that can be inspected without major disassembly and whose failure would cause a safety hazard. This includes the deterioration or leakage in lines, tanks, valves, drain pumps, and other parts of air or hydraulic systems; hooks with deformation or cracks; hoist chains and end connections for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations; control mechanisms; all chords and lacing; tension in guys; and plumb of mast.	Select Status		
6.2.3.2. Slack Rope Inspections. If a slack rope condition has occurred, inspectors shall be positioned to observe the rope seating in the drum and sheave grooves as the load is reapplied, and concurrently inspect the rope for damage.	Select Status		
6.2.5. Crane and Hoist Retest and Reinspection	I		
6.2.5.3. If an accidental overload condition occurs, the equipment user shall notify the facility manager, the Center Lifting Devices and Equipment Manager, payload project, and PSWG chairperson and follow up by submitting a written report.	Select Status		
6.2.6. Dual Crane Lift Operating Requirements. Dual crane lifts are considered hazardous operations without regard to the load. The following is required:	Select Status		
6.2.6.1. The load shall be restricted to no more than 75 percent of rated capacity for each crane for non-critical lifts. The load shall be restricted to no more than 50% of rated capacity for each crane for critical lifts.	Select Status		
6.2.6.2. All mobile crane dual lifts shall require load cells and cab-installed load indicators.	Select Status		
6.2.6.3. A dry run with a geometric/mass simulator shall be required for all critical hardware lifts.	Select Status		
6.2.6.4. A Dual Crane Lift Plan addressing the following information shall be submitted to Range Safety for review and approval:	Select Status		
6.2.6.4.1. The exact weight (+/- 1 percent) of the total load including spreader bar/beam, hoist attachments, fixtures, and slings.	Select Status		
6.2.6.4.2. Any dynamic forces that affect the load.	Select Status		
6.2.6.4.3. All crane movements, including trolley, bridge, boom up, down, extension, and swing, and crane travel.	Select Status		
6.2.6.4.4. Center of gravity throughout the complete lift.	Select Status		
6.2.6.4.5. Certification of cranes and crane operators.	Select Status		
6.2.6.4.6. Operating surface capacity compatibility with mobile cranes (paved areas).	Select Status		
6.2.6.4.7. Soil compaction compatibility with mobile cranes (unpaved areas).	Select Status		
6.2.6.4.8. Provisions for a lift director, two-ways communication, and spotter(s).	Select Status		

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6.2.6.5. Operations involving offset lifts shall not exceed the crane's capability.	Select Status		
6.2.7. WR First Use Tag Program	I		
6.2.7.1. Payload projects requesting approval of a program in which specific equipment certification expiration date and time do not start until the item is issued or installed or first used shall provide the following documentation to Range Safety for review and approval with PSWG concurrence:	Select Status		
6.2.7.1.1. A complete list of all items by nomenclature with identifying part numbers, rated load, maximum test load, and operation where normally tested.	Select Status		
6.2.7.1.2. An approved quality assurance program identifying controls, inspection points, and complete First Use Tag information.	Select Status		
6.2.7.1.3. Identification of shelf-life criteria.	Select Status		
The shelf-life shall not exceed 5 years in an environmentally controlled location without retest.	Select Status		
6.2.7.2. Range Safety shall withdraw approval upon any infraction of the program.	Select Status		
6.2.8. Mobile Cranes. All mobile cranes to be used shall be properly inspected, functionally validated, and maintained according to 29 CFR 1910; 29 CFR 1926; NASA-STD-8719.9, Lifting Standard; applicable ASME standards; applicable state OSHA plans; and the requirements identified below. These requirements apply whether the equipment is government, payload project, or contractor owned, rented, or leased.	Select Status		
6.2.8.1. Mobile cranes shall be certified for operational use by the appropriate authorizing agency.	Select Status		
6.2.8.2. Dual crane lift operations require Range Safety approved lift plans (See 6.2.6.4).	Select Status		
6.2.8.3. The use of mobile cranes to lift critical hardware shall be justified to and approved by the PSWG and Range Safety on a case-by-case basis.	Select Status		
6.2.8.4. Prior to conducting a critical lift with a mobile crane, the upper limit switch shall be tested for proper functioning by raising an empty hook to the upper limit, activating the upper limit switch, and verifying that the hoist stops. After the load is hoisted a small distance, the load shall be left hanging for approximately three minutes (i.e., a holding brake test) to ensure the winch holding brakes functions properly and that there is no load slippage.	Select Status		
6.2.8.5. Mobile cranes used for critical lifts shall be de-rated to 50% of their original load capacity. The total weight of the load shall not exceed 50% of the crane rated capacity for the given lift radius and load line reeving configuration of the crane.	Select Status		
6.2.8.6. Load charts shall be used as the primary means for determining safe loads for various boom angles. Crane computers shall not be used as a sole means for this determination.	Select Status		

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6.2.8.7. Evolutions that actually involve man-rated lifts shall also comply with operational requirements in this chapter and ASME B30.23, Personnel Lifting Systems. For man-rated lifts, the total weight of the loaded personnel platform and related rigging shall not exceed 50% of the rated capacity for the radius and configuration of the crane or derrick.	Select Status		
6.2.8.8. Inspection and Test Requirements. Payload projects utilizing mobile cranes shall submit a data package to the PSWG and Range Safety for review and approval that provides evidence that the mobile crane meets the following requirements:	Select Status		
6.2.8.8.1. Current maintenance documentation.	Select Status		
6.2.8.8.2. Operator qualifications and certification documentation.	Select Status		
6.2.8.8.3. Proof that operators have performed similar type lifts within one year of planned lift.	Select Status		
6.2.9. Lifting Operations	I		
6.2.9.1. Pre-Operational Lifting Requirements. The person responsible for supervising lifting operations shall ensure the following:	Select Status		
6.2.9.1.1. The crane has met all of its maintenance, test, and inspection requirements and is operated within its rated capacity.	Select Status		
6.2.9.1.2. The operator is properly certified.	Select Status		
6.2.9.1.3. The operator remains at the controls the entire time a load is suspended.	Select Status		
Exceptions may be approved by the PSWG and Range Safety in the interest of operational efficiency to allow lifting hardware such as slings, spreader bars, BTHLDs, load cells, and LPDs to remain suspended while unattended provided all of the following conditions are met:	I		
6.2.9.1.3.1. A procedure documenting such exceptions has been approved by the appropriate local safety authority as determined by the PSWG and Range Safety.	Select Status		
6.2.9.1.3.2. The lifting hardware suspended is connected to but not supporting the weight of the objective load (e.g., the launch vehicle stage, motor segment, or payload).	Select Status		
6.2.9.1.3.3. The load is scheduled to be lifted within 24 hours.	Select Status		
6.2.9.1.3.4. The load and immediate vicinity are roped off or otherwise identified to prohibit unauthorized personnel entry.	Select Status		
6.2.9.1.3.5. The crane controls are locked in the off position.	Select Status		
6.2.9.1.3.6. The restrictions against people being under the suspended lifting hardware are enforced.	Select Status		
6.2.9.1.4. The vicinity of the lift is controlled so that:	Select Status		

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6.2.9.1.4.1. Unauthorized personnel entry is precluded.	Select Status		
6.2.9.1.4.2. Personnel or any part of their bodies are prevented from being under or in the way of the load.	Select Status		
6.2.9.1.4.3. For cranes equipped with booms, the area is defined by the swing radius of the crane and includes all of the rotating superstructure.	Select Status		
6.2.9.1.4.4. A large enough area is cleared so as to protect against flying debris from a dropped object.	Select Status		
6.2.9.1.5. All personnel within the controlled hoisting area wear suitable head and foot protection.	Select Status		
6.2.9.1.6. Previously announced lightning advisories and lightning warnings will not cause the load to be in jeopardy.	Select Status		
6.2.9.1.7. All personnel are knowledgeable of the operation to be performed, tasks to be done, route to be traveled, and safety considerations.	Select Status		
6.2.9.1.8. If using a mobile crane, the crane shall be level and the following criteria shall be met:	Select Status		
6.2.9.1.8.1. The area shall be set up so that the lift is made within the shortest possible radius.	Select Status		
6.2.9.1.8.2. The lift shall be made over the rear of the crane, if possible.	Select Status		
6.2.9.1.8.3. When the load to be handled and the operating radius require the use of outriggers, or any time when outriggers are used, the outrigger beams shall be fully extended or deployed per load rating chart specifications. Blocking under outrigger beams is not permitted. Blocking under outrigger floats, when used, shall be strong enough to prevent crushing, bending, or shear failure and of sufficient thickness, width, and length as to completely support the float, transmit the load to the supporting surface, and prevent shifting or topping under load. Outrigger floats shall be made of 4 x 4 inch or cross-hatched 2 x 4 inch lumber, a minimum of 4 x 4 feet square or equivalent support.	Select Status		
6.2.9.1.8.4. When using outriggers, they shall be fully extended and raise the crane so that the wheels are off the ground unless the crane is designed for partial outrigger use and has appropriate load rating charts.	Select Status		
6.2.9.1.8.5. No part of the crane or load shall pass within 10 feet of an electrical power line unless the line is de-energized and visibly grounded on both sides of the area of possible contact.	Select Status		
6.2.9.1.8.6. Outriggers and outrigger floats shall be used on flat hard/compacted surfaces.	Select Status		
6.2.9.1.8.7. Outrigger floats or cribbing is required in areas that do not have a hard surface such as concrete.	Select Status		
6.2.9.1.8.8. Operators shall not exceed inclination angles specified by the mobile crane manufacturer when locating, then leveling the mobile crane prior to lifting operations.	Select Status		
6.2.9.1.8.9. Operators shall not operate mobile cranes upon unapproved, temporary foundations at unimproved surfaces or on road bearing surfaces not rated for the lifting load.	Select Status		

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6.2.9.1.9. Systems shall have sufficient assistant operators or spotters to make sure that all sides of the system are clear for operation.	Select Status		
6.2.9.1.10. All operators or spotters shall have aural communications for coordination between themselves when power is on the system.	Select Status		
6.2.9.1.11. Tag lines shall be used when there is potential for load sway that could damage the article lifted, high value equipment, or flight hardware.	Select Status		
6.2.9.1.12. Tag line personnel shall not impart undesirable motion to the load.	Select Status		
6.2.9.1.13. If the weight of the load to be lifted is not known, the weight shall be estimated with a reasonable degree of accuracy before attempting to lift the load.	Select Status		
6.2.9.1.14. Unattended suspended loads require local safety authority approval.	Select Status		
6.2.9.2. Attaching the Load. To attach the load, the crane hook shall be positioned directly over the center of gravity of the load before attachment unless authorized in a written procedure approved by the appropriate local safety authority.	Select Status		
6.2.9.3. Lifting the Load	I		
6.2.9.3.1. On the first lift of the day or shift, or on a critical lift, the load shall be raised a few inches, then held in place momentarily, to verify that the brakes operate normally.	Select Status		
6.2.9.3.2. The load shall be lifted to a height sufficient to clear all obstacles in its intended path.	Select Status		
6.2.9.3.3. For hoist angles, cranes are designed to function with the load raised perpendicular with respect to the ground. Cranes are normally designed for vertical lifts. Side angle pull lifts should not be attempted unless the crane is specifically designed for this purpose in accordance with the requirements in Volume 3.	Select Status		
6.2.9.3.3.1. Fleet (side) angles shall be kept as close to zero as possible. The appropriate local safety authority’s approval is required for all anticipated fleet angles.	Select Status		
Pulling the rope with a load component perpendicular to the drum or sheave grooves (fleet or side angle) may cause the rope to jump out of the groove and become entangled on the drum or caught between the sheave and its mounting with possible catastrophic results.	I		
6.2.9.3.3.2. Lead (in-line) angles shall be kept as close to zero as possible. The appropriate local safety authority approval is required for anticipated lead angles exceeding 5 degrees unless the hoist is specifically designed for greater angles. Increasing the lead (in-line) angle increases the strain on the load line, brakes, bearings, sheaves, and other crane parts.	Select Status		
6.2.9.3.3.3. When lifting a load, load lines shall not contact load girts, structural members, or any other obstructions.	Select Status		

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6.2.9.3.4. Loads may be lifted with the load line off-perpendicular for the purpose of rotating large pieces of hardware if all of the following conditions are met:	Select Status		
6.2.9.3.4.1. There is no safer way to accomplish the rotation.	Select Status		
6.2.9.3.4.2. The angle on the load line shall not exceed five degrees unless the hoist was specifically designed for a greater angle.	Select Status		
This angle is sometimes referred to as the lead or draft angle; it is not to be confused with the fleet angle.	I		
6.2.9.3.4.3. On an installed crane, the angle is pulled in line with the rotation of the rope onto the drum (lead angle) unless the crane is equipped with a level wind device.	Select Status		
6.2.9.3.4.4. The crane is inspected to ensure that the load line does not engage the load girts, structural members, or any other obstructions at the angle to be used.	Select Status		
6.2.9.3.4.5. Before the lift, the crane is checked to ensure that all rope parts are properly seated in the grooves of the drums or sheaves.	Select Status		
6.2.9.3.4.6. The load is prevented from swinging or otherwise inducing dynamic loads on the hoisting system.	Select Status		
6.2.9.3.5. Mobile or boom-equipped cranes shall not be used for off-perpendicular lifting due to the severe hazard of tipping the crane over or of collapsing the boom.	Select Status		
6.2.9.3.6. Crane maintenance instructions or checklists shall include directions to look for evidence of apparent offset lift damage during inspections.	Select Status		
6.2.10. Suspended Load Operations	I		
6.2.10.1. Moving a Suspended Load	I		
6.2.10.1.1. Crane operations involving lifting of hazardous or explosive materials shall be limited to only those personnel required to perform the task.	Select Status		
6.2.10.1.2. A safety clearance zone shall be established in the vicinity around the load and all non-essential personnel cleared to a safe distance.	Select Status		
6.2.10.1.3. Horizontal and vertical travel speeds shall be kept at a safe level and shall be addressed, as appropriate, in procedures.	Select Status		
6.2.10.1.4. Each lift shall be planned so that the load is suspended for a minimum amount of time.	Select Status		
6.2.10.1.5. The load shall not be lifted until immediately before intended travel.	Select Status		

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6.2.10.1.6. The most direct route of travel shall be used.	Select Status		
6.2.10.1.7. Loads shall not be carried over critical hardware except when that load is being mated to the critical hardware.	Select Status		
6.2.10.1.8. The landing area shall be prepared so that the load may be set down immediately at the end of travel.	Select Status		
6.2.10.1.9. If the load remains suspended for any length of time, the safety clearance zone shall remain in force.	Select Status		
6.2.10.1.10. The load shall not be carried over personnel nor shall personnel be allowed to place any part of their bodies under any part of the load.	Select Status		
6.2.10.1.11. The load shall be transported as low as possible but at a height sufficient to clear all obstacles that may be in its path.	Select Status		
6.2.10.1.12. Alarm device or spotter personnel accompanying the load shall be used to clear other persons out of the load path.	Select Status		
6.2.10.1.13. Tag lines shall be used to control movement of the load and not impart undesirable motion to the load.	Select Status		
6.2.10.1.14. Tag lines shall be long enough to protect personnel from being struck by the load.	Select Status		
6.2.10.1.15. Tag lines shall be used when there is potential for a load swing that could damage flight hardware, property, or cause injury or death.	Select Status		
6.2.10.1.16. Crane operators shall be instructed to stop motion should anyone be in the path of the load or if anyone signals to stop.	Select Status		
6.2.10.1.17. Two-way communication between the test conductor and crane operator shall be maintained.	Select Status		
6.2.10.2. Crane-Suspended Personnel Platforms. Operations involving lifting suspended personnel platforms are prohibited except as provided by NASA-STD-8719.9, Lifting Standard, DAFMAN 91-203, and 29 CFR 1926.1431, Crane, or Derrick Suspended Personnel Platforms, and specifically authorized by the appropriate local safety authority.	Select Status		
6.2.10.3. Man-Rated Crane Criteria. All cranes used to suspend personnel platforms and work baskets shall meet the following requirements:	Select Status		
6.2.10.3.1. Crane free-fall features shall be deactivated.	Select Status		
6.2.10.3.2. Load testing of the current configuration shall have been performed within past 12 months.	Select Status		
6.2.10.3.3. Two-way communication shall be maintained between the crane operator and the person in the basket.	Select Status		
6.2.10.3.4. The crane operator shall be appropriately qualified.	Select Status		

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6.2.10.3.5. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the crane capacity rating.	Select Status		
6.3. Personnel Work Platform Operations	I		
6.3.1. Removable, Extendible, or Hinged Personnel Work Platforms	I		
6.3.1.1. Removable, Extendible, or Hinged Work Platform Operating Standards. Personnel work platforms shall be operated, maintained, and tested in accordance with the manufacturer instructions and the additional requirements listed below.	Select Status		
6.3.1.2. Removable, Extendible, or Hinged Work Platform Periodic Test Requirements. At a minimum, periodic tests shall be performed on all personnel work platforms annually in accordance with Volume 3, 6.3.3.	Select Status		
6.3.1.3. Removable, Extendible, or Hinged Work Platform Recurring Data Requirements. At a minimum, recurring data is required in accordance with Volume 3, Chapter 4.	Select Status		
6.3.2. Aerial Work Platforms	I		
Aerial work platforms are commercial (whether or not modified) vehicle-mounted elevating and rotating aerial devices, manually propelled elevating aerial platforms, boom-supported elevating work platforms, self-propelled elevating work platforms, and airline ground support vehicle-mounted vertical-lift devices.	I		
6.3.2.1. Aerial Work Platform Operating Standards. All aerial work platforms shall be verified to meet the design and construction standards of NASA-STD-8719.9, Lifting Standard; ANSI/SIA A92.2, Vehicle Mounted Elevating and Rotating Aerial Devices; A92.3, Manually Propelled Elevating Aerial Platforms; A92.5, Boom Supported Elevating Work Platforms; and A92.6, Self-Propelled Elevating Work Platforms, and bear identifying mark(s) evidencing the same.	Select Status		
6.3.2.2. Aerial Work Platform Designations. All aerial work platforms operated in a hazardous environment as defined by NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation, shall be approved for fire safety purposes by a nationally recognized testing laboratory [for example, Underwriters Laboratories, Inc. (UL), Factory Mutual Engineering Corp (FM)] using nationally recognized testing standards, bear mark(s) evidencing testing, and bear the appropriate designation (i.e., D, DS, DY, E, ES, EE, EX, G, GS, LP, LPS).	Select Status		
6.3.2.3. Aerial Work Platform Operations	I		
6.3.2.3.1. Only qualified and trained personnel shall operate aerial work platforms.	Select Status		

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6.3.2.3.2. Aerial work platforms shall be operated in accordance to this section, the manufacturer's recommendations and the applicable ANSI/SIA standard and with the safety rules and practices of NASA-STD-8719.9, Lifting Standard; ASME B56.2 Type Designated Area, Use Maintenance, Operator, and ASME B56.3, Electric Battery-Powered Industrial Trucks, safety standards.	Select Status		
6.3.2.3.3. Usage in NFPA 505 Hazardous Area Classifications shall be restricted to aerial work platforms with the appropriate designation per UL 558, Standard for Safety, Industrial Trucks, Internal Combustion Engine Powered; UL 583, Standard for Safety, Battery Powered Industrial Trucks; or comparable nationally recognized testing laboratory.	Select Status		
6.3.2.3.4. Aerial work platforms shall not be used in proximity of critical hardware where inadvertent operation could result in damage of same.	Select Status		
6.3.2.3.5. Before each use, the operator shall perform a pre-operational check to demonstrate operational readiness, including all limit switches and outrigger drift switches, if applicable, but excluding the tilt alarm/shutoff. If controls do not operate properly, the operator is responsible for notifying the supervisor. Repairs and adjustments shall be made before operations begin. The operator shall adhere to all tags on the controls.	Select Status		
6.3.2.3.6. Before each use, the operator shall survey the area for applicable hazards such as overhead obstructions and high-voltage conductors, debris, bumps and loose obstructions, drop-offs and holes, ditches, untamped earth fills, obstructed path of travel, unstable footing, and other possible hazardous conditions. The operator shall establish appropriate safety zones before initiating operations.	Select Status		
In some cases, aerial work platforms are intentionally used in close proximity to critical hardware [e.g., to disconnect the rigging from the top of solid rocket motor upgrade (SRMU) segments when they are placed vertically in the stands]. A hazard analysis should be conducted on such aerial platforms and identified hazards mitigated. Examples of mitigation include padded platform handrails, elimination of single point failures from the hydraulic control system, and stabilization of the chassis to prevent sudden shifting of the platform in case of tire failure. Lessons learned from the SRMU program are listed below: ***(1) Do not use worn or dry rotted tires on aerial platform vehicles. Sudden tire failure may cause platform translation and impact against sensitive flight hardware.*** ***(2) Keep the hydraulic system clean and ensure adequate hydraulic hose chafing guards are installed in the boom articulated joint areas. At least one hydraulic hose failure occurred on the SRMU program, spraying the entire lift with hydraulic oil.*** **(3)** ***Ensure that the hydraulic system components have no unacceptable failure modes. In case of an SRMU aerial platform, reverse command resulted in the vehicle lurching forward and the platform impacting the doorframe. This malfunction was attributed to contamination in the hydraulic system.***	I		
6.4. Powered Industrial Trucks	I		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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Powered industrial trucks are commercial (whether or not modified) fork trucks, platform lift trucks, crane trucks, tow tractors, personnel and burden carriers, and other specialized industrial trucks powered by electric motors or internal combustion engines.	I		
6.4.1. Powered Industrial Truck Standards. All powered industrial trucks shall be verified to meet the design and construction standards of ASME B56 series safety standards and bear identifying mark(s) evidencing the same.	Select Status		
6.4.2. Powered Industrial Truck Designations. All powered industrial trucks shall be approved for fire safety purposes by a nationally recognized testing laboratory (for example, UL, FM) using nationally recognized testing standards, bear mark(s) evidencing testing, and bear the appropriate designation (i.e., D, DS, DY, E, ES, EE, EX, G, GS, LP, LPS).	Select Status		
6.4.3. Powered Industrial Truck Operations	I		
6.4.3.1. Only qualified and trained personnel shall operate powered industrial trucks.	Select Status		
6.4.3.2. Operations of all powered industrial trucks shall be operated in accordance with the safety rules and practices of NASA-STD-8719.9, Lifting Standard; and ASME B56 series safety standards.	Select Status		
6.4.3.3. Use in NFPA 505 Hazardous Area Classifications shall be restricted to powered industrial trucks with the appropriate designation per UL 558, UL 583, or a comparable nationally recognized testing laboratory.	Select Status		
6.4.3.4. Powered industrial trucks shall not be used in the proximity of critical hardware where inadvertent operation could result in damage of the hardware.	Select Status		
6.4.3.5. If external attachments, such as special lifting adaptors, are attached to the forks for lifting, the attachment components shall have the proper load rating and meet the appropriate testing requirements in this publication.	Select Status		
6.4.3.6. Lift trucks shall be de-rated to 75 percent of rated capacity for critical loads.	Select Status		
6.5. Elevator Usage	I		
6.5.1. Passenger elevators not designed in accordance with Volume 5 criteria for freight shall not be used for propellant or other hazardous materials.	Select Status		
6.5.2. Freight elevators used for the movement of ordnance that has been removed from the original shipping containers, toxic propellants, or other hazardous materials shall be controlled remotely.	Select Status		
6.5.3. Personnel shall not ride in elevators during movement of the materials listed in 6.5.2.	Select Status		

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CHAPTER 7 ACOUSTIC HAZARD OPERATIONS	I		
7.1. Acoustic Hazard Operating Standards	Select Status		
Acoustic (noise) protection shall be provided in accordance with the requirements in NPR 1800.1, Occupational Health Program Procedures, latest revision, Hearing Conservation Section. (See Volume 3, Section 7.1 for noise exposure limits and related requirements.)	Select Status		
7.2. Acoustic Hazard Operations Personnel Protection Requirements	I		
7.2.1. Unprotected personnel shall not be exposed to hazardous noise levels.	Select Status		
7.2.2. Approved hearing protection devices shall be worn as required.	Select Status		
7.3. Acoustic Operations	I		
7.3.1. All potential hazardous noise sources in the work environment that could expose personnel shall be identified to the Bioenvironmental Engineer or approving authority (as determined by the PSWG and Range Safety) for hearing conservation.	Select Status		
7.3.2. Identified noise sources shall be surveyed by the Bioenvironmental Engineer or a designated representative.	Select Status		
7.3.3. A means of warning personnel before entering the noise hazard area shall be provided. A description of the hazard and what measures are necessary to ensure the safety of personnel shall be included.	Select Status		
1. Warning signs should be posted in a manner to be visible before entering the noise hazard area. ***2. Warning signs should warn of the hazardous noise and indicate the requirement for hearing protection.*** ***3. Any posting of hazardous noise areas should be coordinated with and approved by the Bioenvironmental Engineer or the approving authority (as determined by the PSWG and Range Safety) for hearing conservation.***	I		

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CHAPTER 8 NON-IONIZING RADIATION OPERATIONS	I		
8.1. Non-Ionizing Radiation Operating Standards	I		
8.1.1. Personnel and electroexplosive devices (EEDs) shall not be exposed to hazardous levels of non-ionizing radiation.	Select Status		
8.1.2. All non-ionizing radiation operation shall be conducted in accordance with the requirements of the following standards:	Select Status		
8.1.2.1. NASA and NASA contractor personnel performing operations that utilize, transport, or dispose of, non-ionizing radiation generating equipment, associated with payload processing, shall comply with NPR 1800.1, NASA Occupational Health Program Procedures, Chapter 4.13, for operations on all NASA centers; and AFMAN 40-201, Radioactive Materials (RAM) Management, and any SLD-specific supplements for personnel during payload processing and operations on USSF or launch service providers facilities.	Select Status		
8.1.2.2. NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics; DESR 6055.09_AFMAN 91-201, Explosive Safety Standards, and American Institute of Aeronautics and Astronautics (AIAA)-S-113, Criteria for Explosive Systems and Devices on Space and Launch Vehicles for radiation limits for ordnance exposure.	Select Status		
8.1.2.3. NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics; DESR 6055.09/AFMAN 91-201, Explosive Safety Standard; and American Institute of Aeronautics and Astronautics (AIAA)-S-113, Criteria for Explosive Systems and Devices on Space and Launch Vehicles for guidance with respect to siting ordnance.	Select Status		
Note: While Range Users do not site ordnance, they participate in the process and both design/operations may be influenced by siting considerations.	I		
8.1.3. The use and operating location of non-ionizing radiation producing devices shall be approved by the appropriate safety authority and the RPO/RSO.	Select Status		
8.2. Radio Frequency Procedures	Select Status		
All Electromagnetic Frequency Radiation (EMFR) transmitters shall be operated using the appropriate safety authority and RPO/RSO approved procedures with the appropriate controls established. The RPO/RSO shall specify minimum power levels below which EMFR transmitters are exempt from controls.	Select Status		
8.3. EMFR Operations	I		
8.3.1. RF EMFR Operations General Requirements	I		
Non-ionizing radiation operations involve EMFR transmitters in the range of 3 kHz to 300 GHz and optical devices such as lasers.	I		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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8.3.1.1. Before transmitting, areas in which power density levels exceed permissible exposure limits shall be controlled to restrict access.	Select Status		
Area control may be accomplished using appropriate warning signs, lights, and access barriers.	I		
8.3.1.2. The RPO/RSO shall survey EMFR transmitting devices as required.	Select Status		
8.3.1.2.1. The payload project shall comply with the survey recommendations.	Select Status		
8.3.1.2.2. Where applicable all safety devices shall be checked by site personnel before operation to ensure proper function. If transmission is required while performing these checks, the tests shall be performed at low output power or with a dummy load. Steps for performing these verifications shall be incorporated into procedures. ***Note: A safety device (or feature) is levied on the system design to control the cause of an identified hazard or to mitigate the effect of a hazard once the cause has been satisfied. As a result, the probability and/or severity of a hazard can be reduced to an acceptable level. Safety devices (or features) can take numerous forms in a design. No matter what form a safety device (or feature) takes, its purpose is to prevent an undesirable (hazardous) event from occurring. Safety devices (or features) may be wholly or partly mechanical, electrical, or software in nature. A safety device (or feature) may inherently be part of the system or be specifically added to a system. Safety devices (or features) may include the following:*** ***1. Barriers - a physical means to keep personnel away from hazardous energy or to contain/deflect hazardous energy if it were released.*** ***2. Fail-safe design - a design feature in which a system reacts to a failure by switching to or maintaining a safe operating mode that may include system shutdown.*** ***3. Inhibit - a device that prevents system operation if a predetermined condition is not satisfied.*** ***4. Interlock - a device that may be inserted into the system to prevent system operation (often used in maintenance).*** ***5. Interrupt - a device that disrupts system operation if a predetermined condition is violated.*** ***6. Redundancy/failure tolerance - the built-in ability of a system to provide continued correct operation in the presence of a specific number of failures.*** 7. ***Special system features - systems or devices, such as fire suppression and hazardous gas detection, that control and/or warn of system hazards.***	Select Status		
8.3.1.3. All new, modified, or relocated EMFR transmitters shall be reported to the appropriate safety authority and the RPO/RSO at least 30 days prior to hardware installation so that potential hazards can be evaluated.	Select Status		
8.3.2. EMFR Transmission Operations for EEDs and Open Grain Solid Propellant	I		
8.3.2.1. As determined by analyses and tests, local or range-wide EMFR silence is required during periods of EED installation, removal, and electrical connection or disconnection. At a minimum, EMFR silence within the complex or area shall be required.	Select Status		

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8.3.2.2. Radio transmitters shall be kept away from systems with installed EEDs in accordance with the guidance found in AFI 91-208, Hazards of Electromagnetic Radiation to Ordnance (HERO) Certification and Management and NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.	Select Status		
The 25-foot radio transmission distance requirement is the minimum requirement; however, this requirement does not consider situations where EEDs are EMFR sensitive and leads are unshielded. Based on the specific radio, ordnance, and area involved, an EMFR analysis performed in accordance with (AIAA)-S-113, Criteria for Explosive Systems and Devices on Space and Launch Vehicles, for radiation limits may be provided to the appropriate safety authority for consideration to reduce this requirement.	I		
8.3.2.3. Transmitting devices shall be kept a minimum of 50 feet from a fueling area unless they are intrinsically safe.	Select Status		
8.4. Class 1M, 2M, 3B, and 4 Optical/Laser Operations	I		
8.4.1. Optical/Laser Operating Standards. NASA and NASA contractor personnel performing operations that utilize, transport, or dispose of, Laser and non-Laser optical generating equipment, associated with payload processing, shall do so in accordance with NPR 1800.1, NASA Occupational Health Program Procedures, Chapter 4.16, for operations on all NASA centers; and AFI 48-139, Laser and Optical Radiation Protection Program, and any SLD-specific supplements for personnel during payload processing and operations on USSF or launch service providers facilities.	Select Status		
8.4.2. Optical/Laser Operation Personnel Protection Requirements	I		
8.4.2.1. NASA and NASA contractor personnel performing operations that utilize, transport, or dispose of laser and non-laser optical generating equipment shall be appropriately trained in work practices commensurate with the degree of potential laser hazards, both from laser radiation and non-beam hazards, in accordance with NPR 1800.1, NASA Occupational Health Program Procedures, Chapter 4.16 paragraph 4.16.3.2. NASA and NASA contractor personnel performing optical/laser operations on USSF property shall be trained and certified in accordance with AFMAN 40-201, Radioactive Materials (RAM) Management, as applicable.	Select Status		
8.4.2.2. Approved protective eye wear and other PPE shall be worn as required.	Select Status		
8.4.3. Optical/Laser Procedures. All optical devices and lasers capable of exceeding allowable energy levels, as determined by the appropriate local safety authority, shall be operated using the appropriate local safety authority and LSO, RPO/RSO approved procedures with the appropriate controls established.	Select Status		
8.4.4. Optical/Laser Inspection	I		
8.4.4.1. Periodic inspections shall be conducted to ensure the laser and controls are in safe working condition and are properly protected from potential damage.	Select Status		

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Conditions of concern include dangerous light radiation, temperature extremes, shatterable materials, contaminating gases, cryogenics, high voltage, and X-rays.	**I**		
8.4.4.2. Inspection records shall be maintained for the life of the program.	**Select Status**		
8.4.4.3. Inspection records shall be available at the request of the appropriate local safety authority.	**Select Status**		
8.4.5. Optical/Laser Operations	**I**		
8.4.5.1. Alignment of targets, optics, filters, and other optical/laser items shall be accomplished following written procedures and using non-hazardous low power (Class 1 or Class 2) lasers.	**Select Status**		
8.4.5.2. Active beam or target viewing shall be accomplished with closed circuit television or an optical comparator with an appropriate filter.	**Select Status**		
8.4.5.3. Laser beams directed toward flammable or explosive materials, pressurized systems, any other system that may become hazardous due to laser energy or directed toward sensitive components of FTSs shall not exceed allowable limits as determined by the appropriate local safety authority.	**Select Status**		
8.4.5.4. Activated lasers shall not be left unattended.	**Select Status**		
8.4.5.5. Unattended lasers shall be locked out and otherwise safed.	**Select Status**		
8.4.5.6. Operations involving laser systems with hazardous materials shall follow the requirements for hazardous materials described in Chapter 10 of this volume.	**Select Status**		
8.4.5.7. Operations involving laser systems with pressurized subsystems such as cryogenic fluids shall follow the requirements described in Chapter 11 of this volume.	**Select Status**		
8.4.5.8. Operations involving lasers with high voltage or capacitance shall follow the requirements in Chapter 14 of this volume.	**Select Status**		
8.4.5.9. All electrical and mechanical azimuth and elevation stops, and other safety devices shall be verified before performing each laser operation. (See the bordered paragraph immediately after 8.3.1.2.2 for examples of safety devices.)	**Select Status**		
8.4.5.10. Laser platforms shall comply with the requirements for mechanical ground support equipment used to handle critical hardware as described in Chapter 6 of this volume.	**Select Status**		
8.4.5.11. Laser operation conforms to the principles and requirements set forth in ANSI Z136.1, American National Standard for Safe Use of Laser, and ANSI Z136.2, Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources.	**Select Status**		

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8.4.5.12. Requirements for the procurement and manufacture of laser products are provided in 21 CFR Part 1040.10, Laser Products, and 21 CFR Part 1040.11, Specific Purpose Laser Products.	Select Status		
8.4.5.13. All nominal hazardous procedural items shall be accomplished including, but not limited to, the following:	Select Status		
8.4.5.13.1. 24-hour notification of Pad Safety.	Select Status		
8.4.5.13.2. Pre-operational PA announcements.	Select Status		
8.4.5.13.3. Clearance of safety clearance zones.	Select Status		
8.4.5.13.4. Posting of applicable warning signs and operation of area warning lights.	Select Status		
8.4.5.13.5. Pad Safety permission prior to start of the hazardous lasing activity.	Select Status		

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CHAPTER 9 RADIOACTIVE (IONIZING) RADIATION SOURCES OPERATIONS	I		
Launch approval of radioactive (ionizing radiation) sources is addressed in Volume 3, Chapter 9 of this publication.	I		
9.1. Payload projects shall comply with NPR 1800.1, NASA Occupational Health Program Procedures, Chapter 4.13, General Radiation Requirements and AFMAN 40-201, Radioactive Materials (RAM) Management, and any SLD specific supplements or instructions, as applicable.	Select Status		
9.2. All ionizing operations shall be planned and conducted in accordance with written procedures, approved by the appropriate safety authority, or RPO/RSO, so that personnel exposure is as low as reasonably achievable (ALARA), but in no case shall exceeded the maximum dose and exposure limits in 10 CFR 20, Standards for Protection Against Radiation, be exceeded.	Select Status		
9.3. Local safety authorities and the RPO/RSO shall be notified of the location of radioactive material spills, releases, and incidents. Local radiation safety requirements shall be followed. CCSFS Cape Support (ER 321-853-5211) or VSFB Command Post (WR 805-606-9961), Range Safety, and the RPO/RSO shall be notified of the location of radioactive material if spilled, released, or dispensed either by design or accident when on Air Force and Space Force property. KNPR 1860.1 shall be followed for releases and spill on KSC property.	Select Status		
9.4. Flight radioactive sources shall be installed as late in the countdown as practical.	Select Status		
9.5. Mishaps involving radioactive materials shall be reported in accordance with NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping and appropriate local safety organizations requirements as required above. DAFMAN 91-110 and DAFI 91-204 shall also apply for mishaps on Air Force and Space Force property.	Select Status		

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CHAPTER 10 HAZARDOUS MATERIALS OPERATIONS	I		
10.1. Hazardous Materials Operating Standards	I		
10.1.1. Hazardous materials shall be selected in accordance with 10.1 of Volume 3 of this publication and NPR 1800.1, Chapter 4.	Select Status		
10.1.2. An operation or process task that includes a solid, liquid, or gaseous material that, under foreseeable conditions, are toxic, carcinogenic, cryogenic, explosive, flammable, pyrophoric, water-reactive, corrosive, an oxidizer, a compressed gas, a combustible liquid, or are chemically unstable shall be conducted as a Hazardous Operation and performed in accordance with the NASA-STD-8719.11, Fire Protection, NASA-STD-8719.12 Safety Standard for Explosives, Propellants, and Pyrotechnics, NPR 8715.1, NASA Safety and Health Programs, AFI 90-821, Hazard Communication (HAZCOM) Program, DAFMAN 91-203, and any Wing-specific supplements or instructions, as directed by the PSWG and Range Safety for process safety management (PSM) and risk management plan (RMP). See Attachment V6 A.23 Classification of Hazardous Procedures.	Select Status		
10.1.3. When threshold quantities of toxic chemicals as defined by OSHA, NASA, or Space Force requirements are being used, the payload project shall comply with any local process safety requirements, the appropriate local safety and health authorities, as identified by the PSWG and Range Safety, and the local Biomedical/Bioenvironmental Office, concerning hazardous material selection, operation, storage, and disposal. At the ER the payload project shall comply with applicable ER Requirements are the 45 SWI 91-101, Process Safety Management. The SLD 45 point of contact for process safety management is System Safety (SLD 45/SE).	Select Status		
10.2. Hazardous Materials Operations Personal Protective Equipment (PPE)	Select Status		
Proper head, eye, hand, body, and respiratory protection shall be worn as required in accordance with 29 CFR 1910, NPR 1800.1, Chapter 4, and local requirements. The PPE shall be approved by the approved local safety/occupational health authority and is subject to the approval of the Bioenvironmental Engineer as required.	Select Status		
10.3. Hazardous Materials Procedures	Select Status		
Hazardous materials procedures shall be established per local requirements. For operations taking place on Air Force or Space Force property, hazardous material procedures shall be established per AFMAN 32-4013. Hazardous materials procedures shall include, but not be limited to, the following topics:	Select Status		
10.3.1. Emergency actions for unplanned events such as spills, fires, and personnel contamination.	Select Status		
10.3.2. Actions for decontamination, neutralization, cleanup, and disposal.	Select Status		
10.4. Hazardous Materials Operations	I		
10.4.1. The use of any hazardous material is subject to the appropriate local safety and bioenvironmental authority's approval.	Select Status		

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10.4.2. Appropriate control measures shall be established for the use of hazardous materials based on known properties. If properties are unknown, testing shall be performed subject to approval by the appropriate local safety and bioenvironmental authorities.	**Select Status**		
10.4.3. Control measures for hazardous liquids include, but are not limited to, the following criteria:	**Select Status**		
10.4.3.1. Approved containers shall be used.	**Select Status**		
10.4.3.2. Containers shall remain capped (covered) when not in use.	**Select Status**		
10.4.3.3. Quantities shall be limited as approved by the Fire Authority Having Jurisdiction (AHJ).	**Select Status**		
10.4.3.4. Work areas shall contain no more than the quantity required for a single shift.	**Select Status**		
10.4.3.5. Work areas shall not be used for storage unless approved storage cabinets and lockers are available.	**Select Status**		
10.4.3.6. Local or general exhaust ventilation shall be used to control solvent vapors from reaching toxic levels or explosive levels.	**Select Status**		
10.4.3.7. Materials that are themselves not hazardous, but that can be hazardous in conjunction with other materials, shall be controlled.	**Select Status**		
10.4.3.8. The location and/or facility shall be compatible with the type and quantity of hazardous material.	**Select Status**		
10.4.3.9. When personnel are in confined spaces, hazardous materials and chemicals shall only be used in accordance with 29 CFR 1910.146, Permit-Required Confined Spaces, compliant program. Proper ventilation shall be used to prevent buildup and/or pocketing of hazardous materials and chemicals to hazardous levels. Due consideration shall be given to all potential sources of toxic buildup, such as chemicals employed by workers within the confined space, from venting of systems, and from off-gassing.	**Select Status**		
10.4.3.10. Materials prone to electrostatic charge buildup shall not be used in the vicinity of ordnance or propellants.	**Select Status**		
10.4.3.11. Glass containers shall not be used in the immediate vicinity of flight hardware or in elevated locations so that they could fall and shattered pieces of glass strike hardware or personnel. In general, use of glass containers is discouraged.	**Select Status**		
10.4.4. In the event of an unplanned toxic release local emergency response plans shall be followed.	**Select Status**		
The following documents applicable at Space Force Ranges: IEMP, AFI 10-2501, Air Force Emergency Management Program, and any SLD-specific supplements, instructions, or plans. At KSC: KNPR 8715.2, Comprehensive Emergency Management Plan.	**I**		
10.5. Restrictions on the Use of Plastic Films, Foams, and Adhesive Tapes (PFAs) and other Static-Producing and Flammable Materials	**I**		

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10.5.1. General. The use of plastic films, foams, and adhesive tapes (PFAs) shall be kept to a minimum in all payload processing and testing areas. Materials prone to electrostatic charge buildup shall not be used on or near ordnance items or in the vicinity of flammable liquids or commodities such as propellants.	Select Status		
10.5.1.1. Compliance with the restriction on static-producing materials is handled on a case-by-case basis; however, the following criteria shall be used as a guideline:	Select Status		
10.5.1.1.1. Materials shall not come into contact with a system having an installed EED or other ordnance.	Select Status		
10.5.1.1.2. Materials shall not come within 10 feet of exposed solid propellant grain, which is defined as when the grain is visible with no nozzle plug or cover.	Select Status		
10.5.1.1.3. Materials shall not come within 50 feet of exposed flammable liquids.	Select Status		
10.5.1.2. Compliance with the use of materials that could be flammable is handled on a case-by-case basis; however, all materials that are used in the vicinity of ordnance or flammable liquids, such as hypergolic propellants, shall pass the material tests described below.	Select Status		
10.5.2. Material Tests	I		
10.5.2.1. Materials such as contamination covers, thermal blankets, splash shields, Velcro, tape, and any other material located in the vicinity of liquid propellant areas or ordnance areas shall be evaluated for compatibility with their intended use.	Select Status		
10.5.2.2. The payload project shall supply a sample of materials to KSC testing laboratory or other approved laboratory for testing, and the results shall be forwarded to the appropriate local safety authority. Materials passing KSC or approved equivalent tests may be deemed acceptable by the appropriate local safety authority.	Select Status		
Material properties may be obtained through NASA MAPTIS (Material and Process Technical Information System), from KSC Materials Testing Labs, or other approved material database.	I		
10.5.2.3. Testing shall consider the following material characteristics:	Select Status		
10.5.2.3.1. Ability to build up a charge (triboelectric test).	Select Status		
10.5.2.3.2. Ability of that charge to decay (triboelectric test).	Select Status		
A material is considered to have good electrostatic dissipation properties if it can dissipate voltage down to 350 volts in 5 seconds using the triboelectric test.	I		
10.5.2.3.3. Flammability	Select Status		
10.5.2.3.4. Compatibility with other materials and liquids the material may come into contact with.	Select Status		

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10.5.2.4. Material restrictions may also arise from other limitations such as being humidity dependent (for charge dissipation) or degradable in sunlight (ultraviolet).	Select Status		
10.5.2.5. The appropriate local safety authority shall approve the use of materials based on the test results.	Select Status		
Materials that do not meet these criteria may be acceptable for a particular usage as determined by the appropriate local safety authority.	I		
10.5.2.6. Material deficiencies shall result in operational restrictions.	Select Status		
10.6. Hazardous Commodity Lockers	I		
10.6.1. Positioning and Use of Hazardous Commodity Lockers. Hazardous commodity lockers or cabinets shall be positioned and used for the purpose of storing flammable and combustible liquids in accordance with 29 CFR 1910.106, NFPA 30, Flammable and Combustible Liquids Code; NASA-STD-8719.11, NASA Standard for Fire Protection; and local fire safety requirements as applicable.	Select Status		
10.6.2. Hazardous Commodity Locker Inspection. The payload project shall inspect hazardous commodity lockers at least weekly.	Select Status		
10.7. Disposal of Contaminated Liquid Propellant, Gas, or Other Regulated Wastes	I		
10.7.1. On Space Force Ranges, the payload project shall notify CCSFS Cape Support (ER) (321-853-5211) or Range Scheduling (WR) (805-606-8825) of any hazardous material requiring disposal on the respective Range location. For other locations the payload project shall follow local policies.	Select Status		
If required, additional guidance shall be obtained from Civil Engineering (Environmental Coordinator) or their designated representative and Range Safety.	I		
10.7.2. Disposal of toxic or contaminated liquid propellants, gases, or other wastes shall be performed using methods and techniques approved by the safety and other local authorities, as well as all applicable federal, state, and local regulations.	Select Status		
On USSF, the approval authority is Range Safety and Civil Engineering (Environmental Coordinator). Follow 45 and 30 Space Wing Operations Plan (SWOP) 19-14, Petroleum Products and Hazardous Waste Management Program.	I		
10.7.3. Payload project shall notify the appropriate local safety authorities to obtain proper clearance and support to dispose of wastes before the generation of such wastes. For Space Force Ranges, Civil Engineering shall be notified.	Select Status		
10.7.4. As needed, those operations involving toxic propellants shall be conducted under the surveillance of Environmental Health and Pad Safety for operations on the AF Range to ensure the safety of personnel involved in the operation and personnel located in adjacent or downwind areas.	Select Status		

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10.7.5. Records of management and identification of wastes shall be maintained by the organization generating the waste.	Select Status		
10.7.7. All spills or releases of hazardous substances, including petroleum products, shall be reported to the local authority responsible for emergency response, in accordance with the facility safety plan and local requirements. For CCSFS Cape Support (ER) (321-853-5211) or Range Scheduling (WR) (805-606-8825) and Pad Safety immediately and for KSC dial 911 (or 321-867-7911 from a cell phone).	Select Status		

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CHAPTER 11 GROUND SUPPORT AND FLIGHT HARDWARE PRESSURE SYSTEMS OPERATIONS	I		
The minimum operational requirements for both ground support and flight hardware pressure systems operations are described below. Operational requirements unique to either category are identified.	I		
11.1. Pressure Systems Operating Standards	I		
The degree of hazard in pressure systems is proportional to the amount of energy stored, which is a function of both the pressure and the volume stored. As a result, low-pressure, high-volume systems can be as hazardous to personnel as high-pressure systems.	I		
11.1.1. Only pressure systems that meet the design requirements of Volume 3 as tailored for each specific project (mission) shall be used.	Select Status		
11.1.2. The handling and storage of propellants shall be in accordance with NASA-STD-8719.12, Safety Standard for Explosive, Propellants, and Pyrotechnics; CPIA 394, Chemical Propulsion Information Agency-Hazards of Chemical Rockets and Propellants; and DESR 6055.09_AFMAN 91-201, Explosive Safety Standards and NAVSEA OP 5, Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation and Shipping.	Select Status		
11.1.3. Propellants shall be used and stored only in facilities designed and suited for that purpose and approved for specified time periods of use by the appropriate local safety authorities.	Select Status		
11.1.4. Propellants shall be used and stored only in systems that meet the design requirements of Volume 3, Chapter 11 and Chapter 12 and shall be approved by the appropriate local safety authorities.	Select Status		
11.1.5. Portable or mobile vessels and packaging used for transportation of pressurized or hazardous commodities shall be maintained and recertified in accordance with applicable Department of Transportation (DOT) 49 CFR.	Select Status		
11.2. Pressure Systems Personnel Requirements	I		
11.2.1. Pressure Systems Training and Certification. All personnel who operate, test, and maintain pressure systems shall be trained and certified.	Select Status		
11.2.2. Pressure Systems PPE	Select Status		
11.2.2.1. Selection of PPE. The PPE selected shall have been approved for the planned usage by the appropriate local safety authorities, occupational health authorities, and other applicable approving authorities as identified by the PSWG and Range Safety (see section 5.3).	Select Status		
11.2.2.1.1. Approval shall be limited to a particular model number of protective equipment and a particular operation.	Select Status		

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11.2.2.1.2. Approval of PPE for an operation depends on the type and volume of propellants involved, the size of the lines, flow rate, pressure, capability to deal with emergencies, and egress accessibility.	Select Status		
11.2.2.1.3. Approvals are not transferable; approvals for similar operations require a reevaluation of the parameters stated above.	Select Status		
11.2.2.1.4. Protective gear shall be compatible with the propellants involved, shall be fire resistant, non-static producing, and shall have been approved for the planned usage by the appropriate local safety authorities, occupational health authorities, and other applicable approving authorities as identified by the PSWG and Range Safety (see section 5.3).	Select Status		
11.2.2.1.5. If the protective gear has limitations, these limitations and subsequent protective actions shall be identified in the operating procedure.	Select Status		
For example, splash suits are not to be used when hydrazine concentrations can exceed 0.01 ppm.	I		
11.2.2.2. SCAPE, Category I or IV	I		
11.2.2.2.1. SCAPE, Category I or IV shall be used for propellant flow and pressurization during the following operations:	Select Status		
11.2.2.2.1.1. Connection and disconnection of wet lines or contaminated (not purged and flushed) dry lines.	Select Status		
11.2.2.2.1.2. Sampling operations.	Select Status		
11.2.2.2.1.3. During propellant flow.	Select Status		
11.2.2.2.1.4. During initial pressurization with propellants until system integrity has been verified (no leaks).	Select Status		
11.2.2.2.1.5. Connections and disconnections of tanker load/off-load lines.	Select Status		
11.2.2.2.1.6. Removal and replacement of components in a liquid line.	Select Status		
11.2.2.2.1.7. Opening any liquid system that has not been drained, purged, and flushed with referee fluid.	Select Status		
11.2.2.2.1.8. When the condition of the system is uncertain or unknown.	Select Status		
11.2.2.2.2. The maximum operating time in a Category I SCAPE suit is 110 minutes; however, the appropriate local safety authorities (including Pad Safety for AF Range facilities) can authorize on-station time not to exceed 120 minutes. In extreme temperatures, the appropriate local safety authorities can restrict on-station times in Category I SCAPE suits to less than 110 minutes. (ER Only). Personnel using Category I SCAPE suits shall observe a 60-minute rest period between consecutive SCAPE operations: for example, no double-packing. All personnel required to wear Category 1 and Category lV Self-Contained Atmospheric Protective Ensemble (SCAPE) shall be certified in accordance with KTI-1202, Propellant Handlers Ensemble User's Manual.	Select Status		

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SCAPE categories are defined as: ***Category I - Propellant Handlers Ensemble (PHE) with environmental control unit (ECU).*** ***Category IV - Propellant Handlers Ensemble (PHE) using remote breathing air supplied by hardline hose.*** ***Category VI - 'Chemturion' Chemical Protection Suit (CPS) "blue suit" with hardline breathing hose.*** ***Please refer to KTI-1202, Propellant Handlers Ensemble User's Manual for Propellant Handlers Ensemble user requirements and further explanation of categories.***	**I**		
11.2.2.2.3. For physiological purposes, the maximum operating time in a Category IV or VI SCAPE suit shall not exceed four consecutive hours.	**Select Status**		
11.2.2.3. Splash Suits. Splash suits, with self-contained breathing apparatus, shall only be used with systems that contain residual vapors and only after the appropriate local safety authority's approval. If any liquid is in the system, splash suits shall not be used.	**Select Status**		
11.2.2.3.1. Removal of full protective gear after system integrity verification shall require approval by the appropriate local safety authorities.	**Select Status**		
11.2.2.3.2. Emergency protective gear shall be available throughout operations to the crew and other personnel who might be affected in the event of a spill.	**Select Status**		
11.2.2.3.3. The following non-liquid operations shall require splash suits:	**Select Status**		
11.2.2.3.3.1. Removal and replacement of components on purged and isolated liquid lines.	**Select Status**		
11.2.2.3.3.2. Removal and replacement of components on vent lines.	**Select Status**		
11.2.2.3.3.3. Connections and disconnections of drained, purged, and isolated lines.	**Select Status**		
11.2.2.3.3.4. Pressure leak checks when required by procedure.	**Select Status**		
11.2.2.3.4. With the appropriate local safety authority concurrence, the use of splash suits during propellant flow after integrity has been established may be allowed at the WR.	**Select Status**		
11.2.2.4. PPE for Cryogenic Systems	**I**		
11.2.2.4.1. All personnel performing liquid oxygen and liquid hydrogen transfer operations, repairs, or adjustments to the system shall wear PPE (flame-resistant treated, non-static producing overalls of liquid resistant material, cryogenic service gloves, hoods or face shields, and non-absorbent shoes) in accordance with 29 CFR 1910, NPR 1800.1, Chapter 4, and local requirements. The PPE shall be approved by the approved local safety/occupational health authority and is subject to the approval of the Bioenvironmental Engineer as required.	**Select Status**		

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11.2.2.4.2. Personnel performing operations on other cryogenic systems shall be similarly protected, except that flame-resistant treating of coveralls is not required for non-flammable commodities.	Select Status		
11.2.2.5. PPE for Hydrogen Peroxide Transfers. Hydrogen peroxide transfers shall require PPE (boots, gloves, and face shields) in accordance with 29 CFR 1910, NPR 1800.1, Chapter 4, and local requirements. The PPE shall be approved by the approved local safety/occupational health authority and is subject to the approval of the Bioenvironmental Engineer as required.	Select Status		
11.2.2.6. If a DOT vessel is installed on a permanent basis, it shall fall under the recertification requirements for a fixed system.	Select Status		
11.3. Pressure Systems Procedures	I		
11.3.1. Procedures shall be prepared governing the safe operation, testing, maintenance, and installation of pressurized systems by the agency performing the specific task.	Select Status		
11.3.2. Procedures shall be developed for all operations involving propellants and the checkout of propulsion systems.	Select Status		
11.3.3. Off-loading procedures for payloads shall be made available at any time propellant is loaded in flight hardware. Off-loading design as outlined in Volume 3, Chapter 11 and Chapter 12 of this publication addresses the complete system during the complete processing flow. The off-loading procedures shall include integration of the following:	Select Status		
11.3.3.1. Hardware:	Select Status		
11.3.3.1.1. Launch vehicle.	Select Status		
11.3.3.1.2. Launch vehicle fairing.	Select Status		
11.3.3.1.3. Spacecraft.	Select Status		
11.3.3.1.4. Launch complex.	Select Status		
11.3.3.1.5. Process facility.	Select Status		
11.3.3.1.6. Transport vehicle.	Select Status		
11.3.3.1.7. Fixed GSE.	Select Status		
11.3.3.1.8. Portable GSE.	Select Status		
11.3.3.2. Software Command Capability:	Select Status		
11.3.3.2.1. Flight Hardware.	Select Status		
11.3.3.2.2. GSE:	Select Status		

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11.3.3.3. Personnel Capability:	Select Status		
11.3.3.3.1. Remote.	Select Status		
11.3.3.3.2. SCAPE.	Select Status		
11.3.3.3.3. Combination of both.	Select Status		
11.4. Pressure Systems Test, Inspection, and Maintenance Requirements	I		
11.4.1. General Test Requirements	Select Status		
11.4.1.1. Pressure systems shall be initially tested in accordance with Volume 3, Chapter 11 or Chapter 12.	Select Status		
11.4.1.2. Any system that has been opened shall be leak tested at 100 percent maximum operating pressure (MOP) with an inert medium.	Select Status		
11.4.1.3. Pressure relief valves and flex hoses shall be retested within one year of intended use.	Select Status		
11.4.1.4. Pressure gauges and transducers shall be calibrated annually.	Select Status		
11.4.1.5. After any disconnection, modification, or repair of a system, the affected part of the system shall be leak tested.	Select Status		
11.4.1.6. Any component that has been damaged, potentially damaged, repaired, replaced, or modified shall be proof tested in accordance with Volume 3.	Select Status		
11.4.1.7. After the component proof test, the system or subsystem shall be proof tested, functionally tested, and leak tested. The determination for system proof testing shall be made on a case-by-case basis.	Select Status		
11.4.1.8. New, modified, or repaired propellant systems shall be tested in accordance with Volume 3, Chapter 11, or Chapter 12.	Select Status		
11.4.1.9. A log shall be kept on propellant systems to keep track of use, maintenance, modification, testing, and inspection.	Select Status		
11.4.2. Ground Support Pressure Systems General Inspection Requirements	I		
11.4.2.1. Before use and each operation, facilities and equipment shall be inspected by the payload project and the appropriate local safety authority to ensure a safe configuration for the facilities, equipment, and propellants involved.	Select Status		
11.4.2.2. Propellant transfer and storage areas shall be spot checked by the appropriate local safety authority, the Fire Department, and Environmental Health. The appropriate area supervisor shall be advised of any discrepancies noted.	Select Status		
11.4.2.3. Periodic inspections shall be performed on all ground pressure systems in accordance with applicable procedures.	Select Status		

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11.4.2.4. Periodic inspections shall be performed on ground based pressure vessels and liquid holding tanks in accordance with the ISI Plan in Volume 3. These inspections shall be performed during the following periods:	Select Status		
11.4.2.4.1. Certification Period. Period from the initial operational use of the vessel and/or system until the vessel and/or system requires recertification.	Select Status		
11.4.2.4.2. First Certification Period. Period from the first recertification effort until second recertification.	Select Status		
11.4.2.4.3. All subsequent Recertification Periods.	Select Status		
11.4.2.4.4. The hazardous pressure system operator shall retain all documentation generated as a result of the recertification effort and place this documentation in the system ISI certification and recertification file.	Select Status		
11.4.3. Pressure Systems General Maintenance	I		
11.4.3.1. Before replacement, storage, or repair of hypergolic or toxic propellant or fluid system components, the system shall be purged and flushed of all residual contaminants. System connections and removed components shall be appropriately capped, bagged, and labeled before moving the component.	Select Status		
11.4.3.2. A record shall be kept on the certification of system and component cleanliness.	Select Status		
11.4.3.3. When it is necessary to remove flight hardware components from the system, all broken connections shall be bagged and tagged to prevent moisture or particle contamination from outside sources.	Select Status		
11.4.3.4. If DOT vessels are used in portable GSE, maintenance and operating procedures for periodic hydrostatic tests shall be in accordance with DOT regulations.	Select Status		
11.4.3.5. All maintenance procedures and training shall ensure that personnel performing visual inspections or other checks shall not walk in front of any National Pipe Thread (NPT)-connected components but shall inspect/observe the NPT connections from a side position to prevent exposure to possible high pressure projectiles.	Select Status		
11.4.3.6. All rupture discs installed in hazardous fluid systems shall be replaced every two years.	Select Status		
11.4.4. Pressure Systems Tests. Tests performed shall meet the requirements as outlined in Volume 3, Chapter 11 and Chapter 12. The following requirements apply unless the payload project has proposed, with supporting risk analysis, and PSWG and Range Safety has approved an alternative test interval for components:	Select Status		
11.4.4.1. Periodic Test Requirements for Pressure System Components:	Select Status		
11.4.4.1.1. Uninstalled Flexible Hose. Uninstalled flexible hoses shall be hydrostatically proof tested to 1.5 times their MAWP within one year before use, or pneumatically tested to 1.1 times MAWP once every two years unless otherwise approved by the PSWG or Range Safety.	Select Status		

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11.4.4.1.2. Installed Flexible Hose. Installed flexible hoses in functional use shall be hydrostatically tested to 1.5 times their MAWP once a year. Exception: This requirement does not apply to flexible hoses that are permanently installed, located, and operated in an environment that does not exceed the rated temperature, pressure, and shelf life of the hose.	Select Status		
11.4.4.1.3. Prior to project use and at least annually, all flexible hoses shall be visually inspected over their entire length. Those with damaged fittings, broken braid, kinks, flattened areas, or other evidence of degradation shall be removed from service. A flexible hose exhibiting major defects as classified in SAE ARP 1658, shall be removed from service.	Select Status		
Exception: This requirement does not apply to flexible hoses that are permanently installed, located, and operated in an environment that does not exceed the rated temperature, pressure, and shelf life of the hose.	I		
11.4.4.1.4. Pressure gauges and transducers shall be calibrated once a year.	Select Status		
Hazardous pressure operations begin at 150 psig.	I		
11.4.4.1.5. Pressure relief valves shall be tested for proper setting and operation once a year.	Select Status		
11.4.4.2. Testing Modified and Repaired Pressure Systems. Tests performed shall meet the requirements as outlined in Volume 3, Chapter 11, and Chapter 12.	Select Status		
11.4.4.3. Pressure Systems Tagging	I		
11.4.4.3.1. Post testing and inspection, pressure system components shall be tagged.	Select Status		
11.4.4.3.2. Tags shall provide the date of the last inspection and proof-load test and the component MAWP.	Select Status		
11.4.5. Ground Support Pressure Vessels and Liquid Holding Tanks Recertification. Recertification data shall be submitted as part of the SDP (MSPSP) as required in Volume 3, Chapter 11, and Chapter 12.	Select Status		
11.4.6. Pressure Vessel and Liquid Holding Tank Recertification Documentation. Documentation shall be recorded and maintained in accordance with Volume 3. Chapter 11.	Select Status		
11.5. Pressure Systems Operating Requirements	I		
11.5.1. General Operating Requirements. Only pressure systems approved by the appropriate local safety authority shall be used.	Select Status		
11.5.1.1. Pressure Systems Marking	I		
11.5.1.1.1. Warning signs shall be posted to keep personnel out of areas where pressurization is taking place.	Select Status		
11.5.1.1.2. High and ultra-high pressure systems (systems equal to or greater than 3,000 psig) shall be marked with danger signs indicating the maximum pressure that could be involved.	Select Status		

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11.5.1.1.3. Pressure relief valves that present a noise hazard on activation shall be marked with danger signs.	Select Status		
11.5.1.2. Pressure Systems Remote Pressurization. Exception. Remote pressurization can be waived IAW the following: (1) The assembled system has been proof tested at a pressure equal to 1.5 times the system MEOP/MOP or to an agreed-upon level for tanks with less than 2:1 safety factor for burst; (2) system configuration has not been modified or repaired before the above testing. Unwelded relief or sensing devices may be replaced after system proof testing; and (3) Inspection of the pressure system at the launch site verifying damage has not been sustained during transportation or handling before the above testing.	Select Status		
11.5.1.2.1. Remote pressurization is required for the following conditions:	Select Status		
11.5.1.2.1.1. Initial pressurization of any vessel or system with an inert medium.	Select Status		
For metallic vessels/tanks or systems, initial pressurization at the ranges does not have to be done remotely and/or use blast protection if initial pressurization was performed at off-range sites, such as factory acceptance testing, and followed-up by acceptable post-test inspection.	I		
11.5.1.2.1.2. Any pressurization that will exceed MOP/MEOP.	Select Status		
11.5.1.2.1.3. Any system or vessel whose design or condition is considered unknown or questionable by the appropriate local safety authority.	Select Status		
11.5.1.2.2. All personnel shall be evacuated whenever pressure exceeds the MAWP.	Select Status		
11.5.1.2.3. Suitable barriers shall be used to protect personnel. The payload project and the appropriate local safety authority shall determine the adequacy of the blast shield for the pressure and volume of the system.	Select Status		
11.5.1.3. Pressure Systems Pressurization Operations	I		
11.5.1.3.1. Pressure systems shall be inspected upon arrival on the ranges or before first operation.	Select Status		
11.5.1.3.1.1. Where there is evidence that systems have been damaged or overstressed, replacement or, at a minimum, remote initial pressurization shall be required.	Select Status		
11.5.1.3.1.2. Payload projects who do not perform initial pressurization remotely shall certify to the appropriate safety authority that no evidence of damage or overstress exists.	Select Status		
11.5.1.3.2. A system and/or facility check shall be made before the start of the pressurization operation.	Select Status		
11.5.1.3.3. Personnel present during any pressurization shall be limited to those in direct support of the operation. During dynamic pressurization of flight pressure vessels/tanks, personnel shall not be exposed any time vessel/tank pressure exceeds 50% of the vessel/tank's design burst rating. Once the flight vessel/tank is in a static condition and verified to not leak, personnel may return to the area as long as vessel/tank pressure does not exceed MOP.	Select Status		

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11.5.1.3.4. Personnel may be present in the area of ground pressure vessels/tanks at all times when pressurized to no greater than MAWP. ***Exception: During initial pressurization of ASME/DOT compliant vessels, personnel must evacuate when pressure exceeds 50% of MAWP during dynamic pressurization activity. After initial pressurization of a ground pressure vessel/tank, it is acceptable for personnel to be present during subsequent pressurizations (static and dynamic states) provided the vessel is still within its design and cycle life.***	**Select Status**		
11.5.1.3.5. If a leak occurs during pressurization, the system and/or subsystem shall be depressurized before adjusting any fittings.	**Select Status**		
11.5.1.3.6. Unless otherwise specified, hoses over 2 feet (0.6 meters) in length, and pressurized above 100 psig (1.03 MPa), shall meet the following restraint requirements: 1) the flexible hose shall be properly secured at each end, unions, and every 6 feet along the length of the hose by an approved stainless resistant device by securely attaching to the structure in a manner that in no way interferes with the hose flexibility. 2) If the hose cannot be securely attached to the structure every 6 feet, weighted bags (minimum of 50 pounds) sand or shot bags (with approval of range safety), ingots, or other suitable weights shall be used as flexible hose anchors or anchoring attach points at a minimum of 6 foot intervals.	**Select Status**		
11.5.1.3.7. Bolts and fittings shall not be loosened or torqued while the system is under pressure.	**Select Status**		
11.5.1.3.8. Any system that requires devices such as pressure regulators, pressure-reducing valves, safety valves, or pressure relief valves shall not be activated unless the devices are in place and in operable condition. Only qualified and authorized personnel shall change the setting of these valves and regulators.	**Select Status**		
11.5.1.3.9. Flight hardware pressure vessels that exhibit a brittle fracture or hazardous leak-before-burst (LBB) failure mode shall maintain a minimum safety factor of 1.5:1 during transport or ground handling operations unless otherwise specified and approved by the PSWG and Range Safety.	**Select Status**		
11.5.1.3.10. Flight hardware pressure vessels that have a non-hazardous LBB failure mode shall maintain a minimum safety factor of 1.5:1 during transport or ground handling operations.	**Select Status**		
11.5.1.4. Pressure Systems Entry, Maintenance, and Repair	**I**		
11.5.1.4.1. Pressure Systems Entry and Repair Requirements	**I**		
11.5.1.4.1.1. Before entry into or repair of a pressurized system, depressurization of that portion of the system is mandatory.	**Select Status**		
11.5.1.4.1.2. The steps listed below shall be followed:	**Select Status**		
11.5.1.4.1.2.1. A minimum of two block valves shall be closed between the portion of the system to be opened and the source of pressure.	**Select Status**		

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11.5.1.4.1.2.2. The section of line to be opened and the section between the block valves in series shall be vented (depressurized) to atmospheric pressure before the start of work and remain vented (depressurized) during all phases of work.	Select Status		
11.5.1.4.1.2.3. Whenever operations permit, the entire system shall be depressurized before a portion of the system is isolated, vented, and opened.	Select Status		
11.5.1.4.1.2.4. Venting a pressure system shall be accomplished through vent valves. Regardless of pressure, venting shall never be accomplished by loosening or removing a fitting.	Select Status		
11.5.1.4.1.2.5. Lockout devices and warning tags shall be attached to the valves that are isolating the area where system entry will be made.	Select Status		
11.5.1.4.1.2.6. The isolated area shall be verified as being depressurized before opening.	Select Status		
11.5.1.4.2. Open System Work Precautions	I		
11.5.1.4.2.1. Whenever a depressurized section of a pressurized system is to be entered or there is disassembly of any system components, it is considered open system work and the following precautions shall be observed:	Select Status		
11.5.1.4.2.1.1. Authorization for entry or disassembly of any system components, is required from the responsible complex or area supervisor.	Select Status		
11.5.1.4.2.1.2. Personnel limits shall be established in a local safety authority approved procedure.	Select Status		
11.5.1.4.2.2. When it is necessary to remove components from the system, due care shall be exercised to prevent moisture or particle contamination from outside sources.	Select Status		
11.5.1.4.2.3. Lockout devices and tagging shall be used to ensure systems or subsystems are not operated while work is being performed on the system.	Select Status		
11.5.1.4.2.4. Work requiring lockout and tagging includes the following:	Select Status		
11.5.1.4.2.4.1. The system is depressurized for maintenance.	Select Status		
11.5.1.4.2.4.2. The work to be performed extends to another shift, either same crew next day or a different crew the same day.	Select Status		
11.5.1.4.2.4.3. The work site is left unattended.	Select Status		
11.5.1.4.2.4.4. The valve is not visible at all times.	Select Status		
11.5.1.4.2.4.5. Valves shall be rendered inoperative with a lockout device compatible with the valve material and the lockout devices shall be approved by Range Safety or the local safety authority.	Select Status		

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Range Safety Approved Lockout Devices: ***1. Passing a metal chain through the hand wheel and the valve yoke or around the bottom of the valve body or pipe, and then locking the chain.*** ***2. Making the valve inaccessible by locking the housing that encloses the valve, locking the cover of a valve pit, or removing or locking the hand wheel extension of an underground valve or a valve that can- not be reached from the ground or a valve platform.*** ***3. Locking and tagging electrical controls of valves with electric motor actuators.***	**Select Status**		
11.5.1.4.2.5. The following criteria shall be observed when removing locks and tags and returning the system to service:	**Select Status**		
11.5.1.4.2.5.1. Lockout devices used to render a valve inoperative shall be removed only by an authorized work crew after all work has been accomplished and, when applicable, approved by the proper authority.	**Select Status**		
11.5.1.4.2.5.2. Tags shall be removed only by the crew placing the tag.	**Select Status**		
11.5.1.4.2.5.3. Removed tags shall be returned to the crew office and mated with the tear off portion of the tag.	**Select Status**		
11.5.1.4.2.5.4. Both tag and tear off portion shall be filed or disposed of in accordance with current practice.	**Select Status**		
11.5.2. Pressure Systems Containing Liquid Propellant. In addition to the requirements noted above, the following requirements shall be adhered to when operating, testing, and maintaining pressure systems containing liquid propellants.	**Select Status**		
11.5.2.1. General Operating Requirements for Pressure Systems Containing Liquid Propellants	**Select Status**		
11.5.2.1.1. The Fire Department shall be notified of the presence of propellants in any facility as well as any specific firefighting and spill handling support requirements.	**Select Status**		
11.5.2.1.2. During Any Mishap or Incident. At the ER, the designated Operations Controller is the on-scene commander until relieved by the 45MSG/DET 1 Commander or Fire Chief. Pad Safety advises, ensures control, and supports, as necessary, in accordance with SLD 45 IEMP 10-2. At the WR, the Support Group Commander or Fire Chief serves as the incident commander and Pad Safety advises, ensures control, and supports, as necessary. At KSC the Fire Chief serves as the incident commander during any mishap or incident. For NASA contracted processing facilities, off of government property follow the local processing facilities safety procedures.	**Select Status**		
11.5.2.1.3. Simultaneous tanking of fuels and oxidizers aboard a launch vehicle/payload is prohibited.	**Select Status**		
11.5.2.1.4. Vessels, lines, and propellant loading systems shall be properly bonded and commonly grounded.	**Select Status**		
11.5.2.1.5. Vapor monitoring equipment shall be used for leak (sniff) checks and general atmosphere monitoring to determine the necessity for PPE. Vapor monitoring equipment shall be approved by the appropriate local safety authority and is subject to approval by Bioenvironmental Engineering.	**Select Status**		

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11.5.2.1.6. A toxic vapor check shall be conducted by the operations control authority when personnel are in a facility that has toxic propellants contained in flight hardware and GSE at the start of each 8-hour shift and before entering a facility in which toxic propellant has been left unattended for 8 hours or more.	Select Status		
11.5.2.1.7. In locations where liquid propellants will be handled, water shall be available in the area in sufficient quantities for fire, spill, and medical use. Skin or eye contact with toxic propellants shall be flushed with copious amounts of water. For specified flush periods, consult the Safety Data Sheet (SDS) for the product being used. Appropriate medical attention shall be sought as early as possible (during flushing if possible).	Select Status		
11.5.2.1.8. The supervisor shall notify the appropriate local safety authority a Bioenvironmental Engineering of any injury involving toxic or non-toxic propellants.	Select Status		
11.5.2.1.9. Transport of more than five gallons of hypergolic propellants. in non-DOT approved containers, shall require a Security or HOS escort as described in Chapter 16 of this volume. Transport of any quantity of hazardous commodities in DOT approved containers does not require escort.	Select Status		
11.5.2.2. Pre-Operational Requirements for Pressure Systems Containing Liquid Propellants	**I**		
11.5.2.2.1. The payload project procedures, approved by the appropriate local safety authority, shall be used for all propellant operations and the checkout of propulsion systems.	Select Status		
11.5.2.2.2. As required by procedure, the appropriate local safety authority (Pad Safety on Space Force property) and other required support shall be on hand before the conduct of operations.	Select Status		
11.5.2.2.3. Appropriate local safety authority concurrence to proceed shall be obtained by the payload project before the conduct of operations.	Select Status		
11.5.2.2.4. Personnel qualification and training shall be verified by the respective supervisors.	Select Status		
11.5.2.2.5. Before starting operations, the payload project and the appropriate local safety authority shall verify that the facility and equipment are ready by performing the following checks:	Select Status		
11.5.2.2.5.1. Wet check of safety showers and water lines before propellant transfer.	Select Status		
11.5.2.2.5.2. Accessibility and operability of emergency exit doors.	Select Status		
11.5.2.2.5.3. Operability of drain and sump systems and their capability for handling a worst case spill and wash down.	Select Status		
11.5.2.2.5.4. Operability of vent systems.	Select Status		
11.5.2.2.5.5. Availability of fire protection.	Select Status		
11.5.2.2.5.6. Proper configuration and grounding of propellant systems.	Select Status		

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11.5.2.2.5.7. Weather conditions.	Select Status		
11.5.2.2.5.8. PA announcements, warning lights, and barriers.	Select Status		
11.5.2.2.5.9. Implementation of access control.	Select Status		
11.5.2.2.5.10. All required support on hand.	Select Status		
11.5.2.2.5.11. Availability of approved operating procedures and emergency procedures.	Select Status		
11.5.2.2.5.12. Removal of ignition sources from the area.	Select Status		
11.5.2.2.6. The appropriate local safety authority or security authority shall inform the Test/Launch Conductor that the appropriate roadblocks have been established, the hazard area cleared, and propellant tanking can begin.	Select Status		
11.5.2.2.7. Propellant transfer shall not start when the passage of an electrical storm is imminent (within 5 nautical miles). A propellant transfer operation already in progress shall be interrupted or expeditiously concluded at the discretion of the appropriate local safety authority or the supervisor in charge of the operation. The OSP for each facility shall detail the procedure for this situation. At the WR, propellant operations shall not start when lightning is within 10 nautical miles. At the WR, the guidance provided in 5.6.3 shall be followed.	Select Status		
11.5.2.2.8. Emergency protective equipment shall be provided as required by the appropriate local safety authority.	Select Status		
11.5.2.2.9. The payload project shall provide the maximum source strength based on quantity (gallon or pound) and surface area. The worst case credible spill (quantity) shall be based on a failure analysis provided to the appropriate local safety authority before the operation. This information shall be used to determine the downwind sector that shall be evacuated if a large spill occurs.	Select Status		
11.5.2.2.10. Where feasible, the payload project shall develop a means to minimize the surface area of spills by providing a dike or other means of containment.	Select Status		
11.5.2.3. Controls	I		
Leaks, spills, and venting of toxic propellants may create a toxic cloud. This toxic cloud will diffuse through the atmosphere at a rate that varies with meteorological conditions and spill size. The establishment of clearance zone controls helps mitigate exposure to this hazard.	I		
11.5.2.3.1. A localized safety clearance zone that limits personnel access to those individuals directly involved with the operation and who have the proper protective equipment shall be established.	Select Status		
11.5.2.3.2. A larger safety clearance zone that limits personnel access to those individuals directly or indirectly involved in the operation or mission shall be established. The determination of the larger safety clearance zone shall include consideration of the availability of fencing and Security or HOS check points and the TNT equivalency of the propellants involved.	Select Status		

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11.5.2.3.3. The minimum downwind sector that must be immediately evacuated in the event of a major spill shall be provided to all personnel involved in the operation, and controls shall be in place to implement the control of this sector. The downwind sector shall be defined in the OSP.	Select Status		
11.5.2.4. Operating Requirements for Pressure Systems Containing Liquid Propellants	I		
11.5.2.4.1. Concurrence from the appropriate local safety authorities (Pad Safety on Space Force property) shall be obtained before starting propellant transfer operations and before pressurization.	Select Status		
11.5.2.4.2. Portable vessels and systems containing incompatible fuels and oxidizers shall not be brought into closer proximity than allowed for permanent systems unless otherwise agreed to in advance by the appropriate local safety authority.	Select Status		
11.5.2.4.3. Fire Protection and Environmental Health shall be available as required by procedure.	Select Status		
11.5.2.4.4. All persons and vehicles not absolutely essential to the operation shall be evacuated.	Select Status		
11.5.2.4.5. Before opening a contaminated or toxic propellant system, the system shall be flushed or purged to concentration levels coordinated with Bioenvironmental Engineering and approved by the appropriate local safety authority. At the ER, Environmental Health shall monitor and report any levels exceeding health standard criteria to the Pad Safety Office. At the WR, Bioenvironmental Engineering and Environmental Health monitor for AF operations only. Contractors are responsible for monitoring their own systems.	Select Status		
11.5.2.4.6. The handling and transfer of toxic materials and propellants shall be monitored by the appropriate local safety authority to ensure the safety of personnel involved in the operation and personnel downwind of the operation.	Select Status		
11.5.2.4.7. Vapor monitoring shall be continuous whenever personnel are in enclosed areas having toxic propellants present.	Select Status		
11.5.2.4.8. At KSC and the ER, in the case of a lightning warning (lightning within 5 nautical miles), the system shall be secured; the complex, storage, or operating area shall be cleared; and the required actions called for in procedures and OSPs shall be taken (see Attachments 3, 4, and 5 of this volume). At the WR, work stop's and systems shall be secured when lightning is within 10 nautical miles. Buildings are evacuated when lightning approaches 5 miles.	Select Status		
11.5.2.4.9. Reentry into the area of a launch vehicle and/or payload with fuel and oxidizer aboard shall be held to a minimum and shall be subject to approval by the appropriate local safety authority.	Select Status		
11.5.2.4.10. Reentry into the area of a launch vehicle and/or payload with only fuel aboard shall also be held to a minimum and shall be subject to the approval of the task or area supervisor and local safety authorities.	Select Status		
11.5.2.4.11. Tanking of toxic or cryogenic liquids aboard a launch vehicle or payload during launch countdown shall be performed as late as possible. If tanking is required during launch processing before the countdown, tanking shall be performed as late in the processing as is practical.	Select Status		
11.5.2.4.12. The appropriate actions and evacuations shall take place in the event of an emergency such as a propellant spill.	Select Status		

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11.5.2.4.13. All appropriate local safety authorities including Cape Support (ER), Range Safety (WR), and Pad Safety (WR), as well as the PSWG Chairperson, shall be notified of any propellant mishap and incidents, including near misses.	Select Status		
11.5.3. Releases of Toxic Vapors	I		
11.5.3.1. All releases of toxic vapors shall comply with NPR 8715.2, NASA Emergency Preparedness Plan Procedural Requirements, and any local response requirements KNPR 8715.2, Comprehensive Emergency Management Plan for KSC; SLD IEMP, AFI 10-2501, and any SLD-specific supplements, instructions, or plans.	Select Status		
11.5.3.2. Any plans to vent toxic vapors shall be coordinated with the appropriate local safety authority and any other approving authorities. At the ER, any plans to vent toxic vapors shall require coordination with the Civil Engineer – Environmental Flight, Bioenvironmental Engineering, and Environmental Health and Range Safety approval. At the WR, venting operations shall be conducted in accordance with 30SWI 91-106 and the applicable facility or operations plan.	Select Status		
11.5.3.3. The actual venting operation shall not start without approval from the appropriate local safety authority.	Select Status		
11.5.3.4. Venting restrictions and controls shall be identified in the appropriate OSP or operating procedure.	Select Status		
11.5.3.5. Venting operations require that the appropriate downwind sector be evacuated.	Select Status		
11.5.3.6. The operations control authority shall verify that Environmental Health or the local equivalent authority is present to verify concentration levels at the control area boundary.	Select Status		
11.5.3.7. The operations control authority shall verify that Security Police or HOS maintain the appropriate roadblocks.	Select Status		
11.5.3.8. Planned releases shall be in accordance with permits maintained by the appropriate local safety authority (e.g., Civil Engineering for Space Force Range Safety locations).	Select Status		
11.5.4. Emergency Decontamination of Facilities and Personnel. Emergency decontamination of facilities and personnel shall be accomplished under the direction of the appropriate local safety authority (Pad Safety on Space Force property) with Environmental Health and the Fire Department performing the decontamination, if required.	Select Status		
11.5.5. Handling Leaks and Spills of Liquid Propellant	I		
11.5.5.1. PPE for Treating Spills. Personnel treating or flushing major spills of toxic and corrosive propellants shall wear the proper protective clothing and equipment.	Select Status		
11.5.5.2. Leak and Spill Procedures	I		

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11.5.5.2.1. The payload project and supporting agencies shall develop procedures for handling major and minor leaks and spills. Notification shall be provided to the appropriate local hazardous spill response personnel, local safety authority, the PSWG Chairperson, and others per NPR 8621.1. Additionally, CCSFS Cape Support (ER 321-853-5211) or VSFB Command Post (WR 805-606-9961) shall be notified of any spill or release of hazardous material on their respective range and when the spill takes place on KSC property dial 911 (or 321-867-7911 from a cell phone) to notify the Protective Services Control Center and receive spill response assistance as needed.	Select Status		
11.5.5.2.2. Each area that contains liquid propellants shall have a plan approved by the appropriate local safety authority for evacuation based on spill size (quantity and surface area). At the ER, an evacuation zone for a small spill (for example, a gallon of hypergolic propellant) is typically 700 feet downwind or more and approximately 200 feet radially if the spill is allowed to spread out on a flat surface. At the WR, required evacuations are 2,000 feet upwind or as published in the OSPs and Toxic Hazard Zones (THZs).	Select Status		
11.5.5.2.2.1. The approved evacuation plan shall describe the localized safety clearance zone, the general support (larger) safety clearance zone, and the minimum downwind sector to be evacuated in the case of a large spill.	Select Status		
11.5.5.2.2.2. The downwind sector shall be based on the following factors:	Select Status		
11.5.5.2.2.2.1. Maximum source strength based on quantity (gallon or pound) and surface area. The payload project shall determine a worst case spill (quantity) based on a failure analysis.	Select Status		
11.5.5.2.2.2.2. Maximum vapor concentration acceptable for personnel exposure.	Select Status		
11.5.5.2.2.2.3. Average weather criteria, such as wind direction, wind speed, temperature, temperature lapse rate.	Select Status		
Weather variables can be obtained from the local Weather Officer.	I		
11.5.5.2.3. These procedures shall be in accordance with the applicable OSP and shall be submitted to the appropriate local safety authority for review and approval.	Select Status		
11.5.5.2.4. Procedures shall address the topics covered in 10.7.	Select Status		
11.5.5.3. Handling Minor Leaks or Spills	I		
11.5.5.3.1. Minor leaks or spills shall be cleaned up with absorbent material where possible.	Select Status		
For safety and hardware protection reasons, certain spills may require the spill to be washed or flushed with water into collecting tanks or holding basins and disposed of properly to prevent ecological or health hazards. See CPIA 394 for information on treating spills.	I		
11.5.5.3.2. The appropriate local safety authority shall be notified of minor leaks and spills and subsequent actions.	Select Status		

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See CPIA 394 and Range Safety for guidance on disposal of toxic or corrosive propellants.	Select Status		
11.5.5.4. Handling Major Leaks or Spills	I		
11.5.5.4.1. Major leaks or spills shall be handled according to the situation with the objective of minimizing injury to personnel and damage to facilities and equipment in accordance with local procedures (KNPR 8715.2, Comprehensive Emergency Management Plan; SLD IEMP, AFI 10-2501, and any SLD-specific supplements, instructions, or plans). If the requirements described below are in conflict with these OPLANS, the OPLANS shall take precedence.	Select Status		
11.5.5.4.2. The following actions shall be taken:	Select Status		
11.5.5.4.2.1. Time and the situation permitting, the source of the propellant flow and pressure source shall be shut down.	Select Status		
11.5.5.4.2.2. All personnel shall be evacuated out of the area including the minimum downwind sector. Travel shall be upwind or crosswind to the minimum evacuation radius as defined in the Facility Operating Plan, Operations Safety and Area Safety Plan, or the payload project emergency procedure, and away from the downwind sector.	Select Status		
11.5.5.4.2.3. Injured or trapped personnel shall be rescued. Appropriate PPE shall be used.	Select Status		
11.5.5.4.2.4. Adjacent areas shall be alerted.	Select Status		
11.5.5.4.2.5. Personnel shall be available to direct emergency crews and to provide information to assist them.	Select Status		
11.5.5.4.2.6. All personnel shall report to the supervisor at the designated assembly point for head count.	Select Status		
11.5.5.5. Handling Cryogenic or Toxic Liquid Spills	I		
11.5.5.5.1. Spills of cryogenic liquids shall be flushed with large amounts of water into the surrounding ground surface or a holding basin.	Select Status		
11.5.5.5.2. Spills of toxic or corrosive propellant, or those that could affect the public health or ecology, shall be flushed with water or another neutralizing agent into a collecting tank to be disposed of in accordance with approved procedures.	Select Status		
Refer to CPIA 394 Volume III, Liquid Propellants, the Medical Department, and the Florida Department of Environmental Protection (ER) or the California Department of Environmental Protection (WR) for guidance.	I		
11.5.5.6. Flight Graphite Epoxy Composite Overwrapped Pressure Vessel Operations. Only composite overwrapped pressure vessels (COPVs) that meet the design, test, and inspection requirements described in Volume 3 of this publication shall be used.	Select Status		

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11.5.5.6.1. If COPVs that contain inert pressurant are in close proximity to propellant tanks, the payload project office shall provide test data proving that the composite overwrap is compatible with the propellant in terms of strength degradation, flammability, and ignition/combustion requirements, when personnel are at risk. If this data is not available, the following actions shall be accomplished:	**Select Status**		
11.5.5.6.1.1. Verification that the COPV is not in a credible "drip zone" for liquid propellants during ground processing operations.	**Select Status**		
11.5.5.6.1.2. If the COPV is in a credible "drip zone," the COPV shall be protected with a coating and/or covers and/or splash shields to guard against contact with potentially incompatible liquids.	**Select Status**		
11.5.5.6.1.3. Hazardous vapor detectors shall be used to monitor the propellant tanks.	**Select Status**		
11.5.5.6.2. If COPVs on USSF ranges will be pressurized to pressures greater than 1/3 of the COPV design burst pressure, the pressurization shall be performed remotely, or a blast shield shall be used to protect personnel. If the vessel is to remain pressurized, personnel access shall not be permitted for a minimum of 10 minutes after the pressurization is completed.	**Select Status**		
11.5.5.6.3. Personnel limits for each operation on or near a pressurized COPV/spacecraft shall be established to minimize personnel exposure to pressurized COPVs.	**Select Status**		
11.5.5.6.4. The transport of pressurized COPVs shall only occur on routes approved by the local safety authority and that minimize personnel and facility exposure. In addition, pressurized COPV transport shall utilize escorts and shall only occur during time periods designated and approved by the appropriate local safety authority.	**Select Status**		
11.5.5.6.5. COPVS shall be protected from damage due to impacts during manufacturing, handling, transportation, assembly, and integration of COPVs into the payload project's system(s).	**Select Status**		
11.5.5.6.6. Except for the pressure test requirements of Volume 3 of this publication, pressure testing of systems with COPVs shall not exceed the manufacturer MOP pressure limit without the manufacturer's approval and the PSWG and Range Safety's agreement.	**Select Status**		
11.5.5.6.7. The payload projects shall develop and provide to the appropriate local safety authority the Emergency Response Plans (ERPs). These ERPs shall include contingency safing and back out plans for COPVs (taking into consideration leaks, impacts, and exposure to incompatible chemical agents). If implemented, a real time assessment shall be accomplished and contingency operations taken, as required. The ERP shall be approved by the appropriate local safety authority.	**Select Status**		
11.5.5.6.7.1. The payload project shall provide the ERP to Range Safety at least 45 calendar days prior to the start of hazardous operations involving COPVs.	**Select Status**		
11.5.5.6.7.2. The payload project shall obtain approval by the by the appropriate local safety authority prior to the start of hazardous operations.	**Select Status**		

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11.5.5.6.8. Prior to the first pressurization of Graphite/Epoxy (Gr/Ep) COPVs at the payload processing launch site, an inspection of the vessel for visible damage shall be performed by a trained inspector. The trained inspector's skills shall be comparable to a Level II visual inspector, per the American Society of Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A (see ANSI/AIAA-081). If this inspection is not possible at the payload processing launch site area (i.e., the Gr/Ep COPV is not accessible), then it shall be conducted the last time the Gr/Ep COPV is accessible for inspection.	**Select Status**		
11.5.5.6.9. After completing the visual inspection and determining that there is no evidence of critical damage to the Gr/Ep COPV, initial pressurization of a COPV at the launch site COPVs shall be pressure tested to 100% of the maximum ground operating pressure. The minimum hold time for this pressure test shall be 5 minutes. This pressurization shall be conducted remotely, or a blast shield shall be used to protect personnel. Personnel will not approach the COPV for a minimum of 10 minutes following the pressurization.	**Select Status**		
11.5.5.6.10. If Gr/Ep COPVs are to be pressurized to pressures greater than 1/3 of the Gr/Ep COPVs design burst pressure, the pressurizations shall be performed remotely, or a blast shield shall be used to protect personnel. If the vessel is to remain pressurized, personnel access shall not be permitted to the area for at least 10 minutes after pressurization is completed.	**Select Status**		
11.5.5.6.11. Personnel limits for each operation on or near the Gr/Ep COPV/Spacecraft shall be established to minimize personnel exposure to the pressurized tank when at pressures greater than one third design burst pressure.	**Select Status**		
11.5.5.6.12. The transport of pressurized Gr/Ep COPVs at pressures greater than one third design burst pressure shall be along routes that minimize exposure to personnel and facilities with escort during designated "off-shift" time periods.	**Select Status**		
11.5.5.6.13. The Mechanical Damage Control Plan (MDCP) for the Gr/Ep COPVs shall be provided by the design agency and made available for review by the applicable safety organization.	**Select Status**		
11.6.13. COPV Test Data Requirements.	**Select Status**		
11.6.13.1. Prelaunch inspection and pressure test reports.	**Select Status**		
11.6.13.2. In-service inspection and recertification test reports for reusable flight COPVS.	**Select Status**		
11.6.14. Testing Flight Hardware Pneumatic and Hydraulic Components. Pressure gauges and transducers shall be periodically calibrated.	**Select Status**		
11.6.15. COPVs with Brittle Fracture or Hazardous LBB Failure Mode Safe-Life Demonstration Requirements. The initial report that documented the fracture mechanics safe-life analysis (for metal liners only) or safe-life testing shall be periodically revised and updated during the life of the program.	**Select Status**		
11.6.16. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Safe-Life Demonstration Requirements. The initial report that documented the fracture mechanics safe-life analysis or safe-life testing shall be periodically revised and updated during the life of the program.	**Select Status**		

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CHAPTER 12 RESERVED	I		
CHAPTER 13 ORDNANCE OPERATIONS	I		
13.1. Ordnance Operations Procedure Requirements	I		
13.1.1. All ordnance operations shall be covered by an appropriate local safety authority approved operating procedure.	Select Status		
13.1.2. All operations conducted in ordnance facilities shall be specified in procedures and/or operating instructions approved by the appropriate local safety authority.	Select Status		
13.1.3. Procedures shall include transportation activity on-Center, all on-base or facility transportation.	Select Status		
13.2. Ordnance Transportation, Receipt, and Storage	I		
13.2.1. Ordnance Transportation, Receipt, and Storage Standards	I		
13.2.1.1. All ordnance transportation, receipt, and storage shall be performed in accordance with, AFMAN 24-204, Preparing Hazardous Materials for Military Air Shipments; NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics; 49 CFR, Transportation; DESR 6055.09_AFMAN 91-201, Explosive Safety Standards , and any Range/SLD-specific supplements or instructions, as applicable.	Select Status		
13.2.1.2. The transportation and shipment of explosives by rail, air, vessel, and public highway shall comply with the Department of Transportation (DOT) Code of Federal Regulation (CFR) Title 49 Parts 172 through 179.	Select Status		
Receipt inspection requires DOT violations to be reported (see 13.2.4).	I		
13.2.1.3. To be acceptable for transportation by any mode, explosives shall have the following items provided to the PSWG and Range Safety and verified by the payload project before shipment:	Select Status		
13.2.1.3.1. Proper DOT classification for transport. For air transport, refer to AFMAN 24-204.	Select Status		
13.2.1.3.2. An assigned hazard classification hazard class and/or division; storage compatibility group; DOT class, markings, shipping name and label; and the United Nations (UN) serial number.	Select Status		
13.2.1.3.3. The availability confirmation of adequate and suitable storage at the payload processing facility and on the launch site area.	Select Status		
Note: Availability of adequate and suitable storage space depends on the hazard classification, the size of the storage containers, and temperature and humidity requirements.	I		

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13.2.1.3.4. The availability of proper connectors and cabling for ordnance checkout if local facilities and equipment are to be used.	Select Status		
For all hazardous ordnance, the presence of a convoy may be required.	I		
13.2.2. Ordnance Transportation General Requirements	I		
13.2.2.1. Transportation Restrictions. Payloads shall not be shipped to the payload processing facility and launch site area with ordnance such as EEDs installed unless prior written approval has been obtained from the appropriate local safety authority.	Select Status		
13.2.2.2. Ordnance Services Coordination. Plans for shipment of ordnance to the payload processing facility and launch site area must be coordinated with the local ordnance support entity.	Select Status		
Note: Plans for shipment of ordnance to CCSFS shall be coordinated with CCSFS Ordnance Services. Plans for shipment of ordnance to VSFB shall be coordinated with SLD30 /SEGW.	I		
13.2.2.3. Ordnance Transportation Address for Space Force Range Deliveries. All ordnance shipments, including EEDs, shall be addressed as shown in 13.2.2.3.1 or 132.2.3.2:	Select Status		
13.2.2.3.1 Ordnance Transportation Address for Eastern Range Deliveries: **To:** Transportation Officer Patrick Space Force Base, FL 32925 **Marked for:** Manager, Ordnance Services Bldg.72910 (Munitions Storage Area #2) Cape Canaveral Air Force Station, FL **Special Markings:** Name of Program Name of Project Monitor or Office Complete Address **From:** Sender's Name and Address	I		

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13.2.2.3.2 Ordnance Transportation Address for Western Range Deliveries: **To:** Transportation Officer Vandenberg Space Force Base, CA 93437 **Marked for:** 30 LRS/LGRDDC 2010 New Mexico Street Vandenberg Space Force Base, CA 93437 Name of Project Monitor and Office Complete Address **From:** Sender's Name and Address	**I**		
13.2.3. ER Ordnance Delivery and Receipt	**I**		
13.2.3.1. The Range User must schedule ordnance deliveries by calling CCSFS Cape Support (321-853-5211). Once CCSFS Ordnance Services has received an ordnance delivery, they are the only authorized transport service on the base. Ordnance Services will only deliver to locations that have been licensed or sited for ordnance.	**Select Status**		
13.2.3.2. The Range User shall notify Pad Safety of ordnance deliveries on CCSFS.	**Select Status**		
13.2.3.3. After receipt at Munitions Storage Area #2 at CCSFS, all ordnance transportation shall be performed by CCSFS Ordnance Services unless specifically approved by SLD45/SE Safety.	**Select Status**		
13.2.4. Ordnance Shipment Inspection	**I**		
13.2.4.1. As soon as possible after receipt, a receiving inspection shall be conducted by ER Contractor Ordnance Services or 30 LRS (WR), the appropriate local safety authority and the payload project to ensure that no damage has occurred during shipment.	**Select Status**		
13.2.4.2. Any shipment discrepancy or DOT violation shall be reported to the Ordnance Services (ER) or 30 LRS (WR) and appropriate local safety authority.	**Select Status**		
13.2.5. Ordnance Storage	**I**		
13.2.5.1. Payload projects operating on the ER and WR shall store ordnance and propellants in facilities specifically designed for that purpose and approved by PSWG, Range Safety and/or the Department of Defense Explosive Safety Board (DDESB) and/or local safety authority. Processing facilities shall not be used for the storage of ordnance.	**Select Status**		
13.2.5.2. The payload project shall plan to remove ordnance from the ranges when it is no longer needed or becomes defective.	**Select Status**		
13.2.5.3. The payload project shall furnish instructions for the disposition of stored ordnance items to the storage provider upon project termination or when ordnance items are no longer required.	**Select Status**		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

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13.3. Ordnance Systems Grounding	I		
13.3.1. Ordnance Systems Grounding PPE	I		
13.3.1.1. Personnel handling, installing, or electrically connecting ordnance or working within ten feet of exposed, solid propellant grain shall wear appropriate local safety authority approved, flame-retardant, non-static producing, long-sleeve, cuffless, full-body garments (coveralls, not smocks) with leg stats, or safety shoes with a Conductive (CD) or Static Dissipating (SD) rating, and/or wrist stats. If required, the payload project shall submit a sample of the garment for testing.	Select Status		
Note: The following is guidance for Ordnance Systems Grounding PPE Criteria:	I		
(1) The two primary concerns in selecting garments to be worn by personnel handling, installing, or electrically connecting ordnance or working within 10 feet of exposed, solid propellant grain are static and fire. The static concern is self-explanatory. Anti-static smocks may be approved by the appropriate local safety authority if there is no significant fire hazard. Fire is a primary concern because of the potential for solid/liquid propellant fires. This concern dates back to the X-248 solid motor mishap in the spin test facility at the ER in 1964. Although the most probable cause for this mishap was static electricity, it was observed the survivors of the mishap would have fared much better had they been wearing full-body protection, in other words, coveralls, rather than smocks. Another key piece of information is the fact that the inadvertent motor initiation occurred during a non-hazardous operation.	I		
(2) With the transition of the Space Force and NASA expendable launch programs to the Space Shuttle Program in the early 1980s, many activities involved both agencies from a launch vehicle, facility, or personnel point of view. It became increasingly more difficult for safety personnel to ascertain the acceptability of the coveralls being used, particularly with respect to Space Force operations in the Payload Changeout (clean) Room on NASA/KSC's shuttle launch pad. For that reason, the ER Safety Office joined forces with the KSC Safety Office to develop common standards and specifications for coveralls for both non-cleanroom and cleanroom environments. The standardized requirements were documented in the KSC Ground Operations Safety Plan GP 1098, a publication that has since been superseded by other documents. The following guidance on the selection of coveralls is provided for the payload projects:	I		
(3) General Criteria for Coveralls:	I		

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a. Flame Retardant. Cotton garments meeting the appropriate local safety authority flame retardant requirements should meet the requirements of MIL-C-43122G, Cloth, Sateen, Cotton, Flame Retardant Treated: "finished cloth shall have an average time of after-flame of not more than 2.0 seconds, and not more than 40 percent consumed both initially and following 15 launderings. **b. Thermal Protection. Garments used in solid rocket motor open grain and Category A ordnance operations should provide a measure of radiant heat and flame contact protection where practical. See Aerospace Medicine, Volume 40, Number 11, Method and Rating System for Evaluation of Thermal Protection, November 1969. NASA/KSC blue-collar garments have been tested for thermal protection (Naval Space Development Center technical memorandum, 6 March 1979) and provide greater than 14 seconds radiation protection before skin blister at a brightness temperature of 1900oC and greater than 3 seconds flame contact protection before skin blister at a flame temperature of 1220oC.** **c. Static Dissipation. Garments meet the appropriate local safety authority static dissipation requirement when voltage drops below 350 volts in 5 seconds at 45 plus 5 percent relative humidity (maximum) and 75oF temperature (maximum). See NFPA 77, Recommended Practices on Static Electricity or NASA KSC Materials Testing Branch Report MMA-1985-79, Standard Test Method for Evaluating Triboelectric Charge Generation and Decay.** **d. Rescue. Consideration should be given to rescue of personnel during hazardous operations. Rescue aids can usually be applied external to the garments in general use applications. However, because of frequent confining work, rescue straps are mandatory for cleanroom garments used for hazardous operations.** **e. Sleeves/Legs. Coveralls should contain full-length sleeves and legs; frocks should contain full-length sleeves.** **f. Pockets. Pockets, if any, should be lattice type, arranged not to trap hazardous fluids.** **g. Cuffs. Garments should not have cuffs (hazardous fluids must not be trapped).** **h. Fasteners. Fasteners should be protected from contact (burning) with the skin.** **i. Color. Garments should be white or natural in color to take advantage of flame/heat reflectivity.** **(4) Detailed Criteria for Non-Cleanroom Coveralls. In addition to meeting general criteria, non-cleanroom coveralls used in ordnance facilities/operations should meet the following:** **a. Garments should be readily identifiable as meeting the appropriate local safety authority requirements:** **(1) Approved general-use, NASA/KSC hazardous operation coveralls are identified by blue collars.** **(2) Aramid (NOMEX) garments containing 1 percent (minimum) filament wire "Brunsmet" or "Bekinox" or carbon thread in one-quarter inch raised grid pattern (carbon grid suits) are approved (carbon thread garments are identified by green rescue straps per Paragraph. 2.16.1.3.d in MIL-C-43122F.).** **(3) Aramid (NOMEX) garments (non-carbon grid suits) dipped with an appropriate local safety authority approved anti-static solution, such as Ethoquad, subject to periodic checks to ensure the anti-static solution remains active, can be used and should be stenciled "KSC Safety Approved." The payload project should acquire white blue-collar coveralls per the KSC specification because the coveralls are known to meet requirements and are readily recognizable. Often the available data on other coveralls is insufficient to determine static resistant and/or fire retardant acceptability. In these cases, a sample set of coveralls needs to be provided to the appropriate local safety authority for testing by the KSC Materials Laboratory.** **b. Coveralls should be properly cleaned to comply with the manufacturer instructions.**	I		

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(5) Detailed Criteria for Cleanroom Coveralls. In addition to meeting the general criteria, cleanroom coveralls used in ordnance facilities/operations should meet the following: **a. The maximum permissible concentration of particles and fibers should not exceed 2,000 particles per square foot of 5 microns and larger, with a maximum of 25 fibers. See ASTM F51-68, Standard Method for Sizing and Counting Particulate Contaminant In and On Cleanroom Garments, (1984), U.S. Air Force Technical Order T.O.-00-25-203, Contamination Control of Aerospace Facilities, and Johnson Space Center JSCM 5322, Contamination Control Requirements Manual.** **Blue-collar garments should not be used for cleanroom use.** **b. Garments should be readily identifiable as meeting appropriate local safety authority requirements.** **(1) Approved cleanroom coveralls used in hazardous operations are identifiable in that they are 99 percent continuous filament NOMEX with approximately 1 percent conductive nylon filament yarn (carbon impregnated)arranged in a one-quarter inch raised grid pattern (carbon grid suits).** **(2) Continuous filament Aramid (NOMEX) garments dipped with an appropriate local safety authority approved anti-static solution such as Ethoquad, subject to periodic checks to ensure the anti-static solution remains active, are approved by the appropriate local safety authority and should be stenciled stating that the garments have been approved and by which appropriate local safety authority.** **c. Non-metallic ("Delrin©" or equal) zippers should be used on garments in lieu of buttons/snaps in the vicinity of flight hardware where the loss of a button/snap is a concern.** **d. When rescue provisions are applicable, green NOMEX parachute grab straps suitable for rescue purposes should be provided on the legs, shoulders, torso, and back of the garment. Straps should withstand a pull of 200 pounds. Grab straps should be tacked down by breakaway stitching at the center of the strap length to prevent the strap catching on objects while the garment is being worn.**	I		
In NASA and Space Force contractor-operated cleanroom facilities, facility users are expected to use cleanroom coveralls provided by the NASA facility operator, Space Force facility operator or Launch Site Integration Manager (LSIM). Besides the fact that (1) it took a long time to develop the currently approved (carbon-grid) cleanroom coveralls and (2) gaining approval for a new type of coverall could be difficult, logistical considerations are involved. For example, a facility evacuation typically requires the facility user to exit the facility to the outside thereby invalidating the cleanroom garments that are worn. Additionally, it is easier for a facility operator to maintain the necessary inventory for replacement garments rather than a facility user. It is strongly recommended that non- NASA and Space Force contractor-managed cleanroom facilities use cleanroom garments that meet the NASA/KSC specifications.	I		
The appropriate local safety authority has the option to invoke more stringent controls regarding PPE when necessary to enforce Range Safety policy. For example, all personnel entering a particular control area may be required to wear the proper coveralls.	I		
13.3.2. Ordnance Processing Restrictions on the Use of Static-Producing Materials	I		
13.3.2.1. Materials prone to electrostatic charge buildup shall not be used in the vicinity of ordnance and propellants.	Select Status		
13.3.2.2. Compliance with the restriction on static-producing materials is handled on a case-by-case basis; however, the following criteria shall serve as a guideline:	Select Status		
13.3.2.2.1. Static-producing materials shall not come into contact with a system having an installed EED or other ordnance.	Select Status		

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13.3.2.2.2. Static-producing materials shall not come within 10 feet of exposed solid propellant grain; for example, no nozzle plug or cover.	Select Status		
13.3.2.3. Further restrictions and testing requirements are provided in 10.5.	Select Status		
13.3.3. Ordnance System Static Ground Point Test. Static ground points in all ordnance and propellant operating and storage facilities shall be tested according to 14.4.1 of this volume.	Select Status		
13.3.4. Ordnance Systems Grounding Operations	I		
13.3.4.1. Ordnance Systems Grounding Operations General Requirements	I		
13.3.4.1.1. Ordnance associated equipment such as handling fixtures and missile structures shall be connected to a common ground to ensure that an electrostatic charge cannot build up to levels that can cause ignition of the ordnance.	Select Status		
13.3.4.1.2. Platforms and ladders shall be grounded when used in conjunction with vehicles and/or payloads containing ordnance.	Select Status		
13.3.4.1.3. Launch complex service tower platforms are not necessarily good electrical conductors due to corrosion, paint, and questionable bonding of work platforms to ground. Conductive mats that are grounded to the service tower ground shall be used if proper grounds cannot be achieved by other means. Wrist stats shall be required if proper grounding cannot be attained.	Select Status		
13.3.4.1.4. Grounding system, Megger high-voltage checks shall not be performed after initiators are installed or electrically connected unless proper fault protection is provided, as approved by the appropriate local safety authority.	Select Status		
Proper fault protection for grounding system Megger high voltage checks can include fuses placed in the leads or other measures, as approved by the appropriate local safety authority.	I		
13.3.4.2. Ordnance Systems Grounding Pre-Operational Checks	I		
13.3.4.2.1. When leg stats or conductive shoes, either CD or SD, are required, grounding of personnel shall be verified using a conductive shoe tester before the start of an ordnance operation. Leg stat or conductive shoe resistance shall not exceed 1 megohm.	Select Status		
13.3.4.2.2. When wrist stats are required, grounding of personnel shall be checked with an ohmmeter. Wrist stats are required to have a resistance between 0.8 and 1.2 megaohms, in accordance with ANSI/Electrostatic Discharge (ESD) S1.1, The Protection of Electrostatic Discharge Susceptible Items Wrist Straps.	Select Status		
13.3.4.2.3. To ensure grounding of personnel, conductive floors shall be verified in all ordnance and propellant operating facilities before operations.	Select Status		

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13.3.4.2.4. Conductive floors and terminals shall be verified to be electrically bonded to a grounding system common to the ordnance device before operations.	Select Status		
13.3.4.2.5. Static ground points shall be tested in accordance with AFI 32-1065, Grounding Systems.	Select Status		
13.3.4.3. Ordnance Systems Grounding Operating Requirements	I		
13.3.4.3.1. Touching a grounded surface is required before handling an EED or other static-sensitive ordnance device.	Select Status		
13.3.4.3.2. When hoisting ordnance systems with a crane, a trailing ground connection to the facility ground shall be maintained during the hoist.	Select Status		
13.3.4.3.3. Metal shipping containers shall be grounded before opening the containers.	Select Status		
13.3.4.3.4. Before removing an ordnance item from a shipping container, the specific ordnance item shall be grounded.	Select Status		
13.3.4.3.5. When hoisting ordnance with a crane, the ordnance and/or container and the hook shall be commonly grounded before connecting the hook to the ordnance and/or container.	Select Status		
13.4. Ordnance Operations	I		
13.4.1. Ordnance Operating Standards and Procedures Guidance	I		
13.4.1.1. Ordnance operations performed on Space Force property shall be conducted in accordance with DESR 6055.09_AFMAN 91-201, Explosive Safety Standard. Ordnance operations on NASA property, shall be conducted in accordance with the following general guidance from NASA STD 8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.	Select Status		
13.4.1.2. All initiators are considered hazardous unless range safety concurs with a downgraded designation.	Select Status		
13.4.2 Ordnance Facility Inspection	Select Status		
13.4.2.1. All new or modified explosives and propellant facilities shall be inspected and approved by the PSWG and Range Safety before first use.	Select Status		
13.4.2.2 Range users shall support an annual explosive safety inspection by Range Safety to determine compliance with explosives safety criteria as defined in this publication, other DoD, and USAF standards (for example, DESR 6055.09/AFMAN 91-201, Explosives Safety Standard, and the provisions of the Explosives Safety Plan.	Select Status		
13.4.2.3.The annual inspection shall include, but not be limited to, the following explosives storage and operating areas:	Select Status		
13.4.2.3.1. Launch complexes.	Select Status		
13.4.2.3.2. Assembly area processing facilities.	Select Status		

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13.4.2.3.3. Support facilities.	Select Status		
13.4.2.3.4. Solid and liquid propellant storage areas.	Select Status		
13.4.2.4. The results of the annual explosives safety inspection shall be reported under the provisions of ESP 1.	Select Status		
13.4.2.5. Ordnance facilities shall be inspected monthly by the facility manager.	Select Status		
13.4.3. Ordnance Operations General Requirements	I		
13.4.3.1. All hazardous ordnance operations on the ranges shall be monitored and approved by Pad Safety. Hazard division 1.4S ordnance and ordnance systems are not required to meet the design requirements of SSCMAN 91-710 Volume 3, Chapter 13; however, all ordnance and ordnance systems shall comply with the operations requirements of this volume. Examples of Pad Safety coverage during ordnance operations are as follows: **1. The receipt of ordnance at the assembly and/or processing area.** **2. Resistance and continuity checks.** **3. "No voltage" (stray voltage) checks.** **4. Hazardous ordnance installation and electrical connection.** **5. Solid propellant work involving open grain.** **6. Handling of liquid and solid propellant motors, segments, stages, or payloads.** **7. Cycling and checkout of safe and arm (S&A) or other safety devices.** **8. Destruct system checks.** **9. Any render-safe operations.** **10. Ordnance removal.** **11. Launch operations.**	Select Status		
13.4.3.2. Testing of any ordnance circuit or device that could result in personnel injury or death (if the ordnance should fire) shall be conducted with no personnel exposed (remotely, in a test cell, or behind a barricade or shield). An appropriate local safety authority (Pad Safety on Air Force or Space Force property) shall be present during on-site ordnance activities.	Select Status		
13.4.3.3. An appropriate local safety representative (Pad Safety on Air Force or Space Force property) shall be present to monitor all ordnance operations designated by the appropriate local safety authority and shall spot check all other ordnance operations.	Select Status		
13.4.3.4. Ordnance electrical continuity and resistance checkout shall not be conducted at a launch complex or vehicle or payload assembly area without the written approval of the appropriate local safety authority.	Select Status		

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13.4.3.5. All test equipment used on the range or processing facility to check out ordnance shall be approved by the appropriate local safety authority (on Air Force or Space Force property, Range Safety) before use. Maximum available applied current shall not exceed 10 percent of the no-fire current of any EED in the circuit, or 50 mA, whichever is less. On Space Force property, a list of currently approved instruments shall be maintained by the Range Safety offices.	**Select Status**		
13.4.3.6. No current, voltage, power, energy, or other type of energy source shall be applied to any ordnance device outside of an approved test facility or with personnel in the immediate vicinity of the ordnance device except under the following conditions:	**Select Status**		
13.4.3.6.1. The operation is covered by an approved procedure.	**Select Status**		
13.4.3.6.2. Approved equipment is used.	**Select Status**		
13.4.3.6.3. The system or subsystem is approved.	**Select Status**		
13.4.3.7. Based upon the RF and EED susceptibility, RF silence is required during periods of ordnance installation, removal, and electrical connection and disconnection aboard a payload and/or vehicle. Where practical, the RF control area shall include the entire facility and/or complex. The periods of RF silence shall be requested by the payload project. The periods of RF silence shall be identified by an approved Standard Operating Procedure (SOP). Radiating payloads are handled on an individual basis.	**Select Status**		
13.4.3.8. The appropriate local safety authority, with the assistance of the payload project, shall provide the local authority in charge of explosive ordnance disposal with familiarization training on the payload ordnance systems upon request. Training will entail (1) launch pad walkdown and (2) payload and launch vehicle familiarization that includes descriptions, locations, and hazards associated with any ordnance. Additionally, payload project shall provide 8 x 10 inch color photographs of all ordnance items. The photographs should be of sufficient detail to identify individual ordnance items as well as to show the ordnance items in installed configurations on the payload and launch vehicle.	**Select Status**		
13.4.3.9. For each electrically initiated ordnance device installed on the payload, the following tools and equipment shall be supplied to the local authority (EOD for Space Force property) in the event of a malfunction that requires render-safe actions or a mishap recovery effort:	**Select Status**		
13.4.3.9.1. One complete set of shielding caps (current design).	**Select Status**		
13.4.3.9.2. One set of safety pins.	**Select Status**		
13.4.3.9.3. Special tools used in installing, removing, and safing the ordnance.	**Select Status**		
13.4.4. Ordnance Operations Pre-Operational Requirements	**I**		
13.4.4.1. Coordination between the Appropriate Local Safety Authority and the Payload Project. Before giving concurrence for any ordnance operations to begin, the appropriate local safety authority and the payload project shall ensure the following:	**Select Status**		

I – Information/Title N/A – Not Applicable C – Compliant T – Tailored NC – Noncompliant

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13.4.4.1.1. All necessary controls are established.	Select Status		
13.4.4.1.2. Test equipment and the system conform to a configuration approved by the appropriate local safety authority.	Select Status		
13.4.4.1.3. For RF susceptible ordnance distance separation requirements, refer to DESR 6055.09_AFMAN 91-201, Explosive Safety Standard and NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.	Select Status		
13.4.4.1.4. All ordnance circuit control switches and firing line interrupt switches are in the off (open) position before electrical connection of ordnance and thereafter when pad access is required.	Select Status		
13.4.4.1.5. Personnel and explosives limits are enforced.	Select Status		
13.4.4.1.6. Proper safety clearance zone has been established and cleared before starting the hazardous operation.	Select Status		
13.4.4.1.7. Proper signs are posted, warning lights are operating, barricades are established, and Security/HOS is posted.	Select Status		
13.4.4.1.8. Proper aural warnings and announcements have been made.	Select Status		
13.4.4.1.9. All serial numbers, calibration dates, proof test dates, and other equipment requirements have been verified before operations.	Select Status		
13.4.4.2. Pre-Installation Checkout of Ordnance Items	I		
13.4.4.2.1. The pre-installation checkout of all ordnance items shall be performed only at the appropriate local safety authority approved test facilities.	Select Status		
13.4.4.2.2. Requests to use alternate facilities shall be submitted in writing to the appropriate local safety authority.	Select Status		
13.4.4.3. Ordnance No Voltage Checks	I		
13.4.4.3.1. Before any ordnance electrical connection, no voltage (stray voltage) checks shall be performed on all launch vehicle and payload ordnance electrical connectors.	Select Status		
13.4.4.3.2. These checks shall be made first with power on, then with power off, and include all pin-to-pin and pin-to-case combinations.	Select Status		
13.4.4.3.3. The power on configuration requires the launch vehicle to be powered up in launch configuration. This configuration also requires the payload and upper stage to be powered (along with the launch vehicle) unless the payload does not have any electrical interfaces with the upper stage.	Select Status		
13.4.4.3.4. The power on check shall be performed anytime in the launch.	Select Status		
13.4.4.3.5. The power off configuration requires the launch vehicle and payload to be powered down.	Select Status		
13.4.4.3.6. Power off checks shall be made immediately before ordnance electrical connection.	Select Status		

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13.4.4.3.7. If a number of connections must be made in the same general area of the launch vehicle and payload, power off checks shall be made on all of the connectors before ordnance electrical connection. These connections shall be made before any electrical configuration or system changes such as bringing power back up occur.	Select Status		
13.4.4.3.8. Shielding caps shall not be removed from EEDs until electrical connection to the ordnance is to be made.	Select Status		
13.4.4.3.9. The resulting measured signal (current, voltage, power, energy) from a no voltage check shall not be capable of producing a current greater than 20 dB below the no-fire current of the EED. The no voltage test procedure shall specify the maximum acceptable reading.	Select Status		
13.4.4.3.10. Meters that are used for no voltage checks shall have a valid calibration seal.	Select Status		
13.4.4.3.11. The integrity of the meter and test leads shall be verified before use. Fixed- or facility-test instrumentation that is used in place of portable GSE shall have a procedure that verifies the integrity of the system. A copy of the completed procedure shall be provided to the appropriate local safety authority.	Select Status		
13.4.4.3.12. The use of computerized no-voltage meters is acceptable if proper current-limiting can be demonstrated.	Select Status		
13.4.5. Ordnance Operating Requirements	I		
13.4.5.1. Ordnance operations shall not be conducted when the relative humidity is less than 35 percent. Payload project shall ensure relative humidity in the operational area is determined and recorded prior to the start and every 4 hours during operations involving open grain, open flammable/combustible fluid systems, and Category A EEDs (when the Faraday cap is removed or firing circuits to EEDs are exposed).	Select Status		
13.4.5.1.1. At or below 50 percent relative humidity the following shall take place: (1) Bonding, grounding, nonconductive materials, and personnel grounding devices shall be verified at less than 350 volts potential. (2) Electrostatic scanning, not to exceed 1 hour intervals, shall be performed during the operation and at any time additional personnel, equipment, or hardware are introduced into the immediate area, the relative humidity goes lower, or the handling of nonconductive materials is required.	Select Status		
Static Charge Risk Assessment. The static charge risk assessment should address the extent of low humidity conditions, any plastic or other materials being used such as contamination covers, the propellant/ordnance that is part of the planned task, and the potential of the activity to build up static electricity and create a hazardous electrostatic discharge situation. The risk assessment should also include a discussion of the hazard controls used, such as equipment grounding, personnel grounding, static meter scans, and static dissipation methods. It should be noted that "approved" plastic materials are considered "anti-static" based on testing at 30 percent humidity; therefore, the use of such materials where the humidity is less than 30 percent is cause for concern.	I		
13.4.5.2. Ordnance operations shall be conducted in facilities and/or locations specifically approved by the DDESB (Department of Defense Explosive Safety Board) as applicable, and the appropriate local safety authority. Such approvals shall be accomplished by explosives site plans or facility licenses.	Select Status		

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13.4.5.3. At the ER, ordnance items shall not be handled, installed, or electrically connected when the passage of an electrical storm is imminent (within 5 nautical miles). Operations Safety Plans shall identify the procedures to be followed for different configurations. At the WR, the guidance provided in 5.6.3 shall be followed.	Select Status		
13.4.5.4. Ordnance items, particularly Category A initiators, shall be installed and electrically connected as late in processing flow as practical.	Select Status		
13.4.5.5. A rotation test shall be performed on all launch vehicle and/or payload safe and arm devices (S&As) after installation and erection on the launch pad but before final connection to the ordnance train. This test shall be performed using the launch day system configuration for cycling the S&A.	Select Status		
Launch day system configuration for performing a rotation test on S&As includes items such as monitor circuitry, power sources, and circuits for cycling the S&A.	I		
13.4.5.6. The ordnance train shall be disconnected from the S&A output during all checkout operations except during the following circumstances:	Select Status		
13.4.5.6.1. Single complete rotation test (safe to arm to safe).	Select Status		
13.4.5.6.2. Final rotation to arm on the last day of the count.	Select Status		
13.4.5.7. When the S&A is rotated on the pad, all personnel shall be cleared to an area designated in the OSP.	Select Status		
13.4.5.8. EMI testing shall not be conducted with initiators installed on the vehicle or payload without the appropriate local safety authority's approval.	Select Status		
13.4.5.9. Launch day system configuration for performing a power-on-self-test (POST) on electronic safe-and-arm-devices (ESADs) includes items such as monitor circuitry, power sources, and circuits for cycling the ESAD.	Select Status		
13.4.5.10. The ordnance train shall be disconnected from the ESAD output during all checkout operations, except during final arm on the last day of the count.	Select Status		
13.4.5.11. When the ESAD is armed on the pad, all personnel shall be cleared to an area designated in the OSP.	Select Status		
13.4.6. Laser Initiated Ordnance Operations Personnel Access Criteria	I		
13.4.6.1. For laser initiated ordnance (LIO) systems, the following personnel access criteria are required:	Select Status		
13.4.6.1.1. For unlimited personnel exposure during LIO tests - the system shall contain three independent verifiable circuit inhibits (dual-failure tolerance).	Select Status		
13.4.6.1.2. For essential personnel exposure during LIO tests - the system shall contain two independent circuit inhibits (single-failure tolerance).	Select Status		

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13.4.6.1.3. For no personnel exposure during LIO tests - the system shall contain one circuit inhibit.	Select Status		
13.4.6.2. One inhibit shall be a disconnection of the ordnance train at the LIO or the destruct charge/solid rocket motor igniter (other ordnance end item).	Select Status		
13.5. Explosive Ordnance Disposal	I		
13.5.1. Rendered Safe Ordnance. All damaged ordnance shall be rendered safe by the local EOD (Explosive Ordnance Disposal) Team unless otherwise approved by the appropriate local safety authority.	Select Status		
13.5.2. Obtaining AF EOD Services. AF EOD services may be obtained by calling Cape Support (321-853-5211) or PAFB Command Post (321-494-7001) on the ER or Range Scheduling (805-606-8825) on the WR.	Select Status		
13.5.3. Appropriate Local Safety Authority Approval for Shipment of Damaged or Rendered Safe Ordnance	I		
13.5.3.1. Shipments of damaged or rendered safe ordnance from the processing facility, ranges or the downrange stations shall be approved in writing by the appropriate local safety authority.	Select Status		
13.5.3.2. This approval and/or certification shall accompany the shipment.	Select Status		
13.5.3.3. A DOT exception shall normally be obtained by the payload project before local explosive ordnance disposal team will release damaged ordnance.	Select Status		
13.6. Ordnance Facilities Operations	I		
13.6.1. Ordnance items shall not be delivered to, placed in, or processed through facilities or locations on the ranges, or downrange stations unless the facility or area has been approved for such operations by the appropriate local safety authority.	Select Status		
13.6.2. Ordnance deliveries from storage to the payload project shall be coordinated with the appropriate local safety authority.	Select Status		
13.6.3. All facilities in which ordnance operations are conducted or stored shall be properly equipped, display the correct explosive safety markings, and otherwise meet the minimum explosives safety standards cited in NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics, and for Space Force facilities, DESR 6055.09_AFMAN 91-201, Explosive Safety Standards , sub tier documents, and this publication.	Select Status		
13.6.4. All operations and activities within an explosives sited facility shall be related and require the appropriate local safety authority approval.	Select Status		

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CHAPTER 14 ELECTRICAL SYSTEMS OPERATIONS	I		
14.1. Electrical Systems Operating Standards and Definitions	I		
14.1.1. Electrical Systems Operating Standards	I		
14.1.1.1. ANSI C2, National Electric Safety Code, shall be followed in the conduct of electrical systems operations and maintenance.	Select Status		
14.1.1.2. Workplace electrical safety shall be in accordance with NFPA 70E, Electrical Safety Requirements for Employee Workplaces; and AFI 32-1064, Electrical Safe Practices.	Select Status		
14.1.1.3. Maintenance of AF owned electric power systems shall be in accordance with AFI 32-1062, Electrical Systems, Power Plants and Generators. Non AF-owned electric power systems shall be maintained per relevant provisions found in 40 CFR, 29 CFR, National Electrical Code (NEC), NFPA, etc., and manufacturer's written instructions or procedures.	Select Status		
14.1.1.4. Maintenance of grounding systems for AF facilities or facilities regulated by the DDESB shall be in accordance with AFI 32-1065, Grounding Systems. Maintenance of grounding systems for non-AF facilities shall be in accordance with relevant provisions found in 7 CFR, 14 CFR, 29 CFR, NEC, NFPA, etc., and manufacturer's written instructions or procedures.	Select Status		
14.1.2. Electrical Equipment Operations in Hazardous (Classified) Locations	I		
14.1.2.1. Definition of Hazardous (Classified) Locations for Electrical Equipment Operations. Hazardous (Classified) locations are defined in NEC Article 500, Hazardous (Classified) Locations.	Select Status		
14.1.2.2. Explosives and Propellants Not Covered in NEC Article 500. For government installations, the following paragraphs define the minimum requirements to be applied in the definitions of locations in which explosives, pyrotechnics, or propellants are present or are expected to be present. These requirements shall be followed unless less stringent classifications are justified and approved as part of the design data submittal process. The responsible facility safety organization and the local Fire Authority Having Jurisdiction (AHJ) or Fire Marshal shall approve all potential critical facility hazardous location designations.	Select Status		
14.1.2.2.1. Class I, Division 1. Complete definitions of classified locations are found in NFPA 70. These include the following locations:	Select Status		
14.1.2.2.1.1. Within 25 feet of any vent opening unless the discharge is normally incinerated or scrubbed to nonflammable conditions [less than 25 percent of Lower Explosive Limit (LEL)]. This distance may be increased if the vent flow rate creates a flammability concern at a distance greater than 25 feet.	Select Status		
14.1.2.2.1.2. Below grade locations in a Class I, Division 2 area.	Select Status		
14.1.2.2.1.3. Locations in which flammable liquids, vapors, or gases may be present in the air during normal operations.	Select Status		

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14.1.2.2.1.4. Locations in which there is a credible risk that ignitable concentrations of vapors or gases may be present in the air during abnormal operations due to a failure, leakage, or maintenance/repair.	Select Status		
14.1.2.2.2. Class I, Division 2. Complete definitions of classified locations are found in NFPA 70. These include the following locations:	Select Status		
Class I, Division 2 usually includes locations where volatile flammable liquids or flammable gases or vapors are used but, in the judgment of the appropriate safety authority and the local AHJ or Fire Marshal, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of an accident, the adequacy of ventilating equipment, and the total area involved are all factors that merit consideration in determining the classification and extent of each location.	I		
14.1.2.2.2.1. Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Locations used for the storage of flammable liquids or of liquefied or compressed gases in sealed containers would not normally be considered hazardous unless also subject to other hazardous conditions.	Select Status		
14.1.2.2.2.2. As determined by the appropriate safety authority and the AHJ or local Fire Marshal, locations may actively change classification depending on the flammable fluid system activity and configuration. For these types of locations, fixed or permanently installed electrical equipment shall be designed for the worst case hazardous environment.	Select Status		
14.1.2.2.2.3. Portable electrical equipment shall be designed for the worst case hazardous environment in which it will be used. Portable equipment that is not designed for use in a particular hazardous environment is not allowed in that environment.	Select Status		
14.1.2.2.2.4. Class I, Division 2 locations include the following equipment or areas:	Select Status		
14.1.2.2.2.4.1. Storage vessels (including carts and drums). 25 feet horizontally and below to grade and 4 feet vertically above the vessel (25 feet in any direction for hydrogen).	Select Status		
14.1.2.2.2.4.2. Transfer lines. 25 feet horizontally and below to grade and 4 feet above the line (25 feet in any direction for hydrogen).	Select Status		
14.1.2.2.2.4.3. Launch vehicle (liquid fueled vehicle, stage, or payload). 100 foot radius horizontally from and 25 feet vertically above (100 feet for hydrogen) the highest leak or vent source and below the vehicle to grade.	Select Status		
14.1.2.2.2.4.4. Enclosed locations such as rooms, work bays, and launch complex cleanrooms that are used to store and handle flammable and combustible propellants when the concentration of vapors inside the room resulting from a release of all fluids stored and handled equals or exceeds the LEL. The quantity of fluids used in the analysis to determine vapor concentration shall be the maximum amount allowed in the explosives site plan.	Select Status		

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14.1.2.2.2.4.5. Locations adjacent to a Class I, Division 1 location into which ignitable concentrations of gases or vapors might occasionally be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.	Select Status		
14.1.2.2.3. Hazardous Commodity Groups. Hazardous commodities are grouped by similar characteristics.	Select Status		
14.1.2.2.3.1. These fuels shall be considered ignitable regardless of the ambient temperature.	Select Status		
14.1.2.2.3.2. The following fuels shall be categorized as follows:	Select Status		
14.1.2.2.3.2.1. Group B: Liquid or gaseous hydrogen.	Select Status		
14.1.2.2.3.2.2. Group C: Hypergolic fuels such as N_2H_4, MMH, UDMH, A50.	Select Status		
14.1.2.2.3.2.3. Group D: Hydrocarbon fuels (RP and JP).	Select Status		
14.1.2.2.3.2.4. Group D: Oxidizers. Oxidizers shall be considered Group D hazardous substances in addition to the fluids listed in NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.	Select Status		
14.1.2.2.3.2.5. Group D: Exposed Solid Propellants. The atmosphere within 10 feet horizontally and directly overhead of exposed solid propellant shall be classified as a Class I, Division 2, Group D location. Solid rocket motors are considered exposed in the following situations:	Select Status		
14.1.2.2.3.2.5.1. The motor nozzle is not attached, and the aft end of the motor does not have a cover.	Select Status		
14.1.2.2.3.2.5.2. The motor nozzle is attached but does not have a nozzle plug.	Select Status		
14.1.2.2.3.2.5.3. The unassembled motor segments do not have front and rear covers.	Select Status		
14.1.2.2.3.2.5.4. The igniter is removed from the motor and cover is not provided.	Select Status		
14.1.2.3. Personnel wearing conductive grounding devices shall not operate electrically powered devices which could result in a shock hazard.	Select Status		
14.1.3. Photography	I		
14.1.3.1. Photography General Requirements	I		
14.1.3.1.1. Manual (with a photographer) photography shall not be allowed in a hazardous (Class I, Division 1) environment.	Select Status		
14.1.3.1.2. Remotely operated, hazard-proofed cameras and UL listed lighting sources shall be used for Class I, Division 1 environments as well as for Class I, Division 2 environments that cannot be verified as non-hazardous.	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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14.1.3.2. Class I, Division 2 Photography Requirements. Requirements for the use of cameras and camera flash attachments in areas containing solid and liquid propellants that would normally be classified as Class I, Division 2 are listed below:	Select Status		
14.1.3.2.1. Before and during the use of photography equipment within 100 feet of a flight vehicle propellant system or within 25 feet of propellant storage vessels, the operating environment of the photography equipment shall be verified to be free of hazardous vapors.	Select Status		
14.1.3.2.2. Before bringing photography equipment into an area, all ordnance installation and/or connection operations and liquid propellant system operations that affect propellant systems within 100 feet of the photography equipment shall cease.	Select Status		
14.1.3.2.3. The user of the photography equipment shall certify to the appropriate safety authority in writing that the camera and/or flash attachments have no sparking/arcing capability. Information, including vendor specifications, shall be made available to the appropriate safety authority upon request. The portable battery operated electrical equipment shall have a UL certification or be purged in accordance with NFPA requirements, meet explosion proof requirements, or demonstrate by analysis to be intrinsically safe. The details of the method of compliance shall be included in a safety assessment report.	Select Status		
14.1.3.2.4. Camera batteries shall be securely installed in the camera or in a protective case. Battery replacement shall occur outside the Class I, Division 2 area. No battery charging shall take place in a hazardous area.	Select Status		
14.1.3.2.5. All equipment that is brought into the hazardous area and poses a drop hazard shall remain in the tethered possession of the photographer or his/her assistant(s).	Select Status		
14.1.3.2.6. The camera shall be tethered to the photographer.	Select Status		
14.1.3.2.7. Photography using heat-producing, expendable flash bulbs such as flash cubes and sun guns shall not be used with photography equipment and not permitted within 100 feet of hazardous liquid propellant systems or solid propellant grain.	Select Status		
14.1.3.2.8. Cameras and/or flash attachments shall be enclosed or otherwise contained to prevent parts from falling into or contacting flight hardware.	Select Status		
14.1.3.2.9. The maximum operating temperature of the camera and/or flash attachment and portable battery operated electrical equipment shall not exceed 80 percent of the ignition temperature for any vapor that may occur in the operating environment of the photography equipment.	Select Status		
14.1.3.2.10. Cameras and/or flash attachments to be used inside solid rocket motor bores shall be designed and specified for that particular use.	Select Status		
14.1.3.2.11. Photo equipment and portable battery operated electrical equipment shall not be stored in the Class I, Division 2 area.	Select Status		
14.1.3.2.12. Photo equipment and portable battery operated electrical equipment shall be removed from the Class I, Division 2 area before any operation that could cause an increase in the hazardous environment.	Select Status		

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14.2. Electrical Systems Operations Personnel and Special Insulated Equipment	I		
14.2.1. If live electrical maintenance or repair work must be performed, special insulated equipment shall be provided.	Select Status		
14.2.2. Special insulated equipment includes, but is not limited to, the following:	Select Status		
14.2.2.1. Insulated hook sticks for opening and closing disconnect switches.	Select Status		
14.2.2.2. Insulated fuse sticks for removing and installing cartridge-type fuses.	Select Status		
14.2.2.3. Rubber insulating sleeves and gloves.	Select Status		
14.2.2.4. Rubber insulation floor mats.	Select Status		
14.2.2.5. Rubber insulating line conductor hose.	Select Status		
14.2.2.6. Dielectric hard hats.	Select Status		
14.3. Electrical Systems Procedures	I		
14.3.1. Procedures shall be written for all electrical maintenance and repair work.	Select Status		
14.3.2. Procedures shall include, but not be limited to, the following topics:	Select Status		
14.3.2.1. Tagging and locking out control switches.	Select Status		
14.3.2.2. Use of approved non-conductive fuse pullers.	Select Status		
14.3.2.3. Provision and use of PPE.	Select Status		
14.3.2.4. Grounding of equipment and personnel.	Select Status		
14.3.2.5. Use of the buddy system (mandatory when working on energized equipment and circuits).	Select Status		
14.3.2.6. Safety precautions to be followed when working on energized equipment and circuits.	Select Status		
14.3.2.7. Fire protection and equipment.	Select Status		
14.3.2.8. Knowledge of resuscitation procedures.	Select Status		
14.4. Electrical Equipment and Systems Test, Inspection, and Maintenance Requirements	I		
14.4.1. Grounding Systems Tests	I		
14.4.1.1. Grounding Systems General Test Requirements	I		

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14.4.1.1.1. Grounding system tests for lightning protection, electrical fault protection, and static protection systems shall be performed for all facilities and/or locations (including launch complexes and integrated rocket checkout facilities) used to store, handle, or process ordnance or liquid propellants.	**Select Status**		
14.4.1.1.2. Facility operators and payload projects shall inspect their portable and movable equipment connections to ground before starting operations each day the equipment is to be used.	**Select Status**		
14.4.1.2. Ground Systems Test Plan and Test Frequency Criteria	**I**		
14.4.1.2.1. A floor plan layout showing all grounding system test points shall be developed by the facility operator and/or the payload project.	**Select Status**		
14.4.1.2.2. Lightning and grounding systems shall be tested in accordance with the responsible facility's approved procedure and for Air Force facilities with AFI 32-1065.	**Select Status**		
14.4.1.2.3. Based on the floor plan, the following tests shall be conducted:	**Select Status**		
14.4.1.2.3.1. Lightning protection system resistance to ground shall be tested annually to the following criteria:	**Select Status**		
14.4.1.2.3.1.1. Ten ohms or less for the counterpoise system.	**Select Status**		
14.4.1.2.3.1.2. Ten milliohms from the terminal to the counterpoise system.	**Select Status**		
14.4.1.2.3.2. The lightning protection system shall be inspected visually and mechanically twice a year.	**Select Status**		
14.4.1.2.3.3. The facility static/electrical ground system resistance shall be tested annually to a criterion of 10 ohms or less using the methods of measuring resistance to earth described in ANSI/IEEE-142.	**Select Status**		
14.4.1.2.3.4. Portable and movable facility equipment connections to the facility ground system shall be visually inspected before each use and tested every two months to a criterion of one ohm or less.	**Select Status**		
Grounding Test Preparations. During the grounding test, ground support equipment and flight hardware containing hazardous commodities may be disconnected but do not have to be removed from the facility.	**I**		
14.4.1.2.3.5. Conductive floors shall be visually inspected and tested twice a year to the requirements of AFI 32-1065, Paragraph 13.4. Hazardous commodities shall be removed before testing.	**Select Status**		
14.4.1.2.3.6. All resistance measurements shall be taken with a currently calibrated instrument in accordance with a Range Safety approved procedure.	**Select Status**		
14.4.1.2.3.7. Measuring devices such as megohm meters (Megger's) shall be current-limited by the use of fuses or equivalent devices when the facility contains electrically connected EEDs.	**Select Status**		

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14.4.1.2.3.8. Test and inspection results shall be provided to the facility custodian and be available at the facility.	Select Status		
14.4.2. Electrical Equipment Inspection. Before first use or first use after repair, electrical distribution equipment shall be inspected for compliance with NFPA 70 and NFPA 70E.	Select Status		
14.4.3. Electrical Equipment Maintenance and Testing	I		
14.4.3.1. Electrical equipment shall be maintained in accordance with NFPA 70E.	Select Status		
14.4.3.2. Conductors with worn, abraded, or defective insulating material shall be repaired or replaced before the circuit being energized.	Select Status		
14.4.3.3. In addition to maintenance requirements, electric motors shall be properly maintained, and excess dust and oil shall be removed from motors by vacuum cleaning or wiping.	Select Status		
14.4.3.4. Electrical system interior inspection and testing of wiring, power circuit breakers, and protective relaying shall be accomplished in accordance with the NFPA 70 NEC .	Select Status		
14.5. Electrical Systems Operating Requirements	I		
14.5.1. Electrical Systems General Operating Requirements. Personnel working with electrical equipment shall comply with NFPA 70E; NPR 8715.1, NASA Safety and Health Program Requirements; and AFI 32-1064. Particular attention shall be given to the following:	Select Status		
Excessive humidity, wet areas, lack of protective matting, or equipment with exposed contacts to ground may require low or lesser voltage to be designated as high voltage. If these conditions exist, they increase the hazards of the operation.	I		
14.5.1.1. Personnel working with high voltage equipment shall wear appropriate non-conductive PPE.	Select Status		
14.5.1.2. Supervisors shall be responsible for ensuring that safe working conditions are provided; the work is done in a safe manner; and frequent inspections of equipment, materials, and the work site are conducted.	Select Status		
14.5.1.3. Whenever maintenance or repair work is performed on potentially hazardous energized electrical equipment or circuits, a minimum of two people shall be present (buddy system).	Select Status		
14.5.1.4. Rescue and first aid equipment shall be readily available in areas where electrical maintenance and repair work is being performed.	Select Status		
14.5.1.5. Personnel exposed to energized electrical circuits shall not wear loose clothing, rings, watches, or other metallic objects that can act as conductors of electricity.	Select Status		

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14.5.1.6. Only a nationally recognized testing laboratory such as UL or FM, or those accredited by OSHA under the Nationally Recognized Testing Laboratory (NRTL) accreditation program, 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory, weather proof or water-tight test and maintenance equipment shall be used in areas subject to excessive moisture.	**Select Status**		
14.5.1.7. Only listed explosion and/or hazard-proofed test and maintenance equipment shall be used in potentially hazardous atmospheres , unless otherwise approved on a case-by-case basis by the PSWG and Range Safety and documented in a safety assessment report.	**Select Status**		
14.5.1.8. Before working on capacitor circuitry, external power and short terminals shall be disconnected and discharged to ground.	**Select Status**		
14.5.1.9. If temporary power lines are required to extend across outside work areas, they shall be protected by a non-conductive cover or elevated so as not to interfere with personnel, vehicles, or equipment traffic.	**Select Status**		
14.5.1.10. Electrical equipment cords shall have an equipment grounding conductor and shall be grounded when in use. Unless double insulated, the equipment exterior shall be securely bonded and grounded.	**Select Status**		
14.5.1.11. Dead-end wires shall be completely insulated.	**Select Status**		
14.5.1.12. Energized equipment will be manned or connected to the manned facility emergency power shut-off system. The electrical equipment will be powered down during non-working hours.	**Select Status**		
14.5.1.13. All electrical equipment located outside a hazardous processing area will be inhibited from supplying power to electrical equipment located within the hazardous processing area during non-working hours.	**Select Status**		
14.5.1.14. Electrical equipment that must remain energized for hazardous operations (i.e., maintaining spacecraft thruster's solenoid valves in an opened or closed state) shall be equipped with an uninterrupted power source such as a battery backup.	**Select Status**		
14.5.2. Electrical Systems Pre-Operational Requirements	**I**		
14.5.2.1. With the exception of test and checkout, all electrical equipment and circuits shall be de-energized before any work is started on these circuits or equipment through a scheduled power outage.	**Select Status**		
14.5.2.2. Power outages in facilities shall be coordinated with the affected parties.	**Select Status**		
14.5.2.3. When work is being done on circuits, the line switch shall be locked out and tagged in accordance with NFPA 70E, Part II.	**Select Status**		
14.5.2.4. Electrical conductors shall be routed to eliminate tripping hazards or contact with energized lines.	**Select Status**		
14.5.3. Electrical Systems Operating Requirements	**I**		

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14.5.3.1. During repair or maintenance, if panel covers are removed and panels left open to obtain power where none is available, a DANGER HIGH VOLTAGE sign shall be placed next to the open panel and a temporary cover manufactured and installed. When cable connections are made that require the removal of the panel cover, a suitable temporary cover with openings to accommodate the temporary cables shall be used.	Select Status		
14.5.3.2. Insulated fuse pullers shall be used for removal of fuses. Only fuses of proper rating shall be used in circuits. No other material shall be used in place of a fuse.	Select Status		
14.5.3.3. Personnel who are exposed to energized circuits for electrical activities such as troubleshooting, maintaining, or repairing electrical equipment energized with 50 volts or more shall stand on non-conductive matting.	Select Status		
14.5.3.4. Grounding or shorting sticks (or cables) shall be used on potentially “hot” circuits and shall not be removed until repairs are completed.	Select Status		
14.6. Battery Operations	I		
14.6.1. Battery Operating Standards	I		
14.6.1.1. An approved means of disposal or transportation to an off-site approved disposal site shall be in place before receipt of the batteries on the ranges.	Select Status		
14.6.1.2. The means of disposal shall be in accordance with DOT and EPA requirements and carry DOT and EPA approvals.	Select Status		
14.6.2. Battery Operations Personnel Requirements	I		
14.6.2.1. Battery Operations Training and Certification. A training program shall be generated and approved by the payload project for all personnel handling batteries not listed or not intended for public use.	Select Status		
14.6.2.2. Emergency First Aid and PPE Requirements	I		
14.6.2.2.1. Emergency First Aid	I		
14.6.2.2.1.1. An emergency eye wash and shower shall be provided in locations where batteries are present/installed and serviced. They shall be installed in accordance with DAFMAN 91-203, ANSI/International Safety Equipment Association (ISEA) Z358.1, Emergency Eyewash and Shower Equipment, or 29 CFR 1910.151 as applicable.	Select Status		
14.6.2.2.1.2. An emergency first aid kit, containing a burn neutralizer shall be provided.	Select Status		
14.6.2.2.2. PPE	I		
14.6.2.2.2.1. The following PPE shall be provided when servicing or handling batteries in accordance with the battery safety data sheet (SDS), DAFMAN 91-203, or ANSI/ISEA Z87.1, Occupational and Educational Personal Eye and Face Protection Devices, as applicable:	Select Status		

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14.6.2.2.2.1.1. Front and side face and eye protection.	Select Status		
14.6.2.2.2.1.2. Rubber gloves.	Select Status		
14.6.2.2.2.1.3. Rubber apron.	Select Status		
14.6.2.2.2.1.4. Foot protection.	Select Status		
14.6.2.2.2.2. In addition, electrolyte/chemical spill containment/adsorption material shall be provided in the close vicinity of the battery(s) for use by operating personnel in the event of an electrolyte spill.	Select Status		
14.6.3. Battery Procedures	I		
14.6.3.1. Procedures for battery receipt, transportation, checkout, handling, installation, safing, packing, storage, and disposal shall be developed and submitted to the appropriate safety authority for review and approval.	Select Status		
14.6.3.2. Specific safing operations of batteries shall be in battery handling and checkout procedures.	Select Status		
14.6.3.3. Battery handling and checkout procedures shall include the following topics:	Select Status		
14.6.3.3.1. A list of proper handling equipment.	Select Status		
14.6.3.3.2. Identification of specific personnel qualified to safe batteries if in an unsafe condition.	Select Status		
14.6.3.3.3. Identification of the exact location of the storage site of depleted or unsafe batteries.	Select Status		
14.6.4. Lithium Batteries Special Requirements	I		
Batteries that have a UL listing and are intended for public use are exempt from these requirements.	I		
Lithium batteries are thermal batteries, also called molten salt batteries. Lithium batteries are different from lithium-ion batteries, even though they both contain the element lithium. Lithium batteries are primary cell batteries, that is, batteries where the electrochemical reaction is not reversible.	I		
14.6.4.1. The appropriate safety authority shall approve temporary lithium battery storage and handling facilities. These facilities shall be used only for lithium batteries and shall not be used for other purposes. Lithium batteries shall not be stored permanently on the ranges.	Select Status		
14.6.4.2. The payload project shall provide certification of lithium battery(s) conforming with all safety critical steps and processes agreed to by the appropriate safety authority during the battery development phase.	Select Status		
14.6.4.3. Before delivery of lithium batteries to the ranges, an approved off-site disposal contract shall be in place for the batteries in any condition.	Select Status		

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14.6.5. Lithium Ion Battery/Cell Special Requirements.	I		
14.6.5.1. Storage of the batteries (when not installed in GSE or the spacecraft) shall be in approved battery storage locations.	Select Status		
14.6.5.2. Battery and cells shall be treated as always having a voltage potential; therefore, connection or disconnection of a battery shall be considered an electrical personnel hazard and a 'spark' potential.	Select Status		
14.6.5.3. Range users shall have an operational plan for battery/cell handling that includes emergency contingency operations for physical abuse incident and battery installation/removal.	Select Status		
14.6.5.4. Support equipment (ground or airborne) shall be verified to operate correctly prior to first operational use on the range, including all fault tolerant devices or subsystems, prior to connecting battery. Verification shall include inducing overvoltage/undervoltage/temperature extremes to the monitoring devices as intended when in use prior to connecting of the battery.	Select Status		
14.6.5.5. On-base transportation to the launch site should meet DOT requirements. Evidence of compliance with DOT requirements for transportation shall be provided.	Select Status		
14.6.5.6. External heating sources for battery/cell maintenance shall be dual fault tolerant and provide feedback monitoring capability or be analyzed for failure modes on cell/battery heating.	Select Status		
14.6.5.7. Charging and Discharging.	I		
14.6.5.7.1. GSE/Flight hardware used for charging (shall prevent each cell from exceeding 4.4 volts) and discharging (driving cells to less than 0 volts) shall be dual fault tolerant. Individual cells that have an internal design which provides high rate discharge protection (e.g., positive temperature coefficient devices and internal fuses) may be considered to already have one inhibit. The GSE shall provide at a minimum one inhibit for charging/discharging control.	Select Status		
14.6.5.7.2. Discharging shall not take place below -20° C or above 60° C.	Select Status		
14.6.5.8. Battery/Cell Monitoring.	Select Status		
14.6.5.8.1. Battery/cell monitoring, and recording is required during charging and discharging.	Select Status		
14.6.5.8.2. Voltages shall be recorded at least every minute for charge rates that exceed the battery capacity (e.g., if capacity is 1 amp-hour and charger is supplying greater than 1 amp of current). Record voltages every 10 seconds for charge rates between 1 and 2 times battery capacity. Record voltages every second for charge rates that exceed 2 times battery capacity.	Select Status		
14.6.5.8.3. Charging data shall be reviewed for anomalies and verification of voltage limits.	Select Status		
14.6.5.8.4. Provisions shall be made for charging, monitoring, and recording each cell/cell pack with electronic ground support equipment that prevents high heat, sparking and high charge/discharge current rates.	Select Status		
14.6.6. Battery Maintenance, Storage, and Operations	I		

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14.6.6.1. Rechargeable storage batteries and batteries requiring activation shall be handled only in PSWG and Range Safety approved, and designated battery shops and areas equipped for servicing and recharging.	Select Status		
14.6.6.2. Separate areas shall be provided for servicing of batteries that have incompatible electrolytic solutions, for example, acid and alkaline.	Select Status		

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CHAPTER 15 MOTOR VEHICLE OPERATIONS	I		
15.1. Motor Vehicle Operating Standards	Select Status		
15.1.1. Motor vehicles that do not meet DOT public transportation requirements shall not be permitted to transport hazardous materials on the range unless the vehicle is covered by a formal DOT exemption and is approved by PSWG and Range Safety.	Select Status		
15.1.2. Special-purpose trailers for range use only shall conform to operational requirements in DESR 6055.09/AFMAN 91-201, Explosives Safety Standard.	Select Status		
15.1.3. All vehicle operations shall comply with federal and state laws, and Space Force and range regulations, including, but not limited to, the following criteria:	Select Status		
15.1.3.1. Proper licensing of operators.	Select Status		
15.1.3.2. The use of vehicle restraint devices such as seat belts.	Select Status		
15.1.3.3. Restrictions on wearing headphones or ear speaker type radios while operating a vehicle.	Select Status		
15.1.3.4. The use of spotters when backing with restricted rear vision vehicles.	Select Status		
15.2. Motor Vehicle Operating Requirements	I		
15.2.1. Operator Instructions	Select Status		
15.2.1.1. Maneuvering in the vicinity of hazardous commodities requires the use of a spotter.	Select Status		
15.2.1.2. When backing, chocks shall be used to prevent contact.	Select Status		
15.2.2. Indoor Operations. Gasoline or diesel vehicle operations in buildings shall require the approval of the Industrial Hygiene and/or Bioenvironmental Engineer.	Select Status		
15.2.3. Ordnance and Propellant Area Parking	I		
15.2.3.1. General Parking Requirements	I		
15.2.3.1.1. Vehicle parking in areas sited and used for ordnance or propellants shall be in accordance with the applicable OSP. (See Attachments 3, 4, and 5 of this volume.)	Select Status		
15.2.3.1.2. These OSPs shall be developed using the criteria found in this document and shall also take into consideration the criteria from NPR 8715.1, NASA Safety and Health Program Requirements; DESR 6055.09_AFMAN 91-201, Explosive Safety Standards.	Select Status		
15.2.3.2. General Parking Restrictions	Select Status		

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15.2.3.2.1. Designated parking areas shall be used.	Select Status		
15.2.3.2.2. Privately owned vehicles shall not be parked within the fenced-in area of hazardous processing facilities.	Select Status		
15.2.3.2.3. No vehicle shall be parked within 25 feet of lines containing liquid propellants.	Select Status		
15.2.3.2.4. No vehicle shall be parked within 50 feet of storage tanks containing liquid propellants.	Select Status		
15.2.3.2.5. When required, delivery vehicles are exempt from the preceding requirements during loading and off-loading but they shall be removed immediately afterwards.	Select Status		
15.2.3.2.6. While parked, the parking brake shall be engaged, and wheels shall be chocked.	Select Status		
15.2.3.3. Restricted Parking Areas. All non-essential vehicles are prohibited from parking in the following areas under the following conditions:	Select Status		
15.2.3.3.1. Within the flight hazard area (FHA) once the FHA has been established.	Select Status		
15.2.3.3.2. In the blast danger area (BDA) during wet dress rehearsal (cryogen tanking).	Select Status		
15.2.3.3.3. Within the FHA during core vehicle tanking (other than cryogens that are tanked) after the BDA/FHA is established.	Select Status		
15.2.3.3.4. Within the launch complex fence line during fueled spacecraft/upper stage mating operations.	Select Status		
15.2.4. Internal Combustion Engine Vehicles. Motor vehicles or equipment having internal combustion engines shall be equipped with spark arresters and carburetor flame arresters as applicable:	Select Status		
15.2.4.1. When transporting explosives that have exposed grain, scrap, waste or items visibly contaminated with explosives.	Select Status		
15.2.4.2. When operating within the control area during propellant transfer operations or continuously within propellant off-loading and/or propellant storage areas.	Select Status		
15.2.5. Hazardous Commodities Vehicle Transportation Standards. Vehicles transporting hazardous commodities shall meet DOT and DoD (for example, DESR 6055.09_AFMAN 91-201, Explosive Safety Standards) regulations unless exempted or approved for use by Range Safety or for non-USSF, the appropriate local safety authority.	Select Status		
15.2.6. Hazardous Location Restrictions. Vehicles shall not be operated in locations classified as hazardous by NEC Article 500 without the appropriate local safety authority approval.	Select Status		
15.3. Special-Purpose Trailers Used to Transport Critical or Hazardous Loads.	I		

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15.3.1. Periodic Tests. A periodic road/load test at 100% rated load shall be performed at least every 4 years on trailers used to transport hazardous hardware, with single failure point (SFP) weld inspection limited to surface NDE. Unless otherwise agreed to by Range Safety, a road/load test shall also be performed after a trailer has experienced structural modification or repair.	**Select Status**		
15.3.2. Data Requirements. Recurring data requirements shall be submitted in accordance with SSCMAN 91-710 Volume 3, Attachment 1. Maintenance records shall be maintained by the operator and made available upon request.	**Select Status**		

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CHAPTER 16 CONVOY OPERATIONS	I		
16.1. General	I		
16.1.1. A convoy is required for all transportation considered hazardous operations unless exempted by the appropriate local safety authority. Convoy operations shall be conducted in accordance with federal, state, and any SLD-specific regulations or policy memorandums.	Select Status		
16.1.2. All transportation of over-sized loads (larger than 12 feet in width, 13.5 feet in height, or 55 feet in length); transport of hypergolic fuels in non-DOT approved containers; transport operations that go against flow of traffic or that take up more than one lane is considered a hazardous operation.	Select Status		
16.1.3. All convoys shall be conducted in accordance with AFMAN 24-306, Operation of AF Government Motor Vehicles.	Select Status		
16.1.4. All convoy and convoy operations shall be in accordance with DOT requirements.	Select Status		
16.2. Convoy Operations Procedures	Select Status		
A procedure for hazardous convoy operations shall be submitted to the appropriate local safety authority for review and approval. This procedure should include a description of a pre-route survey.	Select Status		
16.3. Convoy Operations Requirements	Select Status		
The payload project and/or the agencies responsible for the transportation of a load shall ensure the following items are performed:	Select Status		
16.3.1. The hazardous load or commodity to be transported shall be identified.	Select Status		
16.3.2. The convoy shall be scheduled through the appropriate local safety authority [CCSFS Cape Support (321-853-5211) at the ER and through Range Scheduling (805-606-8825) at the WR].	Select Status		
16.3.3. A convoy commander shall be designated.	Select Status		
16.3.4. If flight hardware or hazardous commodities are involved, a Security/HOS escort shall be arranged.	Select Status		
16.3.5. The appropriate local safety authority approval shall be obtained before the start of the convoy if hazardous commodities or flight hardware are involved.	Select Status		
16.3.6. When transporting hazardous commodities, the transfer route shall be chosen to minimize exposure to populated areas and critical facilities. Transfer should occur during off-peak traffic and population hours.	Select Status		
16.3.7. The selected route shall be identified, and the following items noted/documented:	Select Status		
16.3.7.1. Horizontal and vertical clearances (i.e., bridges, construction, power lines, trees, signs, walls, railings, barriers, etc.).	Select Status		

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16.3.7.2. The hazardous commodity transported.	Select Status		
16.3.7.3. Population along the route.	Select Status		
16.3.7.4. Traffic that may be encountered.	Select Status		
16.3.7.5. Condition of surface being traveled upon.	Select Status		
16.3.7.6. Distance of route.	Select Status		
16.3.8. Radio contact shall be maintained with the convoy commander for all elements of the convoy.	Select Status		
16.3.9. At a minimum, the following items of equipment are required:	Select Status		
16.3.9.1. Flashlights if transport occurs during periods of darkness.	Select Status		
16.3.9.2. Emergency apparatus such as fire extinguishing equipment, reflectors, and flares.	Select Status		
16.3.10. Proper environmental health required by the commodity transported shall be ensured.	Select Status		
16.3.11. Areas shall be cordoned off as required by the appropriate local safety authority.	Select Status		
16.3.12. Emergency actions shall be taken to secure the item being transported in the event of a mishap.	Select Status		
16.3.13. A pre-operational check of the loaded vehicle and trailer shall be conducted.	Select Status		
The prescribed tire air pressure should be verified.	I		
16.3.14. A convoy commander pre-departure briefing guide and requirements shall be prepared and conducted. The briefing guide includes such information as hazards, communication checks, and stop points.	Select Status		
16.3.15. Convoys carrying liquid fuel, solid motors, or installed ordnance shall not commence when a local electrical storm lightning watch or warning is in effect.	Select Status		

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CHAPTER 17 LAUNCH OPERATIONS	I		
To view Launch Operations criteria, please see USSF SSCMAN 91-710.	I		
CHAPTER 18 SOLID ROCKET MOTORS AND ROCKET, ROCKET MOTOR SEGMENTS, AND ROCKET MOTOR OPERATIONS	I		
18.1. Solid Rocket Motors and Rocket Motor Segments Operations General Requirements	Select Status		
In addition to the requirements of Chapter 3 and Chapter 13 of this volume, the payload project shall comply with the following requirements for operations involving solid rocket motors and rocket motor segments.	Select Status		
18.2. Solid Rocket Motor and Rocket Motor Segment Transportation	I		
18.2.1. Operational hazard analyses should be performed for all aspects of solid rocket segment and/or motor handling and buildup.	Select Status		
18.2.2. Solid rocket motor segments/motors transported on trailers or railroad cars shall be properly restrained to the trailer or railroad car support structures to minimize possibility of loss of load in an accident scenario.	Select Status		
18.2.3. For solid rocket motor/segment transporting trailers or railroad cars that use internal combustion engine powered generators for the environmental control units, gasoline or liquid propane gas powered engines shall not be used. If internal combustion engine generator equipped trailers or rail- road cars loaded with solid rocket motors/segments are brought inside processing facilities, care shall be taken to minimize the quantity of fuel in the generator tanks. The fuel tanks shall be reinforced and equipped with a protective shield to minimize possibility of tank rupture and fuel ignition during transport. An insulation barrier shall be provided between the environmental control unit and the solid rocket motor or motor segment to protect the motor from heat or possible fuel fire.	Select Status		
Diesel powered generators are preferred due to much lower flammability of the diesel fuel.	I		
18.2.4. If forced air heaters are used for environmental control on covered railroad cars or trailers transporting solid rocket motors/segments, liquid propane gas heaters or gasoline heaters shall not be used. The effects of heater failures on the trailer/railroad car shall be analyzed and reported in an analysis as required by Volume 3, 18.3.	Select Status		
18.2.5. Canvas covers for solid rocket motor/segment transporting trailers or railroad cars shall not be used. If their use cannot be avoided, the rubberized canvas material shall be subjected to triboelectric testing and meet the test requirements for plastic materials used in solid rocket motor/segment processing. An operational hazard analysis shall be performed to demonstrate that under the worst case conditions (for example, broken or loose canvas tie downs and canvas flapping and rubbing on the segment or motor case), not enough static can be accumulated to cause a catastrophic event, such as propellant ignition).	Select Status		

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18.2.6. Solid rocket motor/segment transport trailers or railroad cars containing solid rocket motors/ segments shall be secured to prevent inadvertent motion when parked; in other words, brakes set and wheels chocked.	**Select Status**		
18.2.7. Locomotives and tractors that transport solid rocket motor/segment cars and trailers shall be removed from processing facilities as soon as possible.	**Select Status**		
18.2.8. If air pallets are used for transport of solid rocket motors/segments inside processing facilities, the structure of the air pallet shall be rigid enough to minimize elastic deformation of the pallet under load and, thus, minimize stresses transferred to the solid rocket motor/segment.	**Select Status**		
Due to the strict requirements for floor surfaces required for such air pallet operation and the fact that such surfaces are easily damaged, extensive use of air pallets for solid rocket motor/segment transport is not recommended.	**I**		
18.3. Solid Rocket Motor and Rocket Motor Segment Inspections	**I**		
18.3.1. Periodic NDE should be performed for all aerospace ground equipment used to handle rocket motors and segments, in accordance with NDE plans.	**Select Status**		
18.3.2. If wetting of a solid rocket motor/segment with water is required for ultrasonic inspections, adequate water intrusion barriers shall be provided to prevent the propellant from getting wet.	**Select Status**		
The wetting of propellant surfaces with water could result in precipitation of ammonium perchlorate crystals on the propellant surface and possibly increase propellant sensitivity.	**I**		
18.3.3. Solid rocket motors/segments with graphite epoxy casings, which are very sensitive to external damage, shall be visually inspected for case damage at each major stage of processing and upon arrival at the launch pad.	**Select Status**		
Protective measures, such as blankets, should be used to shield solid rocket motors/segments from damage during transport and storage where practical.	**I**		
18.3.4. For igniter uncrating and inspection operations of separately shipped igniters, corrosion protection coatings shall be removed from the igniter metal flange before special lifting adapters are attached to the flange.	**Select Status**		
Failure to remove the coatings may cause the lifting adapter to stick to the igniter flange, possibly resulting in the igniter being lifted after the adaptor bolts have been removed when attempting to remove the unsecured adaptor. This may result in the igniter being raised and dropped into its crate.	**I**		
18.3.5. Extreme care shall be taken when inspecting and handling igniters.	**Select Status**		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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Igniter propellant may contain a higher percentage of oxidizer and have a higher burn rate than regular motor propellant and may be very energetic.	I		
18.3.6. Fixtures using cradles for the storage and handling of solid rocket motors/segments shall be inspected for cleanliness and the absence of any objects that could damage the sensitive solid rocket motor/segment cases when they are lowered into the cradles.	Select Status		
18.3.7. For open grain inspections, wrist stats shall be used within five feet of the open grain.	Select Status		
18.4. Solid Rocket Motor and Rocket Motor Segment Processing and Handling	I		
18.4.1. Solid Rocket Motor and Rocket Motor Segment Processing and Handling General Requirements	I		
18.4.1.1. Pathfinder operations using size and weight representative of inert solid rocket motors/ segments shall be conducted before live/operational solid rocket motor/segment processing operations are conducted.	Select Status		
18.4.1.2. For solid rocket motor/segment lifting operations, main processing facility overhead doors shall be kept at least partially open, weather permitting, to provide additional exit routes, unless the doors are required to be closed to reduce exposure of additional personnel.	Select Status		
18.4.1.3. If rotating fixtures are used to rotate solid rocket motors/segments (for purposes of cork installation, for example), the rotating fixture cradles shall be equipped with a means to restrain the solid rocket motors/segments during rotation.	Select Status		
A hydraulic powered rotating mechanism is preferred.	I		
18.4.1.4. If internal combustion powered vehicles, such as forklifts or man lifts, are required for support of solid rocket motor/segment handling operations and are operated in close proximity of the solid rocket motors/segments, gasoline and liquid propane gas powered equipment shall not be used. The equipment shall be located no less than 25 feet from the solid rocket motors/segments and at least 100 feet away when being refueled. If a forklift is used as a hoist in close proximity of a solid rocket motor/segment, OSHA approved fork lifting adapters shall be used.	Select Status		
Battery powered equipment is preferred.	I		
18.4.1.5. All tapes and plastic materials used around open grain areas of a solid rocket motor/segment shall be subjected to triboelectric and flammability testing and be listed on NASA-STD-6001, Flammability, Offgassing, and Compatibility Requirements and Test Procedures, and/or KTI-5212, Material Selection List for Plastic Films, Foams, and Adhesive Tapes.	Select Status		
18.4.1.6. For joint cleaning operations where solid rocket motors/segments are placed on elevated adaptors, extreme care shall be taken to ensure that such adaptors are properly attached to the support structures. If solid rocket motors/segments are suspended from a crane during such operations, at least 50 percent of the solid rocket motor/segment weight shall be supported by the crane.	Select Status		

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18.4.1.7. An operations safety plan shall be written for each solid rocket motor/segment processing facility. This plan shall define the required clearance areas for all hazardous operations.	Select Status		
18.4.1.8. Solid rocket motor/segment processing facilities shall be kept clean and uncluttered at all times. Separate facilities for storage of support equipment and receiving and uncrating of flight hardware shall be used, as necessary, to maintain unobstructed access to exit's at all times. Shipping containers shall be removed from the processing facility immediately as soon as possible after unpacking the hardware.	Select Status		
18.4.1.9. Solid rocket motor/segment processing facilities shall not be used for storage of ground support equipment or flight hardware belonging to other programs or not related or not needed for the solid rocket motor/segment handling operations.	Select Status		
18.4.1.10. Solid rocket motor/segment processing and storage facilities containing ordnance shall not be used as emergency garage facilities for motor vehicles; for example, storing these vehicles next to stored solid rocket motors/segments before an earthquake, tropical storm, or a hurricane.	Select Status		
18.4.1.11. An unobstructed access to at least two exits in the processing facility shall be maintained at all times during solid rocket motor/segment handling operations.	Select Status		
18.4.1.12. Breakout gates shall be provided in the processing facility perimeter fence to enable speedy evacuation in case of emergency. The number and location of the gates shall be based on worst case conditions (facility population, facility configuration, and meteorological conditions) and shall be approved by the appropriate local safety authority.	Select Status		
18.4.1.13. Waste collection dumpsters shall not be located inside solid rocket motor/segment processing and storage facilities.	Select Status		
18.4.1.14. Combustible materials, such as lumber and dunnage used in support of rocket segment/ motor handling operations, shall be treated with flame retardant paint. Bulk stacks of combustible materials shall be no closer than 100 feet from the solid rocket motors/segments and removed from the facility as soon as possible.	Select Status		
18.4.1.15. Flammable materials needed for processing of solid rocket motors/segments shall be stored in appropriate local safety authority approved lockers and used in minimum necessary quantities around the solid rocket motors/segments. Waste, such as degreaser or oil soaked rags, shall be placed in closed appropriate local safety authority approved metal containers and the containers shall be emptied at the end of every shift. Due to the possibility of spontaneous fires, contaminated waste material shall be removed from the facility as soon as possible and, in no case, left unattended overnight. Waste collection metal containers shall be placed no closer than 25 feet from the solid rocket motor segments/motors.	Select Status		
18.4.1.16. Complete solid rocket motors that are capable of unguided flight upon ignition (as determined by analysis) that are stored vertically or horizontally shall be restrained or thrust termination devices shall be provided to prevent fly-away.	Select Status		
Vertical storage of built-up rocket motors is undesirable unless they are mated to the core vehicle.	I		

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18.4.1.17. When built-up solid rocket motors must be stored vertically in the stands, provisions shall be made to protect the motor nozzles from external facility fires. The motors shall be restrained in the stands to ensure that they will not topple in case of an earthquake, tornado, high winds, or a hurricane impacting the facility, or some other mishap in the facility.	Select Status		
For example, a separation wall could be built between the processing area and the stand.	I		
18.4.1.18. If desiccant cartridges are used in the stored solid rocket motor/segment covers, provisions shall be made for their periodic replacement.	Select Status		
18.4.1.19. For large vertically stacked solid rocket motor igniter installations, the bore opening on top of the motor shall be guarded to prevent personnel from falling into the motor bore.	Select Status		
18.4.2. Grounding and Open Grain Work	I		
18.4.2.1. All solid rocket motors/segments and built-up motors shall be grounded at all times. When solid rocket motor segments and built-up motors are in storage stands or fixtures, the resistance to ground shall not exceed 10 ohms. When moving the solid rocket motors/segments, make-before-break technique shall be applied. The new ground wire shall be connected to ground and the resistance verified.	Select Status		
18.4.2.2. If a solid rocket motor/segment and/or built-up motor is found ungrounded for any reason (for example, the grounding wire is disconnected), the ground wire shall be immediately reconnected, the ground verified, and a static meter shall be used to measure the voltage on the case surface. The voltage shall be 1,000 V or less before the solid rocket motor/segment can be worked on or moved from its storage stand or fixture. Grounding shall be accomplished in the manner that attaches the grounding wire to the ordnance item first and then to the facility ground (away from the ordnance) last.	Select Status		
18.4.2.3. For open grain work, wrist stats shall be used within five feet of the open grain. Electrically powered equipment used within ten feet of the open grain shall be explosion proof or designed to be intrinsically safe.	Select Status		
18.4.3. Solid Rocket Motor and Rocket Motor Segment Processing and Handling Crane Operations	I		
18.4.3.1. If lifting of a rocket motor/segment with a crane is required, the height of such a lift shall be kept to the absolute minimum required to accomplish the mission.	Select Status		
18.4.3.1.1. The propellant ignition threshold shall be determined for each lift (i.e., the height from which if dropped, the propellant would ignite upon impact with the ground or other surface).	Select Status		
18.4.3.1.2. For each lift where the lift height must exceed the propellant ignition threshold, detailed justification data shall be submitted to the appropriate local safety authority for review and approval.	Select Status		
18.4.3.2. A clear area shall be established around each lift to ensure that the solid rocket motor/segment will not impact any objects in case of crane or rigging failure.	Select Status		

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Sharp object impalement may reduce the ignition threshold of propellant by a factor of two.	**I**		
18.4.3.3. Lifting of solid rocket motors/segments over other motors or flight hardware shall be avoided except where necessary for stacking or storing operations.	**Select Status**		
18.4.3.4. The number of spotters and personnel required to support the solid rocket motor/segment lift operations shall be kept to the absolute minimum required. Remote cameras or similar devices shall be used in locations where NFPA 101, Life Safety Code, requirements for evacuation of personnel from high hazard facilities cannot be met.	**Select Status**		
18.4.3.5. Proposed breakover operations of solid rocket motors/segments shall be submitted to the appropriate local safety authority with substantiation that there is no other practical means to accomplish the task. The data shall illustrate how risks are minimized and managed. A detailed operational hazard analysis is required.	**Select Status**		
The cranes shall be designed for breakover operations in accordance with section 3.6 and the heights of the lift kept to the absolute minimum required.	**Select Status**		
18.4.3.6. Crane hoisting operations that involve lifting large stacked solid rocket motors are not recommended due to the extreme hazards involved. A detailed operational hazard analysis is required. Lifting heights shall be kept to the absolute minimum required.	**Select Status**		
Stacking on a transporter or on the launch pad is always a safer alternative.	**I**		
18.4.3.7. If a crane operational fault occurs during a solid rocket motor/segment lifting operation that leaves the load suspended, the crane power shall not be recycled to clear the fault until crane troubleshooting determines the nature of the fault.	**Select Status**		

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ATTACHMENT 1 GROUND OPERATIONS PLAN	I		
A1.1. INTRODUCTION	I		
A1.1.1. Purpose. The Ground Operations Plan (GOP) provides a detailed description of the hazardous and safety critical operations associated with a payload (spacecraft) and its associated ground support equipment. It is the medium from which payload safety approval is obtained from the PSWG in conjunction with Range Safety, along with the Safety Data Packages [Missile Systems Prelaunch Safety Package (MSPSP)] required in NPR 8715.7 and Volume 3 of this document. The GOP may be a stand-alone document or part of the Safety Data Package (MSPSP).	Select Status		
A1.1.2. Content. This attachment contains the content preparation instructions for the data generated by the requirements delineated in Volume 6.	Select Status		
A1.1.3. Applicability. The requirements in this attachment are applicable to the payload projects activities in the payload processing facility and the launch site.	Select Status		
A1.1.4. Submittal Process. The GOP submittal periods are delineated in NPR 8715.7 and 4.1 of Volume 6.	Select Status		
A1.1.5. Final Approval. The GOP shall be approved by the PSWG and Range Safety as delineated for Safety Data Packages in NPR 8715.7 and in 4.1 and 4.1.4 of this volume.	Select Status		
A1.2. PREPARATION INSTRUCTIONS	I		
A1.2.1. Content. This attachment contains the content preparation instructions for the data generated by the requirements delineated in Volume 6. The GOP contains a description of planned operations (including back out) and the associated hazard analysis of those operations. Where applicable, previously approved documentation may be referenced throughout the package. The high level Ground Operations Flow Overview presented at the Payload Safety Introduction Briefing shall provide an overview of the major payload activities and tasks, where these activities and tasks take place, and an operations flow timeline for these activities and conform to Volume 6 and this Attachment. The Draft GOP is due 30 days prior to project's mission CDR for Safety Review II per NPR 8715.7. The Final GOP shall be submitted 90 days prior to the payload shipment to the processing site per NPR 8715.7. The information from a GOP may be part of the respective Safety Data Packages as an inclusion or may be a separate document. The level of detail provided in the GOP data shall be commensurate with the level of data available at the time of submission.	Select Status		
A1.2.2. Format. Payload project format is acceptable provided the information described below is provided.	Select Status		
A1.2.2.1. Table of Contents and Glossary. The GOP shall contain a table of contents and a glossary.	Select Status		
A1.2.2.2. Introduction. The "introduction" section shall address the purpose and scope of the GOP.	Select Status		

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A1.2.2.3. General Description. The "general description" section shall present an overview of the system and the general processing flow as a prologue to the hazardous and safety critical operation descriptions. The following items are included in this section:	Select Status		
A1.2.2.3.1. General flow of system integration and testing.	Select Status		
A1.2.2.3.2. Facilities to be used.	Select Status		
A1.2.2.3.3. Generic timeline with sufficient granularity to identify the major hazardous and/or FTS operations.	Select Status		
A1.2.2.4. Ground Operations. The "ground operations" section shall identify the ground processing flow including all hazardous and safety critical operations. The following items are included in this section:	Select Status		
A1.2.2.4.1. List of all non-hazardous, hazardous, and safety critical procedures by title and numerical designation with an indication as to which have been designated as hazardous or related to FTS operation.	Select Status		
A1.2.2.4.2. Procedure Descriptions. Procedure descriptions shall include separate listing of tasks so that hazardous tasks within each procedure can be identified.	Select Status		
A1.2.2.4.3. Procedure Task Summaries. Task summaries for each procedure shall include the following information:	Select Status		
A1.2.2.4.3.1. Each separate task.	Select Status		
A1.2.2.4.3.2. Responsible agency.	Select Status		
A1.2.2.4.3.3. Objective.	Select Status		
A1.2.2.4.3.4. Initial and final configuration.	Select Status		
A1.2.2.4.3.5. Equipment and support required.	Select Status		
A1.2.2.4.3.6. Description.	Select Status		
A1.2.2.4.3.7. Hazards and precautions.	Select Status		
A1.2.2.4.3.8. List of approved PPE and detection equipment used in ground operations.	Select Status		
A1.2.2.4.4. Flow Chart Task Summary. A flow chart indicating expected time sequence and location of each individual procedure and task shall be included. Each flow chart block used shall be assigned a maximum of one procedure and include the following information:	Select Status		
A1.2.2.4.4.1. Identifier for each procedure.	Select Status		
A1.2.2.4.4.2. Procedure number.	Select Status		

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A1.2.2.4.4.3. Hazardous, non-hazardous, or safety critical designation.	Select Status		
A1.2.2.4.4.4. Task summary number(s).	Select Status		
A1.2.2.4.5. Identification of emergency and abort/back-out actions.	Select Status		
A1.2.2.4.6. A list of personnel training certifications, medical certification examination (e.g., crane, propellant, ordnance) as per NPR 1800.1, NASA, Occupational Health Procedures, and experience requirements for each type of hazardous operation such as ordnance, crane, and propellant operations.	Select Status		
A1.2.2.5. Off-Site Processing. The “off-site processing” section shall include the following information:	Select Status		
A1.2.2.5.1. A detailed description of the off-site build-up and transport configuration of the payload that will be transported to the Range or launch area.	Select Status		
A1.2.2.5.2. A description of the tests performed on hazardous and safety critical systems such as rotation of S&A devices, no voltage checks on ordnance systems, pressure checks of pressure and propellant vessels, RF radiation measurements, and preliminary FTS checks.	Select Status		
A1.2.2.6. Operating and Support Hazard Analysis. An Operating and Support Hazard Analysis (O&SHA) shall be performed for each procedure and the results summarized in the GOP.	Select Status		
A1.2.2.6.1. 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 Volume 1, Attachment 2, O&SHA requirements.	Select Status		
A1.2.2.6.2. O&SHAs shall be conducted for activities such as testing, installation, maintenance, support, transportation, storage, operations, and training.	Select Status		
A1.2.2.6.3. O&SHAs shall coincide with the flow chart task summaries in A1.2.2.4.	Select Status		
A1.2.2.6.4. O&SHAs shall incorporate a worksheet associated with each specific flow block in the flow chart and shall include the following information:	Select Status		
A1.2.2.6.4.1. The general hazard group.	Select Status		
A1.2.2.6.4.2. The specific hazard condition.	Select Status		
A1.2.2.6.4.3. The effect if the hazard is not controlled.	Select Status		
A1.2.2.6.4.4. Hazard control hardware.	Select Status		
A1.2.2.6.4.5. The hazard control procedure.	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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A1.2.2.6.4.6. Hazard control personnel.	Select Status		
A1.2.2.6.4.7. Reference to the flow block task number.	Select Status		
NF 1825 The NASA Payload Safety Hazard Report Form found on the Payload Safety Program's website at: https://sma.nasa.gov/sma-disciplines/elv-payload-safety under the Payload Safety Forms button should be used to record all identified hazards.	I		
A1.2.2.7. Payload Project Plans. Payload project plans that include, but are not limited to, the following, shall be submitted in or added as appendixes to the GOP as identified in 4.5 and 4.6.2 of this volume.	Select Status		
A1.2.2.7.1. Payload Project Training Plan.	Select Status		
A1.2.2.7.2. Accident Notification Plan.	Select Status		
A1.2.2.7.3. Emergency Response Plans for Graphite Epoxy Composite Overwrapped Pressure Vessels.	Select Status		
A1.2.2.8. Changes. The "change" section contains a summary of all changes to the latest edition of the GOP. All changes shall be highlighted using change bars or similar means of identification.	Select Status		

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ATTACHMENT 2 HAZARDOUS AND SAFETY CRITICAL PROCEDURES	I		
A2.1. INTRODUCTION	I		
A2.1.1. Determination of Non-Hazardous, Hazardous and Safety Critical Documented Procedures. The Ground Operations Plan (GOP) (Attachment 1 of this volume) is the basic document used to initially determine the classification of a procedure. Specifically, all documented procedures description and task summaries along with the associated Operating & Support Hazard Analyses (O&SHAs) are reviewed. This review validates the payload project's determination of documented procedures as non-hazardous, hazardous, or safety critical. Once the classification of hazardous, non-hazardous, and safety critical is determined, hazardous or safety critical procedures are submitted to the local safety authority for review and approval. The PSWG and Range Safety shall determine if select local safety authority notification or attendance shall be required during review of the initial draft of hazardous or safety critical documented procedures. During review of the initial documented procedures draft that will take place on an Space Force range, Range Safety shall determine if Pad Safety notification or attendance shall be required. The review of the draft documented procedure allows a second opportunity to ensure the classification is appropriate.	Select Status		
A2.1.2. Purpose. All documented procedures identified as hazardous or safety critical shall provide a detailed, step-by-step description of the manner in which hazardous and safety critical operations will be accomplished. The procedures are the medium from which approval to start any hazardous or safety critical operation is obtained from the appropriate safety authority.	Select Status		
A2.1.3. Content. This attachment contains the content preparation instructions for the data generated by the requirements delineated in Volume 6.	Select Status		
A2.1.4. Applicability. This attachment is applicable to the following:	Select Status		
A2.1.4.1. All launch vehicle, payload, or service contractors performing hazardous or safety critical operations at the payload processing facility and launch site area.	Select Status		
A2.1.4.2. Construction and management contracts for hazardous facilities.	Select Status		
A2.1.5. Submittal Process. All hazardous documented operational procedures submittal, review, and approval process is in accordance with the safety requirements and processes of the specific operating location. For operations in areas under KSC jurisdiction KNPR 8715.3 shall be followed. For Space Force Ranges, the hazardous procedure submittal process is as follows:	Select Status		
A2.1.5.1. For operations on Space Force Ranges, one copy of the procedures shall be submitted to Range Safety and one copy to Pad Safety for review and approval 55 days prior to the operation. The payload project shall review, approve, and sign the final procedures to be submitted to Range Safety or the appropriate local safety authority for approval.	Select Status		
A2.1.5.2. Final Pad Safety and Range Safety comments, reviews, and approvals shall be provided to the Range User 45 calendar days after receipt of all documented operational procedures.	Select Status		

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A2.1.6. Final Approval. Hazardous and safety critical documented operational procedures shall be approved before starting any hazardous or safety critical operations at the payload processing facility and launch site area.	Select Status		
A2.2. PREPARATION INSTRUCTIONS	I		
A2.2.1. Documented Procedures. Documented Procedures are a written communication that identifies, directs and authorizes work to be performed and provides the detailed instructions necessary to successfully accomplish and verify task completion.	Select Status		
A2.2.2. Content. Documented procedural instructions of non-hazardous and hazardous documents shall consist of a set of numerically listed steps, ranked sequentially, in the order of importance, to ensure the safe performance of task that involve ground support equipment used to store, transport, handle, check-out, and control aircraft, launch vehicles, spacecraft, or payloads, payload systems and facilities and processes used for servicing, operating, or test operations. Hazardous or safety critical procedures shall be written in a logical format with clear instructions as to the tasks to be performed and hazards and precautions involved. A decimal numbering system shall be used.	Select Status		
A2.2.3. Criteria for Hazardous Documented Procedures. Any servicing, operation or test activity that has a high potential to result in loss of life, serious injury to personnel or public, or damage to property due to the material or equipment involved or the nature of the operation/activity itself shall be identified as Hazardous (Safety Critical). At a minimum, documented procedures shall be classified as hazardous for activities listed in Attachment A2.3, Classification of Hazardous Operations.	Select Status		
A2.2.4. Cover Page	I		
A2.2.4.1. A cover page with the procedure title and required approval signatures, to include the Payload Organization Safety Engineer date and revision level shall be provided. The signature page shall contain a block for signature approval by the appropriate safety authority.	Select Status		
A2.2.4.2. The words Draft or Preliminary shall appear on any signed procedure that does not have the required safety approval.	Select Status		
A2.2.4.3. The cover sheet shall state, "This Document Does Not Contain Hazardous Operations" for non-hazardous documented procedures and state "WARNING: This Procedure Contains Hazardous (or Safety Critical) Operations" and shall be outlined with a border and marked in bold print for hazardous or safety critical operations or equivalent for electronic documented procedures).	Select Status		
A2.2.4.4. The cover sheet shall indicate revision level and date.	Select Status		
A2.2.5. Purpose Section	I		
A2.2.5.1. The "purpose" section shall provide a brief synopsis of all major tasks in each operating procedure.	Select Status		
A2.2.5.2. The synopsis shall include the following information:	Select Status		

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A2.2.5.2.1. A brief description of the tasks, operations, tests, or checkouts to be performed. For hazardous or safety critical task, all conditions that cause the documented procedure to be classified as hazardous or safety critical shall be identified.	Select Status		
A2.2.5.2.2. The facility and area where the procedure is to take place.	Select Status		
A2.2.5.2.3. The departure and arrival locations if transportation is required.	Select Status		
A2.2.5.2.4. For launch vehicle and payload tests, when the test is normally performed in relation to launch day (for example, L-5).	Select Status		
A2.2.5.3. Revision Log	Select Status		
A2.2.5.3.1. A revision log shall be maintained and used to identify the date, the step in the procedure where corrections, technical modifications or changes made to previously submitted hazardous procedures. This would not apply to grammatical changes unless it alters critical procedural steps or increases or reduces the hazard level of the documented procedure.	Select Status		
A2.2.5.3.2. Changes to previously submitted hazardous procedures shall list the specific procedural steps revised in the revision log and be noted with change bars or a similar method of marking.	Select Status		
A2.2.6. Identification of Specific Hazards. The following specific hazards shall be identified in each procedure:	Select Status		
A2.2.6.1. The quantity and hazard classification of ordnance and propellants involved.	Select Status		
A2.2.6.2. The hazardous and non-hazardous configurations of the system before, during, and upon completion of the operation.	Select Status		
A2.2.7. Safety Precautions. As applicable, the following precautions shall be incorporated in each procedure at the beginning of the procedure as well as at the applicable step in the body of the procedure:	Select Status		
A2.2.7.1. Warnings: Warnings shall consist of (a) the word "WARNING" in upper case letters, enclosed in a border, and centered on the page, and (b) the text of the warning shall include (a) a brief description of the hazard, (b) the likely result if the warning is ignored, and (c) specific steps to take to avoid the hazard. Warnings shall precede the information to which they apply.	Select Status		
A2.2.7.2. Cautions: Cautions shall consist of (a) the word "CAUTION" in upper case letters and centered on the page, and (b) the text of the caution shall include (a) a brief description of the hazard, (b) the likely result if the hazard is ignored, and (c) specific steps to take to avoid the hazard. Cautions shall precede the information to which they apply.	Select Status		
A2.2.7.3. Note inhibits.	Select Status		
A2.2.7.4. Safety devices.	Select Status		
A2.2.7.5. Control areas.	Select Status		

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A2.2.8. Facility Configuration Inspections. The procedure shall indicate the specific facility and safety clearance zone control area to be used.	Select Status		
A2.2.8.1. The requirements for the performance of facility configuration inspections shall be incorporated in the procedures.	Select Status		
A2.2.8.2. The facility configuration inspection requirements shall address verification of the following:	Select Status		
A2.2.8.2.1. Facility explosive limits.	Select Status		
A2.2.8.2.2. Facility personnel limits.	Select Status		
A2.2.8.3. Posting of fire symbols when ordnance and propellants are moved into or out of a facility.	Select Status		
A2.2.9. PPE and Emergency Equipment	I		
A2.2.9.1. PPE, fit testing, and emergency equipment requirements for each operation shall be incorporated in hazardous procedures.	Select Status		
A2.2.9.2. The PPE and emergency equipment shall address the following:	Select Status		
A2.2.9.2.1. PPE requirements according to the manufacturer model number, MIL-SPEC, or standard for compliance.	Select Status		
A2.2.9.2.2. The occasions for the use of PPE.	Select Status		
A2.2.9.2.3. Types of emergency equipment required.	Select Status		
A2.2.9.2.4. Location of the emergency equipment during the operation.	Select Status		
A2.2.9.2.5. The number of emergency equipment units required. No substitution or configuration alteration of PPE shall be allowed without specific appropriate local safety approval.	Select Status		
A2.2.10. Pre-Operational Checklist of Required Tools and Equipment	I		
A2.2.10.1. A pre-operational checklist of all tools and equipment required for safe operations shall be incorporated in the procedures.	Select Status		
A2.2.10.2. For safety critical equipment, the following information shall be included:	Select Status		
A2.2.10.2.1. Manufacturer, model, and serial number.	Select Status		
A2.2.10.2.2. Location of the equipment during the operation.	Select Status		
A2.2.10.2.3. The number of units required.	Select Status		
A2.2.10.2.4. The required monitoring devices and their alarm settings.	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS AND MATERIAL, GROUND OPERATIONS SAFETY REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.10.2.5. Proof test requirements.	Select Status		
A2.2.10.2.6. Nondestructive examination requirements.	Select Status		
A2.2.10.2.7. Calibration requirements.	Select Status		
A2.2.11. Support Personnel Requirements	I		
A2.2.11.1. Payload project and any support personnel requirements such as Pad Safety, Fire, Medical, and Security/HOS personnel shall be incorporated in the procedures. In a multi-task procedure, the times these support personnel are needed shall be stipulated.	Select Status		
A2.2.11.2. The following support personnel requirements shall be addressed:	Select Status		
A2.2.11.2.1. The hazardous periods when personnel limits shall be enforced.	Select Status		
A2.2.11.2.2. The minimum essential personnel by functional title and number required.	Select Status		
A2.2.11.2.3. The Pad Safety or local safety authority notification in all cases. In accordance with local safety requirements, local safety authority or Pad Safety presence and concurrence is required before beginning all hazardous operations.	Select Status		
A2.2.11.2.4. Special training, certifications, or experience requirements.	Select Status		
A2.2.12. References to Applicable Documents	I		
A2.2.12.1. All applicable documents, drawings, and specifications shall be referenced in the procedures.	Select Status		
A2.2.12.2. If a specific operations safety plan or other safety plans apply to the procedure, they shall be listed in the procedure reference section.	Select Status		
A2.2.12.3. This document and USSF SSCMAN 91-710 shall be listed in the procedures.	Select Status		
A2.2.12.4. Procedures shall not use excessive second tier references.	Select Status		
NOTE: Use of excessive second tier references to incorporate references in such volume that the meaning is lost and use of the procedure becomes confusing, unnecessarily complex, or irrelevant.	I		
A2.2.13. CCSFS Cape Support and WR Range Scheduling Notification. Notification of the local safety authority at least 24 hours before the planned start of an operation is required to ensure appropriate support is provided and shall be incorporated in the procedures. The PSWG shall provide the notification information. CCSFS Cape Support (321-853-5211) and Range Scheduling (321-853-5941) on the ER and Range Scheduling (805-606-8825) on the WR.	Select Status		

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS AND MATERIAL, GROUND OPERATIONS SAFETY REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.14. Pre-Task Briefing	I		
A2.2.14.1. A step for the conduct of a pre-task briefing shall be incorporated in the procedures.	Select Status		
A2.2.14.2. The following topics shall be addressed:	Select Status		
A2.2.14.2.1. Operational hazards.	Select Status		
A2.2.14.2.2. Precautions.	Select Status		
A2.2.14.2.3. Emergency actions.	Select Status		
A2.2.14.2.4. Critical task items.	Select Status		
A2.2.14.2.5. Procedure flow.	Select Status		
A2.2.14.2.6. Operational discipline.	Select Status		
A2.2.14.2.7. Communication discipline.	Select Status		
A2.2.14.3 Specification that when a change of shift/personnel occurs the pre-task briefing shall be repeated.	Select Status		
A2.2.15. Step-by-Step Directions	I		
A2.2.15.1. A set of numerically listed, step-by-step directions, written in clear language, with sufficient detail to allow a qualified technician or mechanic to clearly understand the tasks to be performed and hazards and precautions involved, shall be incorporated.	Select Status		
A2.2.15.2. The procedure shall contain applicable data sheets, figures, and schematics to document or clarify system parameters and connect points.	Select Status		
A2.2.16. Identification of Hazardous and Safety Critical Portions of Procedures	I		
A2.2.16.1. The beginning and end of a hazardous or safety critical portion of a procedure shall be incorporated according to the following criteria:	Select Status		
A2.2.16.1.1. A "Warning" shall be used to identify hazards to personnel.	Select Status		
A2.2.16.1.2. A "Caution" shall be used to identify hazards to equipment.	Select Status		
A2.2.16.1.3. A "Note" shall be used to indicate an operating procedure of such importance that it must be emphasized.	Select Status		
A2.2.16.2. The activation of warning lights, Public Address (PA) announcements, and notification to Security/HOS of any controlled areas, if not accomplished as a pre-task item, shall be incorporated.	Select Status		

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS AND MATERIAL, GROUND OPERATIONS SAFETY REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.16.3. Safety highlights such as evacuations, safety clearance zones, clearances, activation of aural and visual warnings shall be detailed before the hazardous sequence and in the applicable section of the procedure.	Select Status		
A2.2.17. Emergency Shutdown and Backout Steps. Emergency shutdown and backout procedures or steps necessary to safe the system or facility in the event of a mishap, incident, or abort shall be incorporated.	Select Status		
A2.2.18. Transmittal of Procedures. For payloads launched via NASA's Launch Services Program procedures shall be forwarded to the NASA Launch Site Integration Manager (LSIM) unless otherwise agreed to go to the local safety authority. The PSWG Chairperson is responsible for all safety coordination and the LSIM is responsible for all launch site coordination and Launch Services Program coordination. Transmittal of procedures shall be made with a transmittal letter containing the following information:	Select Status		
A2.2.18.1. Need Date (minimum of 55 calendar days review time required).	Select Status		
NOTE: Prior to use, final version of any new, changed, or revised hazardous procedure shall be reviewed and approved by the appropriate safety authority.	I		
A2.2.18.2. Procedure title and number.	Select Status		
A2.2.18.3. Program identified or other identifier to ensure that the proper safety point of contact receives the procedure.	Select Status		
A2.2.18.4. Special instructions for such items as review and comment and final copy for filing.	Select Status		
A2.2.18.5. Pertinent information such as "procedure is non-hazardous," "procedure change does not affect the hazardous portion of the procedure nor otherwise have a safety impact," or "all previous comments have been incorporated."	Select Status		
A2.2.18.6. If the procedure has been previously submitted as a draft or with a different revision number, clarification of the extent of the changes shall be noted in the document revision log.	Select Status		
A2.3. CLASSIFICATION OF HAZARDOUS PROCEDURES	I		
A2.3.1. Hazardous Operation (Hazardous Tasks): Documented Procedures that should be classified as hazardous include but are not limited to operations involving or controlling activities that:	Select Status		
A2.3.1.1. Require personnel to enter a work area with atmospheric conditions that could exceed occupational exposure limits or contain an oxygen deficient or enriched environment, but which does not meet the NPR 8715.1, NASA Safety and Health Programs, definition of a "confined space."	Select Status		
A2.3.1.2. Involve the handling, receipt, storage, transportation, installation, removal, checkout, or closeout of explosives including solid propellants.	Select Status		
A2.3.1.3. Involve liquid propellant loading, unloading or flow, venting, sampling, connecting, or disconnecting, moving or storing of loaded storage units, or opening of contaminated systems.	Select Status		
A2.3.1.4. Involve cryogenic loading, unloading or flow, venting, sampling, connecting, or disconnecting, moving, or storing of loaded storage units, or repairing of a system containing cryogenics.	Select Status		

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS AND MATERIAL, GROUND OPERATIONS SAFETY REQUIREMENTS	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.3.1.5. Involve the handling or transfer of hazardous fluids, hazardous gases, combustible/corrosive liquids, or other hazardous materials when the given quantity of the gas/vapor or liquid, when mixed or unmixed with air, could result in death or serious physical injury.	Select Status		
A2.3.1.6. Involve "critical lift operations" as defined in NASA-STD-8719.9, Lifting Standard. The PSWG or Range Safety.	Select Status		
A2.3.1.7. Involve the use of ionizing or non-ionizing radiation sources that have hazard controls specified in the approved Radiation Use Authorization for that source as issued by the facility Radiation Safety Officer.	Select Status		
A2.3.1.8. Involve energized electrical systems that may expose personnel to injury and/or death. Exposure to energized electrical systems operating at voltages of less than 30 volts alternating current (AC) or 50 volts direct current (DC) may be considered non-hazardous if an assessment has been performed to verify the current levels will not result in a shock.	Select Status		
A2.3.1.9. Call up hazardous step(s) of subtask Documented Procedures. The controlling documented procedure shall be classified as hazardous.	Select Status		
A2.3.1.10. Involve the pressurization of systems or components and include at least one of the following cases:	Select Status		
A2.3.1.10.1. Flight system pressure vessels controlled by fracture mechanics.	Select Status		
A2.3.1.10.1.1. Any pressurization that exceeds any previously recorded pressurization in the pressure vessel operational time/cycle log.	Select Status		
A2.3.1.10.1.2. Any pressurization above the Maximum Allowable Working Pressure (MAWP).	Select Status		
A2.3.1.10.1.3. Any pressurization greater than 25 percent of the MAWP when the vessel contains hazardous fluids.	Select Status		
A2.3.1.10.2. Flight system pressure vessels not controlled by fracture mechanics with:	Select Status		
A2.3.1.10.2.1. Any pressurization greater than 25 percent of the MAWP that exceeds any previously recorded pressurization in the pressure vessel operational time/cycle record log.	Select Status		
A2.3.1.10.2.2. Any pressurization above MAWP.	Select Status		
A2.3.1.10.2.3. Any pressurization greater than 25 percent of the MAWP when the vessel contains hazardous fluids.	Select Status		
A2.3.1.11. Involve the pressurization of ground-based pressure vessels/systems that include at least one of the following cases:	Select Status		
A2.3.1.11.1. Any pressurization above the MAWP/Design Pressure.	Select Status		
A2.3.1.11.2. First time pressurization to rated pressure of any new vessel/system or the modified portion of an existing vessel/system. This excludes pressurization after removal or replacement of a component with a like item that has been pressure tested prior to installation. This also excludes pressurization of Flexible hoses up to rated operating pressure, provided hose restraints IAW KSC specification 80K51846 Flexible Hose Handling and Installation Requirements are in place.	Select Status		
A2.3.1.11.3. In-place calibration at more than 80 percent of full scale for pressure gauges with scale range over 200 pounds per square inch gauge (psig) unless the gauge has a solid front case with pressure relief back.	Select Status		
A2.3.1.11.4. Involve procedures that manually control pressurization of systems where MAWP/Design Pressure can be reached.	Select Status		

I – Information/Title **N/A – Not Applicable** **C – Compliant** **T – Tailored** **NC – Noncompliant**

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A2.3.1.12. Involve the pressurization of Composite Overwrapped Pressure Vessel (COPV) to pressures greater than one-third of the COPV design burst pressure.	Select Status		
A2.4. EASTERN AND WESTERN RANGE OPERATIONS/AREAS SAFETY PLANS	I		
A2.4.1 Eastern and Western Range Operations Safety Plans for base or launch complex and payload processing facilities covering launch vehicle and payload processing operations, may be requested by the PSWG, the eastern or western range safety organizations or the launch vehicle service provider upon request. *Note: Additional plans shall be developed for facilities, systems, and operations as needed.*	I		
A2.5. LAUNCH COMMIT CRITERIA	I		
Note: To view Range Safety Launch Commit Criteria see USSF SSCMAN 91-710	I		

VOLUME 7: INDEX OF APPLICABLE AND REFERENCE DOCUMENTATION, TERMS AND SUPPORTING INFORMATION

Applicable Documents

Code of Federal Regulations (CFR)

10 CFR	Energy
14 CFR	Chapter III, Subchapter C, Part 450, Subpart C Safety Requirements
21 CFR 1040	Performance Standards for Light Emitting Products
29 CFR 1910	Occupational Safety and Health Standards – General Industry
29 CFR 1910, Subpart N	Material Handling and Storage
29 CFR 1910.7	Definition and Requirements for a Nationally Recognized Testing Laboratory
29 CFR 1910.23	Guarding Floor and Wall Openings and Holes
29 CFR 1910.27	Fixed Ladders
29 CFR 1910, Subpart F	Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms
29 CFR 1910.106	Flammable and Combustible liquids
29 CFR 1910.109	Explosives and Blasting Agents
29 CFR 1910.119	Process Safety Management of Highly Hazardous Chemicals
29 CFR 1910.132, Subpart I	Personal Protective Equipment, General Requirements
29 CFR 1910.133	Eye and Face Protection
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.135	Head Protection
29 CFR 1910.136	Foot Protection
29 CFR 1910.146	Permit-Required Confined Spaces
29 CFR 1910.147	The Control of Hazardous Energy (Lockout/Tagout)
29 CFR 1910.151	Medical Services and First Aid
29 CFR 1910.179	Overhead and Gantry Cranes
29 CFR 1910.180	Crawler Locomotive and Truck Cranes
29 CFR 1910.184	Slings
29 CFR 1910.252, Subpart Q	Welding, Cutting and Brazing, General Requirements
29 CFR 1910.301, Subpart S	Electrical
29 CFR 1910.307	Hazardous (classified) locations
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.550	Cranes and Derricks
29 CFR 1926.550 (g)	Crane or Derrick Suspended Personnel Platforms
29 CFR 1926.1427	Operator Training, Certification, and Evaluation for All Lifts of Personnel
29 CFR 1926.1431	Crane or Derrick Suspended Personnel Platforms
40 CFR 68	Chemical Accident Prevention Provisions, Subpart G, Risk Management Plan
49 CFR 173.56	New Explosives – Definitions and Procedures for Classification and Approval
49 CFR 173.185	Lithium Batteries and Cells

49 CFR, Subpart 6	Surface Transportation Board, Department of Transportation, Parts 1000 through 1199

NASA Directives, Programs, Standards and Requirements

NPR 1800.1	Occupational Health Program Procedures
NPR 7120.5	Space Flight Program and Project Management Processes and Requirements
NPR 7150.2	Software Engineering Requirements
NPR 8000.4	Risk Management Procedural Requirements
NPR 8621.1	Procedures and Guidelines for Mishap Reporting, Investigating and Recordkeeping
NPR 8715.1	NASA Safety and Health Programs
NPR 8715.2	NASA Emergency Preparedness Plan Procedural Requirements
NPR 8715.3	General Safety Program Requirements
NPR 8715.7	Payload Safety Program
NPR 8715.26	Nuclear Flight Safety
NASA-STD-5005	Standard for the Design and Fabrication of Ground Support Equipment
NASA-STD-5006	General Fusion Welding Requirements for Aerospace Material Used in Flight Hardware
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, And Ground Support Equipment
NASA-STD-5009	Nondestructive Evaluation Requirements for Fracture Critical Metallic Components
NASA-STD-6001	Flammability, Offgassing, and Compatibility Requirements and Test Procedures
NASA-STD-6016	Standard Materials and Processes Requirements for Spacecraft
NASA-STD-7001	Payload Vibroacoustic Test Criteria
NASA-STD-7002	Payload Test Requirements
NASA-STD-8719.9	Lifting Standard
NASA-STD-8719.11	Safety Standard for Fire Protection
NASA-STD-8719.12	Safety Standard for Explosives, Propellants, and Pyrotechnics
NASA-GB-8719.13	Software Safety Guidebook
NASA-STD-8719.14	Process for Limiting Orbital Debris
NASA-STD-8719.17	Requirements for Ground-based Pressure Vessels and Pressurized Systems (PV/S)
NASA-STD-8739.8	Software Assurance and Software Safety Standard
NF 1825	Hazard Report Form
NF 1826	Payload Safety Post Tailoring Request Form
NF 1827	Payload Safety Waiver Request Form
NASA-KNPR-1860.1	KSC Ionizing Radiation Protection Program
NASA-KNPR-1860.1	KSC Ionizing Radiation Protection Program
NASA-KNPR-1860.2	KSC Nonionizing Radiation Protection Program
NASA-KNPR-8715.2	Comprehensive Emergency Management Plan
NASA-KNPR-8715.3	KSC Safety Procedural Requirements
NASA KSC-C-123	Specification for Surface Cleanliness of Ground Support Equipment Fluid System

NASA KSC-DE-512-SM	Facility, System and Equipment General Design Requirements
NASA KSC-GP-425	Fluid Engineering Standards
NASA KSC/MMA-1985-79	Standard Test Method for Evaluating Triboelectric Charge Generation and Decay
NASA KSC/MTB-175-88	Procedure for Casual Exposure of Materials to Hypergolic Fluids: Exothermic Reaction Test Method
NASA KSC-SPEC-Z-0008	Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies
NASA KSC Specification	
80K51846	Facility and GSE Flex Hose Handling and Installation Requirements
NASA FLAGRO JSC-22267	NASA Fatigue Crack Growth Computer Program
MSFC-STD-3029	NASA/MSFC Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments
MSFC-SPEC-3746	Flow-Induced Vibration Assessment Requirements for Metal Bellows and Flexible Hoses
NASA JPR 5322.1	Contamination Control Requirements Manual
PD/NSC 25	Presidential Directive/National Security Council 25Scientific or Technological Experiments with possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space

United States Air Force

AFPD 91-1	Nuclear Weapons and Systems Surety
AFPD 91-2	Safety Programs
AFMAN 24-306	Operation of Air Force Government Vehicles
AFMAN 40-201	Radioactive Materials (RAM) Management
DAFMAN 91-110	Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems
DAFMAN 91-203	Air Force Occupational Safety, Fire and Health Standards
DESR 6055.09_AFMAN 91-201	Explosives Safety Standards
AFI 40-201	45TH Space Wing Supplement Radioactive Materials Management (RAM)
AFI 48-109	Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program
AFI 48-139	Laser and Optical Radiation Protection Program
DAFI 91-204	Safety Investigations and Reports
AFI 91-208	Hazards of Electromagnetic Radiation to Ordnance (HERO) Certification and Management
30 SWI 10-119	Western Range Emergency Procedures Responsibilities
30 SWI 15-101	Weather Support
30 SWI 91-201	Launch Support Team Process
45 SWI 15-101	Weather Support
45 SWI 91-203	Process Safety Management (PSM) Plan
45 SW IEMP 10-2	Installation Emergency Management Plan

30/45 SWOP P19-14	Space Wing Operations Plan Petroleum Products and Hazardous Waste Management Program

United States Space Force Space

USSF SSCI 91-701	The Space Systems Command Launch and Range Safety Program
USSF SSCMAN 91-710	Volume 1, Range Safety User Requirements Manual – Space Systems Command Range Safety Policies and Procedures
USSF SSCMAN 91-710	Volume 3, Range Safety User Requirements Manual – Launch Vehicles, Payloads, and Ground Support Systems Requirements
USSF SSCMAN 91-710	Volume 6 - Range Safety User Requirements Manual – Ground and Launch Personnel, Equipment, Systems, and Material Operations Safety Requirements
USSF SSCMAN 91-710	Volume 7 - Range Safety User Requirements Manual – Glossary of References, Abbreviations and Acronyms, and Terms.

USSF Space Launch Delta Instructions (SLDI)

SLD30I91-106	Toxic Hazard Assessment

Department of Defense (DOD) Directives, Programs, Standards and Requirements

DODD 3100.10	Department of Defense Directive 3100.10 Space Policy
DOD (no designator)	Joint Software Systems Safety Engineering Handbook
DOD JS-SSA	Software System Safety Implementation Process and Tasks Supporting MIL-STD-882
DOD T.O. 11A-1-47	DoD Ammunition and Explosives Hazard Classification Procedures
MIL-C-43122G	Cloth, Sateen, Cotton, Flame Retardant Treated
MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-454	Standard General Requirements for Electrical Equipment
MIL-HDBK-6870	Inspection Program Requirements Nondestructive for Aircraft and Missile Materials and Parts
MIL-HDBK-729	Corrosion and Corrosion Prevention Metals
MIL-PRF-25567	Leak Detection Compound, Oxygen Systems
MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-464	Electromagnetic Environmental Effects Requirements for Systems
MIL-STD-810	Environmental Engineering Considerations and Laboratory Testing
MIL-STD-882	Standard for System Safety
ST/SG/AC.10/1	Recommendations on the Transport of Dangerous Goods - Model Regulations

Consensus Standards and Requirements

AIA/NAS 1514	Radiographic Standard for Classification of Fusion Weld Discontinuities
AIAA S-113A-2016	Criteria for Explosive Systems and Devices on Space and Launch Vehicles
ANSI/AIAA S-080-2018	Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components
ANSI/AIAA S-081-2018	Space Systems Composite Overwrapped Pressure Vessels (COPVs)
ANSI/SIA A92.2	Vehicle Mounted Elevating and Rotating Aerial Devices
ANSI A10.14	Construction and Demolition Operations - Requirements for Safety Belts, Harnesses, Lanyards and Lifelines for Construction and Demolition Use
ASME B30	Cranes, Hoists, and Lifting Devices
ASME B30.9	Slings
ASME B30.20	Below Hook Lifting Devices
ASME B30.23	Personnel Lifting Systems
ASME B56.2	Type Designated Area, Use Maintenance, Operator
ANSI C84.1	Electric Power Systems and Equipment - Voltage Ratings (60 Hz)
ANSI/ISEA Z87.1	Occupational and Educational Personal Eye and Face Protection Devices
ANSI Z117.1	Safety Requirements for Confined Spaces
ANSI Z136.1	Safe Use of Lasers
ANSI Z136.2	Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
ANSI Z244.1	Safety Requirements for the Lockout/Tagout of Energy Sources
ASME B1.1	Unified Inch Screw Threads
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flange
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory Made Wrought Steel Butt Welding Fittings
ASME B18.2.1	Square and Hex Bolts and Screw Inch Series
ASME B18.2.2	Square and Hex Nuts (Inch Series)
ASME B31.3	Process Piping
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B40.1	Gauges, Pressure Indicating Dial Type
ANSI/IEEE C95.1	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 Khz. to 300 Ghz.
ANSI Y32.2-1975	Graphic Symbols for Electrical & Electronics Diagrams
ASCE/SEI 7-10	Minimum Design Loads for Buildings and Other Structures
ASME-BPVC	Section VIII, Pressure Vessels, Division 1 Appendix M, Installation and Operations
ASTM A182	Forged or Rolled Alloy-Steel Pipe Flanges, Forged
ASTM A312	Standard Specifications for Seamless and Welding Austenitic Stainless-Steel Pipes
ASTM A403	Standard Specification for Wrought Austenitic Stainless-Steel Piping Fittings
ASTM E1417	Standard Practice for Liquid Penetrant Inspection
ASTM E1742	Radiographic Inspection

ASTM MNL 36	Safe Use of Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation
ASTM F51-68	Standard Method for Sizing and Counting Particulate Contaminant in and on Clean- room Garments
AWS D17.1	Specification for Fusion Welding for Aerospace Applications
CPIA 394	Chemical Propulsion Information Agency, Hazards of Chemical Rockets and Propellants
CPIA 394, Volume III	Liquid Propellants
CMAA 70	Specifications for Electric Overhead Traveling Cranes
CMAA 74	Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist
FEMA 74	Reducing the Risks of Nonstructural Earthquake Damage, A Practical Guide
Global Information Grid	Technical Guidance Federation
International Civil Aviation Organization (ICAO)	Technical Instructions for the Safe Transport of Dangerous Goods by Air
International Air Transport Association (IATA)	Dangerous Goods Regulations
IEEE/EIA 12207	Standard for Information Technology

Consensus Standards

NEC Article 250-102	Bonding Jumpers
NEC Article 500	Hazardous (Classified) Locations
NEC Article 504	Intrinsically Safe Systems
NFPA 30	Flammable and Combustible Liquids Code
NFPA 70	National Electric Code
NFPA 70E	Standard for Electrical Safety in the Workplace
NFPA 77	Recommended Practices on Static Electricity
NFPA 101	Life Safety Code
NFPA 496	Purges and Pressurized Enclosures for Electrical Equipment
NFPA 497	Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and Hazardous Locations (Classified) for Electrical Installations in Chemical Process Areas
NFPA 505	Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation
RTCA DO-311	Minimum Operational Performance Standards for Rechargeable Lithium Batteries and Battery Systems
SAE AS4330	Design Standard - Standard Dimensions for Flared Tubing
SVFISP MSS-SP-6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings
UL 558	Standard for Safety, Industrial Trucks, Internal Combustion Engine Powered
UL 583	Standard for Safety, Battery Powered Industrial Trucks

UL 913	Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Divisions 1, Hazardous Areas

Reference Documents

29 CFR 1910.106	Flammable and Combustible liquids
29 CFR 1910.1200	Hazard Communication
29 CFR 1910, Subpart F	Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms
30 SLD 30/SE	Space Launch Delta 30/Chief of Safety
3008DOT/FAA/AR MMPDS	Metallic Materials Properties Development and Standardization
30 SW OPLAN 32-40020A	Hazardous Materials (HAZMAT) Emergency Response Plan
45 SWI 15-101	Weather Support
45 SWI 91-203	Process Safety Management (PSM) Plan
45 SPW/JOP 15E-3-50	Transportation of Oversized Loads
45 SW Range SOR 19	Range Safety Operations Requirements (SOR), Number 19, Toxic Hazard Control Daily and Launch Operations
49 CFR	Department of Transportation, Chapter 49, Code of Federal Regulation
ADA 086259	Joint Services Safety and Performance Manual for Qualification of Explosives for Military Use
AFI 10-2501	Air Force Emergency Management Program
AFI 91-202	The US Air Force Mishap Prevention Program
API 579-1/ASME FFS-1	Fitness-For-Service
ASME B1.	Unified Inch Screw Threads
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flange
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory Made Wrought Steel Butt Welding Fittings
ASME B56.3	Electric Battery-Powered Industrial Trucks
ASME-BPVC	Section VIII, Pressure Vessels Division 1, Pressure Vessel Rules
ASME-BPVC	Section VIII, Pressure Vessels, Division 1 Appendix G, Suggested Good Practice Regarding Piping Reactions and Design of Supports and Attachments
ASME BPVC	Section VIII, Pressure Vessels Division 2, Alternative Rules
ASME BPVC	Section X, (ASME S001100), Fiber-Reinforced Plastic Pressure Vessels
ASTM A182	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ANSI/SIA A92.3	Manually Propelled Elevating Aerial Platforms
ANSI/SIA A92.5	Boom Supported Elevating Work Platforms
ANSI/SIA A92.6	Self-Propelled Elevating Work Platforms
ANSI/ASCE 7	Minimum Design Loads for Buildings and Other Structures
ANSI Z49.1	Safety in Welding and Cutting
ANSI Z358.1	Emergency Eyewash and Shower Equipment
ANSI Z359.1	Personnel Fall Arrest Systems, Subsystems, and Components

ASNT - SNT-TC-1A	Recommended Practices for Personnel Qualifications and Certification in Nondestructive Testing
CCEMP/JHB 2000	Cape Canaveral Spaceport Consolidated Comprehensive Emergency Management Plan
CMH-17	Composite Materials Handbook
KNPR 1820.3	KSC Hearing Loss Prevention Program
KTI-5212	NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes
MIL-STD-1751	Safety and Performance Tests for Qualification of Explosives
NACE RP0285-95	Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NASA-STD-4003	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment
NASA-SPEC-5022	NASA Manufacturing and Test Requirements for Normally Closed Pyrovalves for Hazardous Flight Systems Applications
NASA-KNPR-8715.3-1	Safety Procedural Requirements for Civil Servants NASA Contractors
NASA-KNPR-8715.3-2	Safety Procedural Requirements for Partner Orgs Operating in Joint use Facilities
NASA-KNPR-8715.3-3	Safety Procedural Requirements for Partners Operating in Exclusive Use Facilities
NASA-KSC-KTI-5212	NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes
NASA-KSC-KTI-1202	Propellant Handlers Ensemble User’s Manual
NASA/FLAGRO (JSC-22267)	NASA Fatigue Crack Growth Computer Program
NEPA	National Environmental Policy Act
NFPA 70 Article 501	Class I Locations
NFPA 70 Article 700	Emergency Systems
NFPA 70 Article 702	Optional Standby Systems
NPR 1800.1	NASA Occupational Health Program Procedures
T.O. 00-25-203	Contamination Control of Aerospace Facilities
T.O. 31Z-10-4	Electromagnetic Radiation Hazards
T.O. 42C-1-11	Cleaning and Inspection Procedures for Ballistic Missile Systems

Abbreviations and Acronyms

A-50	Aerozine 50 (UDMH)
AC	Alternate Current
AF	Air Force
AFI	Air Force Instruction
AFJMAN	Air Force Joint Manual
AFMAN	Air Force Manual
AFPD	Air Force Policy Directive
AFSPC	Air Force Space Command (Replaced by the United States Space Force)
AFSPCI	Air Force Space Command Instruction
AFSPCMAN	Air Force Space Command Manual
AGE	aerospace ground equipment
AHJ	Authority Having Jurisdiction
AIA	Aerospace Industries Association
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASIC	Application Specific Integrated Circuit
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AVE	aerospace vehicle equipment
BDA	blast danger area
BPVC	boiler and pressure vessel code
BTHLD	below-the-hook-lifting-device
CAD	cartridge-activated device
CAL-OSHA	California Occupational Safety and Health Administration
CC	Commander
CCSFS	Cape Canaveral Space Force Station
CCCV	constant current constant voltage
CDR	critical design review (*Note: Throughout this document, "CDR" refer to the project's mission CDR).*
CD ROM	compact disc read only memory
CFR	Code of Federal Regulations
CMAA	Crane Manufacturers Association of America
COPV	composite overwrapped pressure vessel
COTS	commercial-off-the-shelf
CPIA	Chemical Propulsion Information Agency
CPLD	Complex Programmable Logic Devices
CPU	central processing unit
CPS	cycles per second
CSOSA	commercial space operations support agreement
CW	continuous wave
DAFMAN	department of the air force manual

dB	decibel
dBA	decibels on the A scale
DFMR	Design for Minimum Risk
DoD	Department of Defense
DP	Documented Procedure
DOT	Department of Transportation
EBW	exploding bridgewire
EBW-FU	exploding bridgewire firing unit
ECP	Engineering Change Proposal
EED	electroexplosive device
EGSE	electrical and electronic ground support equipment
ELS	equivalent level of safety
ELV	expendable launch vehicle
EMC	electromagnetic compatibility
EMFR	electromagnetic field radiation; electromagnetic frequency radiation
EMI	electromagnetic interference
EOD	explosive ordnance disposal
EPA	Environmental Protection Agency
EPROM	erasable programmable read only memory
ER	Eastern Range
ERP	emergency response plan
ESO	explosives safety officer
ETA	explosive transfer assembly
ETS	explosive transfer system
FAA	Federal Aviation Administration
FCDC	flexible confined detonation cord
FHA	flight hazard area
FM	(1) Factory Mutual; (2) frequency modulation
FMECA	failure modes, effects, and criticality analysis
FOC	fiber optic cable
FPGA	Field Programmable Gate Array
FSS	Force Support Squadron
FTS	flight termination system
GH_2	gaseous hydrogen
GHe	gaseous helium
GHz	gigahertz
GOP	Ground Operations Plan
GOTS	government off-the-shelf
GOX	cryogenic oxygen
Gr/Ep	graphite epoxy
GSE	ground support equipment
GSS	ground support system
HA	Hazard Analysis

HAZMAT	hazardous materials
HDBK	handbook
HIF	Horizontal Integration Facility
HMS	Hazard Monitor System
HMX	cyclotetramethylenetetranitramine
HNS	hexanitrostilbene
HOS	Hazardous Operations Support
Hz	hertz
I	importance factor
IATA	International Air Transport Association
IAW	in accordance with
IBC	International Building Code
ICAO	International Civil Aviation Organization
IEEE	Institute of Electrical and Electronics Engineers
INSRB	Interagency Nuclear Safety Review Board
IPF	Integration Processing Facility
IRSO	Installation Radiation Safety Officer
ISI	in-service inspection
JP	jet propellant
JTA	Joint Technical Architecture
KHz	kilohertz
KNPR	Kennedy NASA Procedural Requirements
K1	stress intensity
KIc	plane-strain fracture toughness
K Ie	surface-crack tension specimen fracture toughness
KISCC	stress-corrosion cracking threshold
Kmax	maximum stress intensity factor
KSC	Kennedy Space Center
KTI	Kennedy Technical Instruction
kV	kilovolts
LBB	leak before burst
LED	light emitting diode
LEL	lower explosive limit
LFU	laser firing unit
LH_2	liquid hydrogen
LHe	liquid helium
LID	laser initiated device
Li-Ion	Lithium Ion
LIO	laser initiated ordnance
LIOS	laser initiated ordnance system
LN_2	liquid nitrogen
LO_2	liquid oxygen
LOX	liquid oxygen

LSIM	Launch Site Integration Manager
LSO	Laser Safety Officer
LSRRR	Launch Safety Requirements Relief Request
mA	milliamps
MAC	maximum allowable concentration
MAPTIS	Material and Process Technical Information System
MAWP	maximum allowable working pressure
MDCP	Mechanical Damage Control Plan
MEOP	Maximum Expected Operating Pressure
MHE	material handling equipment
MIL-HDBK	military handbook
Mil-Spec	military specification
MIL-STD	military standard
mm	millimeters
MMH	mono-methyl hydrazine
MOP	maximum operating pressure
MPE	maximum predicted environment; maximum permissible exposure
MRB	Material Review Board
MSA	Mine Safety Appliances
N_2H_4	hydrazine
N_2O_4	nitrogen tetroxide
NACE	National Association of Corrosion Engineers
NASA/FLAGRO	NASA Fatigue Crack Growth Computer Program
NDE	nondestructive examination
NDI	nondestructive inspection
NEC	National Electric Code
NEI	non-explosive initiator
NFPA	National Fire Prevention Association
NFSO	NASA Nuclear Flight Safety Officer
NIOSH	National Institute of Occupational Safety and Health
NPT	National Pipe Thread
NRC	Nuclear Regulatory Commission
NRTL	Nationally Recognized Testing Laboratory
O&M	operating and maintenance
O&SHA	operating and support hazard analysis
OIS	Operational Information System
OPLAN	operations plan
OSC	Operations Safety Console
OSHA	Occupational Safety and Health Administration
OSP	operations safety plan
OTV	Operation Television
PA	public address
PAD	percussion-activated device

PD	Presidential Directive
PDR	preliminary design review (*Note: Throughout this document, "PDR" refer to the project's mission PDR.)*
PETN	Pentaerythritol tetranitrate
PFA	plastic films, foams, and adhesive tapes
PHA	preliminary hazard analysis
PHE	propellant handlers' ensemble
PLC	programmable logic controller
PLD	Programmable Logic Devices
PM	project manager
PPE	personal protective equipment
PPF	payload processing facility
PSI	payload safety introduction
PSIB	payload safety introduction briefing
psi	pounds per square inch
psig	pounds per square inch gauge
PSM	process safety management
PSWG	payload safety working group
PTFE	polytetrafluoroethylene
PTR	program trouble report; public traffic route
PV/S	pressurized vessels and pressurized systems
QA	quality assurance
RADSAFCOM	Radiation Safety Committee (Western Range)
RDX	cyclotrimethylenetrinitramine
RF	radio frequency
RLV	reusable launch vehicle
RMP	risk management plan
RP	rocket propellant
RPO	Radiation Protection Officer
RSC	Radiation Safety Committee (Eastern Range)
RSO	Radiation Safety Officer
RT	radiographic testing
S&A	(1) safe and arm device; (2) status and alert
SAS	Safety Analysis Summary
SCAPE	self-contained atmospheric protective ensemble
SCCB	Software Configuration Control Board
SCCSF	safety critical computer system function
SCM	software configuration management
SCN	specification change notice
SDP	safety data package formerly MSPSP
SDS	Safety Data Sheet
sec	second, seconds
SEE	single event effects
SEU	single event upset

SEW	Weapons Safety Office
SFP	single failure point
SGI	service group I
SHA	system hazard analysis
SLC	space launch complex
SLD	space launch delta
SLD30	space launch delta 30 (Formerly the 30th Space Wing)
SLD30/SE	space launch delta 30 Safety (Formerly 30th Wing Safety)
SLD30I	space launch delta 45 instruction (Formerly 30th Space Wing Instruction, SWI)
SLD45	space launch delta 45 (Formerly the 45th Space Wing)
SLD45/SE	space launch delta 45 Safety (Formerly 45th Wing Safety)
SLD45I	space launch delta 45 instruction (Formerly 45th Space Wing Instruction, SWI)
SMA	safety and mission assurance
SNT-TC	Society for Nondestructive Testing-Testing Certification
SNS	space nuclear systems
SOC	System on Chip
SOP	standard operating procedures
SSCMAN	Space Systems Command Manual
SPR	software problem report
SR	safety review
SSC	United States Space Force Space Systems Command
SSHA	subsystem hazard analysis
SSP	System Safety Plan
STD	software test description
STD	Standard
STP	standard temperature and pressure
STR	software trouble reports
SVFISP	Society of the Valve and Fittings Industry Standard Practice
SW	Space Wing
SWI	Space Wing Instruction
SWOP	Space Wing Operation Plan
T.O.	technical order
TBI	through bulkhead initiator
THZ	toxic hazard zone
TIM	technical interchange meeting
TLV	threshold limit value
TMO	Transportation Management Office
TNT	trinitrotoluene
TWA	time weighted average
UDMH	unsymmetrical dimethylhydrazine
UDS	Universal Documentation System
UL	Underwriters Laboratories
UN	United Nations

UNO	united nations organizations
US	United States
USAF	United States Air Force
USSF	United States Space Force
UT	ultrasonic test
VSFB	Vandenberg Space Force Base
V	Volt
Vac	volts, alternating current
Vdc	volts, direct current
Vrms	volts, root mean square
WOCC	Wing Operations Control Center
WR	Western Range

Definitions

"A" Basis Allowables. The minimum mechanical strength values guaranteed by the material producers or suppliers such that at least 99% of the material they produce, or supply will meet or exceed the specified values with a 95% confidence level.

"B" Basis Allowables. The mechanical strength values specified by material producers and suppliers such that at least 90% of the materials they produce, or supply will meet or exceed the specified values with a 95% confidence level.

Abort. An action used to cut short or break-off an action, procedures or operation, in order to preserve the mission for a future attempt. Aborts can fall into two categories: (1) Contingency abort: re-direction of vehicle flight during ascent or descent in a manner that does not jeopardize public health and safety and the safety of property, in accordance with mission rules and procedures. Contingency abort includes landing at an alternative location that has been designated as a contingency abort location in advance of vehicle flight. (2) Emergency abort: redirection of vehicle flight during ascent or descent in a manner that minimizes risk to public health and safety and the safety of property. Emergency abort involves failure of a vehicle, safety-critical system, or flight safety system such that contingency abort is not possible.

Acceptable hazard. Determination of the acceptability of any hazard imposed by a launch vehicle/missile or orbital vehicle launched from or onto the range is solely the responsibility of the USSF SLD Commander; the acceptability varies with operational requirements and/or national need and is determined by the USSF SLD Commander on a case-by-case basis.

Acceptable launch risk. The allowable collective risk to the general public, without higher management review and approval, is an aggregated (all hazards, all people including personnel on ships) expectation of casualty (Ec) of ≤ 100 x 10-6. The allowable individual public risk criterion is an aggregated Ec of ≤ 1 x 10-6.

Acceptance tests. The required formal tests conducted on hardware to ascertain that the materials, manufacturing processes, and workmanship meet specifications and that the hardware is acceptable for its intended use; also the formal required tests conducted on software to ascertain that the code meets specifications and is acceptable for its intended use.

Acceptable risk. A residual hazard that has been accepted by the Program Manager and the Space Wing SLD30 or SLD45 Commander.

Accumulated risk. The combined collective risk to all individuals exposed to a particular hazard through all phases of an operation.

Aggregated risk. The accumulated risk due to all hazards associated with a flight; see also *accumulated risk*.

Aerozine 50. A 50-50 blend of hydrazine and unsymmetrical dimethylhydrazine.

All-fire level. The minimum direct current or radio frequency energy that causes initiation of an electroexplosive initiator or exploding bridgewire initiator or laser initiated device with a reliability of 0.999 at a confidence level of 95% as determined by a Bruceton test. Recommended operating level is all-fire current, as determined by test, at ambient temperature plus 150%of the minimum all-fire current.

Allowable load (stress). The maximum load (stress) that can be allowed in a material for a given operating environment to prevent rupture or collapse or detrimental deformation; allowable load (stress) in these cases are ultimate load (stress), buckling load (stress), or yield load (stress), respectively.

Allowable strength. The ratio of material strength to the specified factor of safety.

Antenna. A device capable of radiating or receiving radio frequency energy.

Apogee. The point of an object's greatest distance from the center of the Earth, where the object's velocity is lowest. The apogee altitude is the distance of the apogee point above the surface of the Earth.

Applied load. The static or dynamic load applied to a structure, excluding load amplification factors.

Applied load (stress). The actual load (stress) imposed on the structure in the service environment.

Arm/Disarm device. An electrically or mechanically actuated switch that can make or break one or more ordnance firing circuits; operate in a manner similar to safe and arm devices except they do not physically interrupt the explosive train.

Arming plug. A removable device that provides electrical continuity when inserted in a firing circuit.

Automatic flight termination (destruct) system. A flight safety system that is installed on each propulsion system on the launch vehicle, including stages, upper stages, and payload systems; this system functions autonomously during flight to render the powered stage non-propulsive in the event of the inadvertent breakup of a vehicle.

Autonomous flight safety system. An onboard system that includes all hardware and software needed to make a flight termination decision (or other safety decision) and initiate actions that end vehicle flight (or otherwise restrict vehicle flight) without ground-based intervention. An Autonomous Flight Termination System (AFTS) is a type of AFSS.

Auxiliary payload. A small satellite (e.g., CubeSats, Nanosatellites, Picosatellites) that does not interfere with the primary payload mission.

Azimuth. The initial launch direction measured clockwise from zero degrees north.

Battery capacity. (1) Rated capacity: the capacity assigned by the battery manufacturer based on a set of specific conditions such as discharge temperature, discharge current, end of discharge voltage, and state of charge at start of discharge; (2) measured capacity: the capacity determined by the specific qualification tests, including any time the battery is under load during qualification; the end of discharge voltage is the minimum voltage that flight termination system components have been qualified to.

Below-the-hook lifting device. Structural and mechanical lifting devices and equipment (except for slings, load positioning devices, and load cells) used to connect a crane/hoist hook and a load being lifted, including lifting beams (and arms) and attachment hardware such as bolts and pins (lifting assemblies).

Blast danger area. A hazardous clear area; clearance prior to establishment of a major explosive hazard such as vehicle fuel/oxidizer load and pressurization; the area subject to fragment and direct overpressure resulting from the explosion of the booster/payload.

Brittle fracture. (1) A type of failure mode in structural materials that usually occurs without prior plastic deformation and at extremely high speed, (2) a type of failure mode such that burst of the vessel is possible during cycling [normally this mode of failure is a concern when cycling to the maximum expected operating pressure (MEOP) or when the vessel is under sustained load at MEOP], and (3) a type of fracture that is characterized by a flat fracture surface with little or no shear lips (slant fracture surface) and at average stress levels below those of general yielding.

Bruceton Test Method. A statistical method for determining the all-fire and no-fire characteristics of an electro-explosive device using a small sample size, but with high reliability.

Burst factor. A multiplying factor applied to the MEOP to obtain the design burst pressure; synonymous with ultimate pressure factor.

Casualty. A serious injury or worse, including death, to a human.

Casualty area. The area on the ground about the impact point of a fragment within which an exposed person would be expected to become a casualty.

Catastrophic hazard. A hazardous condition causing a mishap that could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact or facility, ground, or flight equipment loss greater than $10,000,000.00.

Cell. A single electrical energy or electrical charge-storing unit described by minimum voltage and minimum capacity.

Certified inspector. A person qualified and certified in nondestructive examination inspection techniques according to the American Society for Nondestructive Testing, recommended practices (SNT-TC-1A).

Collective risk. The total combined risk to all individuals within a category (for example, launch-essential personnel, general public) exposed to any hazard from an operation. Unless otherwise noted, collective risk is the mean number of casualties (Ec) predicted to result from all hazards associated with an operation. Collective risk is specified as either for a mission or per year. The collective risk should include the aggregated and accumulated risk.

Collision avoidance. A process designed to prevent collisions between on-orbit tracked objects or to prevent collisions between on-orbit tracked objects and launched vehicles (including spent stages)/payloads by determining and implementing courses of action through careful analysis of validated conjunction assessments and satellite health and mission requirements. The process includes establishing launch wait periods in either the launch window or spacecraft thrust firings based on validated conjunction assessments and accounts for uncertainties in spatial dispersions, arrival time of orbiting objects and/or the launch vehicle/payload, and modeling accuracy.

Command control system. The portion of a flight safety system that includes all components needed to send a flight termination control signal to an onboard vehicle flight termination system; a command control system starts with flight termination activation switches at the mission flight control console and ends at each command-transmitting antenna; it includes all intermediate equipment, linkages, and software and any auxiliary transmitter stations that ensure a command signal will reach the onboard vehicle flight termination system from liftoff until the launch vehicle achieves orbit or can no longer reach a populated or other protected area.

Command destruct. The process in which a sequence of commands are issued from a ground station or center that, when executed by the flight system, causes the launch vehicle to be destroyed.

Command destruct system. A portion of a flight termination system that includes all components on board a launch vehicle that receive a flight termination control signal and achieve destruction of the launch vehicle; a command destruct system includes all receiving antennas, receiver decoders, explosive initiating and transmission devices, safe and arm devices and ordnance necessary to achieving destruction of the launch vehicle upon receipt of a destruct command; a command destruct system is one type of a command terminate system.

Command system. The portion of the flight safety system consisting of the airborne flight termination system and the ground flight termination system command transmitter system that sends arm and terminate commands.

Command terminate system. A portion of a flight termination system that includes all components on board a launch vehicle that receive a flight termination control signal and achieve termination of the flight of a launch vehicle; a command terminate system includes all receiving antennas, receiver decoders, explosive initiating and transmission devices, safe and arm devices and ordnance necessary to achieving destruction of the launch vehicle or other devices to stop propulsion or otherwise terminate flight upon receipt of a terminate command.

Commercial/FAA-licensed launch. Any launch that is performed under a license from the FAA. This includes activity required to prepare, conduct, or recover from a launch action (to include such activity as a static fire, engine test, booster assembly, launch, payload fueling operations, etc.) when requesting services, commodities, or resources from USSF under the provisions of 51 USC, Subtitle V, Commercial Space Transportation, Chapter 509, Commercial Space Launch Activities, U.S.C. §§ 50901 - 50923.

Compatibility. The ability of two or more materials or substances to come in contact without altering their structure or causing an unwanted reaction in terms such as permeability, flammability, ignition, combustion, functional or material degradation, contamination, toxicity, pressure, temperature, shock, oxidation, or corrosion.

Composite material. The combinations of materials differing in composition or form on macro scale. The constituents retain their identities in the composite; normally, the constituents can be physically identified, and there is an interface between them.

Composite material. The combinations of materials differing in composition or form on macro scale. The constituents retain their identities in the composite; normally, the constituents can be physically identified, and there is an interface between them.

Conflagration. A destructive fire, usually an extensive one.

Conjunction assessment. The process of determining the point of closest approach of two orbiting objects, or between a launch vehicle and an orbiting object, in association with a specified miss-distance screening criterion or the corresponding probability of collision. Associated with the closest approach assessment is the closest approach distance, the times of launch or orbital firing that would result in the closest approach and meeting the miss-distance or collision probability criteria.

Contamination. The introduction of impurities, undesirable material, suspect material, or material potentially out of specification that may render the system or equipment unusable for its intended purpose or in such a state that special measures need to be taken before the equipment or system can be restored to normal service.

Control area clears. A hazardous clear area: clearance of defined areas to protect personnel from hazardous operations.

Conventional facility or structure. Office buildings, libraries, auditoriums, warehouses, cafeterias, utility buildings, and other facilities whose structures are characterized by well-established design precedents and loading conditions and whose function is non-hazardous.

Control authority. A single commercial user on-site director and/or manager, a full time government tenant director and/or commander, or United States Space Force squadron/detachment commander responsible for the implementation of launch complex safety requirements.

Countdown. The timed sequence of events that must take place to initiate flight of a launch vehicle.

Crew rest. That period of time immediately prior to the beginning of duty as assigned; for launch-essential personnel, it is mandatory that the rest period include the time necessary for meals, transportation, and 8 hours of uninterrupted rest prior to reporting for duty. In preparation for launch operations, rest periods start no earlier than 2 hours after the assigned personnel are released from an earlier launch or range operation. Only the Chief of Safety or USSF SLD Commander has the authority to waive the safety rest period requirements for Mission Ready (Category A) personnel; see also *rest period*.

Critical condition. The most severe environmental condition in terms of loads, pressures, and temperatures, or combination thereof imposed on structures, systems, subsystems, and components during service life.

Critical facility/structure. A hazardous facility or structure; a facility or structure used to store or process explosives, fuels, or other hazardous materials; a facility or structure that contains or is used to process hazardous systems or critical hardware; or a facility or structure determined to be critical.

Critical hardware. Any hazardous or safety critical equipment or system; non-hazardous DoD high value items such as spacecraft, missiles, or any unique item identified by DoD as critical; non-hazardous, high value hardware owned by Range Users other than the DoD may be identified as critical or non-critical by the authority having jurisdiction; see also *safety critical*.

Critical hazard. A hazardous condition causing a mishap that 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 facility, ground, or flight equipment loss equal to or exceeding $1,000,000 but less than $10,000,000.

Critical lift. Per the NASA-STD-8719.9 Lifting Standard, a critical-lifts are lifts, during which failure/loss of control presents an elevated risk of serious injury, loss of life, or loss of one-of-a-kind articles, high dollar items or major facility components whose loss would have serious programmatic or institutional impact. Lifts of high-value flight hardware and/or non-routine lifts (e.g., lift point below center of gravity) are usually classified as critical lifts, while lifts of small, improvised mini-satellites, for example, most likely would not be. Lifting and movement of flight hardware components packaged per applicable shipment specifications are typically not classified as critical lifts.

Critical load. A load consisting of critical hardware and/or any personnel.

Crossrange. The distance measured along a line whose direction is either 90° clockwise (right crossrange) or counter-clockwise (left crossrange) to the projection of a launch vehicle's planned nominal velocity vector azimuth onto a horizontal plane tangent to the ellipsoidal earth model at the launch vehicle's sub-vehicle point; the terms, right crossrange and left crossrange, may also be used to indicate direction.

Crossrange direction. Measured along the Y axis of the X, Y, Z coordinate system. Left crossrange is measured in the direction of the negative Y axis and right crossrange is measured in the direction of the positive Y axis.

Cryogen. A super cold liquid such as liquid nitrogen or oxygen.

Crystal salts. The formation of salt oxidation by the cathode/electrolyte process in batteries; the resulting salt can inhibit the electrochemical process, be a corrosive to the metal plates, and affect the salt solubility that, in turn, affects the passivation film.

Danger area information plan. An Eastern Range document prepared by Operations Safety specifying roadblocks and the fallback area associated with hazardous areas for each launch complex during launch operations.

Decibel. A unit of relative power; the decibel ratio between power levels, P1 and P2, is defined by the relation dB = 10 log (P1/P2).

Dedicated. Serving a single function, such as a power source serving a single load.

Design burst pressure. The calculated pressure (the analytical value that was calculated using an acceptable industry and/or government practice to determine its design pressure) that a component must withstand without rupture and/or burst to demonstrate its design adequacy in a qualification test; during qualification testing, the actual burst pressure for a tested component must demonstrate that the design burst pressure is less than the actual burst pressure; safety factors are based on design burst pressure, not actual burst pressure of a particular component.

Design load. The value used by the manufacturer as the maximum load around which the device or equipment is designed and built based on specified design factors and limits. This is also the load referred to as the "Manufacturer's Rated Load." see also *applied load*.

Design safety factor. A factor used to account for uncertainties in material properties and analysis procedures; often called *design factor of safety* or simply *safety factor*.

Design pressure. The pressure used in the design of a vessel or system for the purpose of determining minimum permissible thickness or physical characteristics of the different parts. When applicable (for liquids), static head will be added to the design pressure to determine the thickness of any specific part of a vessel. (Reference Appendix 3, Paragraph 3-2, ASME Code, Section VIII, Division 1, and Paragraph 301.2, ASME B31.3).

Destabilizing pressure. A pressure that produces comprehensive stresses in a pressurized structure or pressure component.

Detonating cord. A flexible fabric tube containing a filler of high explosive material intended to be initiated by an electroexplosive device; often used in destruct and separation functions.

Detonation. A violent chemical reaction within a chemical compound or mechanical mixture evolving heat and pressure that proceeds through the reacted material toward the unreacted material at a supersonic velocity; the result of the chemical reaction is exertion of extremely high pressure on the surrounding medium forming a propagating shock wave which is originally of supersonic velocity; a detonation, when the material is located on or near the surface of the ground, is normally characterized by a crater.

Detonator. An explosive device (usually an electroexplosive device) that is the first device in an explosive train and is designed to transform an input (usually electrical) into an explosive reaction.

Detrimental deformation. Includes all structural deformations, deflections, or displacements that prevent any portion of the structure from performing its intended function or that reduces the probability of successful completion of the mission.

Development test. A test to provide design information that may be used to check the validity of analytic technique and assumed design parameters, to uncover unexpected system response characteristics, to evaluate design changes, to determine interface compatibility, to prove qualification and acceptance procedures and techniques, or to establish accept and reject criteria.

Downrange. The distance measured along a line whose direction is parallel to the projection of a launch vehicle's planned nominal velocity vector azimuth into a horizontal plane tangent to the ellipsoidal earth model at the launch vehicle sub-vehicle point; may also be used to indicate direction.

Ductile failure. See *failure, ductile*.

Ductile fracture. A type of failure mode in structural materials generally preceded by large amounts of plastic deformation and in which the fracture surface is inclined to the direction of the applied stress.

Ductile materials. See *materials, ductile*.

Ductility. The ability of a material to be plastically deformed without fracturing in tension or compression, respectively; two commonly used indices of ductility are the *ultimate* elongation and the reduction of cross-sectional area; the usual dividing line between ductility and brittleness is 5 percent elongation (See ***Metallurgy for Engineers, Mechanics of Materials,*** **and** ***Mechanical Engineering and Design*** in References.).

Dudding. The process of permanently degrading an electroexplosive initiator to a state where it cannot perform its designed function.

Duty time. The time personnel are at work from the time they arrive at their duty location until the end of the duty tour; duty time begins on first arriving at the base or office for transportation to later launch support positions.

Eastern range. The Eastern Range (ER) is the National Launch Range that supports missile and rocket launches from the two major launch facilities located at Cape Canaveral Space Force Station and the Kennedy Space Center (KSC), Florida. The ER facilities are managed by the United States Space Force Space Lunch Delta 45 located at Patrick Space Force Base and includes the operational launch and base support facilities located at Cape Canaveral Space Force Station, and the downrange sites at Jonathan-Dickinson Missile Tracking Annex, Florida, in the Ascension Islands, and in the context of launch operations, the Atlantic Ocean.

Electrical component. A component such as a switch, fuse, resistor, wire, capacitor, or diode in an electrical system.

Electromagnetic compatibility (EMC). Capability of a space system, etc., to perform its mission without degradation due to electromagnetic interference between equipment and subsystems.

Electrically initiated devices (EIDs). Single unit, device, or subassembly that uses electrical energy to produce a non-reversible explosive, pyrotechnic, thermal, or mechanical output.

Electromagnetic interference (EMI). Degradation of equipment/subsystem performance due to unintentional electromagnetic interaction with another part of the space system.

Environmental health. On the Western Range, the Range User is responsible for performing the EH tasks described in this document for contractor operations; on the Eastern Range, the responsible agency is 45 MG/SGPB and a range contracto**r**.

Equivalent level of safety. An approximately equal level of safety; may involve a change to the level of expected risk that is not statistically or mathematically significant as determined by qualitative or quantitative risk analysis; equivalent level of safety replaces the former “meets intent” certification process.

Expendable launch vehicle. A launch vehicle whose propulsive stages are flown only once.

Explosion proof apparatus. An enclosure that will withstand an internal explosion of gases or vapors and prevent those gases or vapors from igniting the flammable atmosphere surrounding the enclosure, and whose external temperature will not ignite the surrounding flammable atmosphere.

Explosives. Any chemical compound or mechanical mixture that, when subjected to heat, impact, friction, detonation, or other suitable initiation, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium; the term applies to materials that either detonate or deflagrate.

Factor of safety. The ratio of the yield or ultimate strength of the structure to the applied load; see factor of safety (ultimate) and factor of safety (yield); ratio of the design condition to the maximum operating conditions specified during design.

Fail-safe. A design feature in which a system reacts to a failure by switching to or maintaining a safe operating mode that may include system shut down; ability to sustain a failure and retain the capability to safely terminate or control the operation.

Failure. The inability of a system, subsystem, component, or part to perform a required function within specified limits.

Failure, ductile. Materials exhibiting a ductile failure mode are those that (1) have ductile behavior under the environmental and operating conditions; i.e., ultimate strain of 20 percent elongation or greater, and appropriate notch toughness, and (2) provide warning of an incoming failure via visually detectable (by eye and without magnification aids) deformation of structural components; see also ductile behavior.

Fatigue. The progressive localized permanent structural change that occurs in a material subjected to constant or variable amplitude loads at stresses having a maximum value less than the ultimate strength of the material.

Fatigue life. The number of cycles of stress or strain of a specified character that a given material sustains before failure of a specified nature occurs.

Fault. The manifestation of an error in software that may cause a failure.

Fault tolerance. The built-in ability of a system to provide continued correct operation in the presence of a specified number of faults or failures.

Firing circuit. The current path between the power source and the initiating device.

Firmware. Computer programs and data loaded in a class of memory that cannot be dynamically modified by the computer during processing; for Systems Safety purposes, firmware is to be treated as software.

Fittings. Pressure components of a pressurized system initialized to connect lines, other pressure components, and/or pressure vessels within the system.

Flaw. An imperfection or unintentional discontinuity that is detectable by nondestructive examination.

Flight hazard area. A hazardous launch area; the controlled surface area and airspace about the launch pad and flight azimuth where individual risk from a malfunction during the early phase of flight exceeds 1×10^{-5}; because the risk of serious injury or death from blast overpressure or debris is so significant, only launch-essential personnel in approved blast-hardened structures with adequate breathing protection are permitted in this area during launch.

Flight plan approval. An approval process that results from a written application by the Range User; a two-phase approach stemming from a Preliminary Flight Plan Approval and a Final Flight Plan Approval.

Flight termination system. All components, onboard a launch vehicle, that provide the ability to terminate a launch vehicle's flight in a controlled manner; the flight termination system consists of all command terminate systems, inadvertent separation destruct systems, or other systems or components that are onboard a launch vehicle and used to terminate flight.

Foreign government agency or company. A Range User entity who is not a US citizen, not a US company, or not a foreign-registered company with a majority holding by a US company or citizen.

Fracture, brittle. For the purpose of this document, those materials that exhibit a failure mode outside of ductile failure.

Fracture control. The application of design philosophy, analysis method, manufacturing technology, quality assurance, and operating procedures to prevent premature structural failure due to the propagation of cracks or crack-like flaws during fabrication, testing, transportation and handling, and service.

Fracture mechanics. An engineering concept used to predict flaw growth of materials and structures containing cracks or crack-like flaws; an essential part of a fracture control plan to prevent structure failure due to flaw propagation.

Fracture toughness. A generic term for measures of resistance to extension of a crack.

Function. Any electronic commands, such as arm, destruct, safe, and test, issued by the Mission Flight Control Officer and transmitted to the airborne elements of a flight termination system.

Fuse. A system used to initiate an explosive train.

General public. All persons who are not in the launch-essential personnel or neighboring operations personnel categories; for a specific launch, the general public includes visitors, media, and other non-operations personnel at the launch site as well as persons located outside the boundaries of the launch site who are not associated with the specified launch; see also *launch-essential personnel* and *neighboring operations personnel*.

Handling structures. Structures such as beams, plates, channels, angles, and rods assembled with bolts, pins, and/or welds; includes lifting, supporting and manipulating equipment such as lifting beams, support stands, spin tables, rotating devices, and fixed and portable launch support frames.

Hardware (computer). Physical equipment used in processing; items made of a material substance but excluding computer software and technical documentation.

Hazard, hazardous. A real or potential condition that could lead to an unplanned event or series of events (i.e. mishap) resulting in death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Hazard analysis. The identification and evaluation of existing and potential hazards and the recommended mitigation for the hazard sources found; the process of identifying hazards and their potential casual factors.

Hazard area. An area where known products can cause harm to the on- and off-base public.

Hazard proof. A method of making electrical equipment safe for use in hazardous locations; these methods include explosion proofing, intrinsically safe, purged, pressurized, and non-incendive and must be rated for the degree of hazard present.

Hazard severity. The categorization of severity based on potential consequences and probabilities.

Hazardous facility or structure. A facility or structure used to store, handle, or process hazardous materials or systems and/or perform hazardous operations.

Hazardous leak before burst. A pressure vessel that exhibits a leak before burst failure mode and contains a hazardous material.

Hazardous materials. Defined by law as “a substance or materials in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce” (49 U.S.C S 5102, Transportation of Hazardous Materials; Definitions). The Secretary of Transportation has developed a list of materials that are hazardous which may be found in 49 CFR Part 172.101. Typical hazardous materials are those that may be highly reactive, poisonous, explosive, flammable, combustible, corrosive, radioactive, produce contamination or pollution of the environment, or cause adverse health effects or unsafe conditions.

Hazardous operations. (Hazardous Tasks): Any operation or other work activity that has a high potential to result in loss of life, serious injury to personnel or public, or damage to property due to the, commodity, material or equipment involved or the nature of the operation/activity itself. Refer to Volume 6, attachment A2.3 for operations classified as Hazardous.

Hazardous operations support. A Western Range contractor responsible for specific security operations.

Hazardous pressure systems. The systems used to store and transfer hazardous fluids such as cryogens, flammables, combustibles, hypergols; systems with operating pressures that exceed 150 psig; systems with stored energy levels exceeding 14,240 ft lb.; systems that are identified by Range Safety as safety critical; see also *safety critical*.

Hazardous procedure. A designation for a required documented procedure, with specific steps in sequential order, applicable to hazardous operations, or any work activity, that has a high potential to result in loss of life, serious injury to personnel or public, or damage to property due to the, commodity, material or equipment involved or the nature of the operation/activity itself. Hazardous operational procedures have specific content requirements delineated in Volume 6, Attachment A2 and require Range Safety approval.

High voltage exploding bridgewire. An initiator in which the bridgewire is designed to be exploded (disintegrated) by a high energy electrical discharge that causes the explosive charge to be initiated.

Hoist angle. An angle at which the load line is pulled during hoisting.

Hold. A temporary delay in the countdown, test, or practice sequence for any reason.

Holdfire. An interruption of the ignition circuit of a launch vehicle.

Hydra Set. The trade name for a closed circuit hydraulically operated instrument installed between a crane hook and load that allows precise control of lifting operations and provides an indication of applied load, precision load positioning device.

Hydraulic. Operated by water or any other liquid under pressure; includes all hazardous fluids as well as typical hydraulic fluids that are normally petroleum-based.

Hydrogen embrittlement. A mechanical-environmental failure process that results from the initial presence or absorption of excessive amounts of hydrogen in metals, usually in combination with residual or applied tensile stresses.

Hygroscopic. Absorbs moisture from the air.

Hydrostatic test. The test of a pressure vessel or system during which the vessel or system is filled with a liquid (usually water) and pressurized to a designated level in a manner prescribed in the applicable code. (Reference

Paragraph UG-99, ASME Code, Section VIII, Division 1 or Part 8 Paragraph 8.2, ASME Code, Section VIII, Division 2., Paragraph 345.4, ASME B31.3)

Hypergolic propellants. Fluids that ignite spontaneously upon mixing for the purposes of propulsion and power, such as certain rocket fuels and oxidizers, Self-igniting upon contact of a fuel and an oxidizer, without a spark or external aid.

Igniter. A device containing a specifically arranged charge of ready burning composition, usually black powder, used to amplify the initiation of a primer.

Imminent danger. Any condition, operation, or situation that occurs on the range where a danger exists that could reasonably be expected to cause death or serious physical harm, immediately or before the imminence of such danger can be eliminated through control procedures; these situations also include health hazards where it is reasonably expected that exposure to a toxic substance or other hazard will occur that will cause harm to such a degree as to shorten life or cause a substantial reduction in physical or mental efficiency even though the resulting harm may not manifest itself immediately.

Independent. Not capable of being influenced by other systems.

Indication. The response or evidence from the application of a nondestructive examination including visual inspection.

Inhibit. An independent and verifiable mechanical or electrical device that prevents a hazardous event from occurring; device has direct control and is not the monitor of such a device. An inhibit is a physical interruption or barrier between an energy source and the action or function that would take place if the energy source is released. Examples would be a relay or transistor between a battery and a pyrotechnic initiator, or a latch valve between a pressurized propellant tank and a thruster. *Note: An inhibit control is a device or function that operates an inhibit. Controls do not satisfy the inhibit or failure tolerance requirements for hazardous functions. An example, as stated in Volume 3 paragraph 3.2.8 of this document, is software. Software is considered an inhibit operator control, not an inhibit.*

Initial flaw. A flaw in a structural material before the application of load and/or environment.

Initiator. Includes low voltage electroexplosive devices and high voltage exploding bridgewire devices.

Interrupter. A mechanical barrier in a fuse that prevents transmission of an explosive effect to some elements beyond the interrupter.

Intrinsically safe. Design is incapable of producing sufficient energy to ignite an explosive atmosphere.

Ionizing radiation. Gamma and X-rays, alpha and beta particles and neutrons.

Launch abort. The termination of a launch sequence in an unplanned manner or the failure of the launch vehicle to liftoff for reasons not immediately known.

Launch area. The facility or location where launch vehicles and payloads are processed and launched; includes any supporting sites; also known as *launch head*. The launch area extends to the over-water areas used during submarine-launched ballistic missile intercontinental ballistic missile tests and launches where the range controls the launch for countdown.

Launch area safety. Safety requirements involving risks limited to personnel and/or property located on the launch base; involves multiple commercial users, government tenants, or United State Space Force SLD commanders; this is the on-base component of public safety.

Launch complex. A defined area that supports launch vehicle or payload operations or storage; includes launch pads and/or associated facilities.

Launch complex safety. Safety requirements involving risk that is limited to personnel and/or property located within the well-defined confines of a launch complex, facility, or group of facilities; for example, within the fence line; involves risk only to those personnel and/or property under the control of the control authority for the launch complex, facility, or group of facilities.

Launch processing. All preflight preparation of a launch vehicle at a launch site, including buildup of the launch vehicle, integration of the payload, and fueling.

Launch site. The specific geographical location from which a launch takes place.

Launch vehicle. A vehicle that carries and/or delivers a payload to a desired location; a generic term that applies to all vehicles that may be launched from the Eastern and Western ranges, including but not limited to airplanes; all types of space launch vehicles; manned space vehicles; missiles; rockets and their stages; probes, aerostats, and balloons; drones; remotely piloted vehicles; unmanned aerial systems: projectiles, torpedoes, and air-dropped bodies.

Lifting device and equipment manager (LDEM). NASA person responsible for overall management of the installation lifting devices and equipment program, coordinating with appropriate personnel at their installation on lifting issues and providing their installation's position on lifting devices and equipment safety issues.

Lead angle. An angle in which the load line is pulled during hoisting. Commonly used to refer to an angle in line with the grooves in the drum or sheaves.

Lead time. The time between the beginning of a process or project and the appearance of its results.

Leak before burst. A failure mode in which it can be shown that any initial flaw will grow through the wall of a pressure vessel or pressurized structure and cause leakage rather than brittle fracture/burst before leak; normally determined at or below maximum operating pressure.

Limit load. The calculated maximum loads to which a structure may be subjected during its lifetime of service; i.e., the applied load (static or dynamic) multiplied by applicable load amplification factors; see *limit load (design load)*.

Lines. The tubular pressure components of a pressurized system provided as a means for transferring fluids between components of the system.

Loading spectrum. A representation of the accumulated loadings anticipated for the structure under all expected operating environments; significant transportation and handling loads are included.

Local safety authority. Approving organization designated and authorized to make safety decisions for a specific facility or launch site (i.e., Range Safety, LSP S&MA, PPF Safety, etc.).

Major leak or spill. A leak or spill that could affect regions beyond the immediate work area, constitute a hazard to personnel, or involve damage to facilities or equipment; a major leak or spill is more than one gallon.

Major mishap. An event or incident that has the potential of resulting in a fatality or major damage such as the loss of a processing facility, launch complex, launch vehicle, or payload.

Mandatory (in reference to instrumentation or capability). A system that must be made operationally ready to support Range Safety and be fully mission capable before entering the plus count. (in reference to instrumentation or capability)

Margin of safety. The percentage by which the allowable load (stress) exceeds the limit load (stress) for specific design conditions; Yield Margin of Safety = [(Yield Strength/Limit Load Stress) x (Yield Factor of Safety)] - 1; Ultimate Margin of Safety = [(Ultimate Strength/Limit Load Strength) x (Ultimate Factor of Safety)] – 1.

Marginal hazard. A hazardous condition causing a mishap that results in one or more of the following: injury or occupational illness resulting in one or more lost workday(s), reversible moderate environmental impact, or facility, ground, or flight equipment loss equal to or exceeding $100,000 but less than $1,000,000.

Materials, brittle. Those materials that undergo little plastic tensile or shearing deformation before rupture; see also *ductile behavior*.

Materials, ductile. Those materials that undergo considerable plastic tensile or shearing deformation before rupture and have sufficient notch toughness to fracture in a ductile manner at operating temperatures and under impact loading; see *ductile behavior* in this volume and ***Mechanics of Materials*** in References.

Maximum allowable working pressure (MAWP). The maximum gauge pressure permissible at the top of a completed vessel in its operating position for a designated temperature. This pressure is based on calculations for every element of the vessel using nominal thickness exclusive of allowances for corrosion and thickness required for loading other than pressure. It is the same as the design pressure for all cases where separate calculations are not made to determine MAWP. The MAWP is the basis for the pressure setting of the pressure relieving devices protecting the vessel.

Maximum expected operating pressure (MEOP). Is synonymous with maximum operating pressure.

Maximum operating pressure (MOP) (MEOP). The maximum service pressure at which the system or component actually operates in a particular application. MOP is synonymous with MEOP (Maximum Expected Operating Pressure) or maximum working pressure. MOP includes the effects of temperature, transient peaks, vehicle acceleration, and relief valve tolerance.

Megger. High voltage resistance meter.

Minor leak or spill. A leak or spill that does not affect regions beyond the immediate work area, constitute a hazard to personnel, or involve damage to facilities or equipment; a minor leak or spill is less than one gallon.

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

Mis-mating. The installation of incompatible connectors or non-compatible components.

Missile System Prelaunch Safety Package. A data package demonstrating compliance with the system safety requirements of Volume 3, serves as a baseline for safety related information on the system throughout its life cycle; now known as the Safety Data Package (SDP).

Monitor circuit. A circuit used to verify the status of a system, such as an inhibit directly; control circuits can be monitored but they cannot serve as a monitor circuit.

Nationally recognized testing laboratory. See *testing laboratory (nationally recognized)*.

Negligible hazard. A hazardous condition causing a mishap that results in one or more of the following: injury or occupational illness not resulting in a lost workday, minimal environmental impact, or facility, ground, or flight equipment loss less than $100,000.

No-fire current. The maximum direct current or radio frequency energy at which an electroexplosive initiator shall not fire with a reliability of 0.999 at a confidence level of 95 percent as determined by a Bruceton test and shall be capable of subsequent firing within the requirements of performance specifications.

Noncompliance. A noticeable or marked departure from requirements, standards, or procedures; includes equivalent level of safety determinations (formerly meets intent certifications), and waivers.

Noncritical hardware. Equipment and systems used for standard industry use; equipment or systems that are determined not to be hazardous, of high value, or safety critical.

Non-essential personnel. Those persons not deemed launch-essential or neighboring operations personnel; includes the general public, visitors, the media, and any persons who can be excluded from Safety Clearance Zones with no effect on the operation or parallel operations.

Non-incendive. Will not ignite group of gases or vapors for which it is rated. Similar to *intrinsically safe* but does not include failure tolerance ratings; used in rating electrical products for Class I, Division 2 locations only.

Nuclear Flight Safety Officer (NFSO). The person in the Office of Safety and Mission Assurance responsible for assisting the mission directorates and Centers in meeting the nuclear flight safety requirements.

Chief of Safety. The range office headed by the Chief of Safety; this office ensures that the Range Safety Program meets range and Range User needs and does not impose undue or overly restrictive requirements on a program.

Operating environment. An environment that a launch vehicle component will experience during acceptance testing, launch countdown, and flight; includes shock, vibration, thermal cycle, acceleration, humidity, and thermal vacuum.

Operation. A scheduled activity where range assets are necessary to support Range User requirements for a specified time period.

Operations safety plan. The detailed safety procedures used for missile operations; these plans are written by the Range Contractor and Operations Safety; includes Explosives Safety Plans, Facility Safety Plans, and Safety Operational Plans.

Optical coverage ratio. The percentage of the surface area of the cable core insulation covered by a shield.

Ordnance. All ammunition, demolition material, solid rocket motors, liquid propellants, pyrotechnics, and explosives as defined within DESR 6055.09_AFMAN 91-201, Explosive Safety Standards.

Ordnance component. A component such as a squib, LOS, detonator, initiator, igniter, or linear shape charge in an ordnance system.

Ordnance operation. Any operation consisting of shipping, receiving, transportation, handling, test, checkout, installation and mating, electrical connection, render safe, removal and demating, disposal, and launch of ordnance.

Passive component. A flight termination system component that does not contain active electronic piece parts such as microcircuits, transistors, and diodes: includes, but need not be limited to, radio frequency antennas, radio frequency couplers, and cables and rechargeable batteries, such as nickel cadmium batteries.

Planetary Protection Officer (PPO). The person in the NASA Office of Safety and Mission Assurance responsible for assisting the mission directorates and Centers in meeting NASA planetary protection program requirements in accordance with NPR 8715.24 Planetary Protection Provisions for Robotic Extraterrestrial Missions and NASA-STD-8719.27 Implementing Planetary Protection Requirements for Space Flight.

Payload. The object(s) within a payload fairing carried or delivered by a launch vehicle to a desired location or orbit.

Payload processing facility and launch site area. The areas and support facilities (such as payload processing facilities and launch pad) where the payload is processed, stored, or transported in support of final payload processing, payload to launch vehicle integration, and launch.

Payload safety working group (PSWG). A working group formed for each NASA Payload with a primary purpose to (1) ensure a project's compliance with applicable safety requirements and (2) that the safety risk is identified, understood, and adequately controlled.

Performance specification. A statement prescribing the particulars of how a component or part is expected to perform in relation to the system that contains the component or part; includes specific values for range of operation, input, output, or other parameters that define the component's or part's expected performance.

Personnel work platforms. Platforms used to provide personnel access to flight hardware at off-pad processing facilities as well as at the launch pad; they may be removable, extendible, or hinged.

Pneumatic. Operated by air or other gases under pressure.

Pneumatic test. A test of a pressure vessel or system in which a gas is introduced and pressurized to a designated level in a manner prescribed in the applicable code. (Reference Paragraph UG-100, ASME Code, Section VIII, Division 1, or Part 8 Paragraph 8.3, ASME Code, Section VIII, Division 2, and Paragraph 345.5, ASME B31.3.)

Populated area. An outdoor location, structure, or cluster of structures that may be occupied by people; sections of roadways and waterways that are frequented by automobile and boat traffic are populated areas; agricultural lands, if routinely occupied by field workers, are also populated areas.

Positive control. The continuous capability to ensure acceptable risk to the public is not exceeded throughout each phase of powered flight or until orbital insertion.

Power source. (1) A battery; (2) the point of direct current (DC) to alternating current (AC) conversion for capacitor charged systems.

Pressure component. a component such as lines, fittings, valves, regulators, and transducers in a pressurized system; normally pressure vessels or pressurized structures are excluded, because of the potential energy contained; they generally require additional analysis, test and inspection.

Pressure system. Any system above 0 psig that is classified as follows: low pressure, 0 to 500 psi; medium pressure, 501 to 3000 psi; high pressure, 3001 to 10,000 psi; ultra-high pressure, above 10,000 psi. The degree of hazard of a pressure system is proportional to the amount of energy stored, not the amount of pressure it contains; therefore, low pressure, high volume systems can be as hazardous to personnel as high pressure systems; see *pressurized system*.

Pressure vessel. A container that stores pressurized fluids and (1) contains stored energy of 14,240 foot pounds (19,130 joules) or greater based on adiabatic expansion of a perfect gas; or (2) contains gas or liquid which will create a mishap (accident) if released; or (3) will experience a MOP greater than 100 psia; excluded are special equipment including batteries, cryostats (or dewars), heat pipes, and sealed containers; or (4) per the ASME definition, summarized briefly;

pressure containers that are integral pumps or compressors, hot water heaters and boilers, vessels pressurized in excess of 15 psi (regardless of size), and vessels with a cross-sectional dimension greater than 6 inches (regardless of length of the vessel or pressure).

Pressurized structure. A structure designed to carry both internal pressure and vehicle structural loads; the main propellant tank of a launch vehicle is a typical example.

Pressurized system. A system that consists of pressure vessels or pressurized structures, or both, and other pressure components such as lines, fittings, valves, and bellows that are exposed to and structurally designed largely by the acting pressure; electrical or other control devices required for system operation are not included; a pressurized system is often called a pressure system; see pressure system.

Program. The coordinated group of tasks associated with the concept, design, manufacture, preparation, checkout, and launch of a launch vehicle and/or payload to or from, or otherwise supported by the Eastern or Western ranges and the associated ground support equipment and facilities.

Proof factor. A multiplying factor applied to the limit load or maximum expected operating environment to obtain proof load or proof pressure for use in the acceptance testing.

Proof pressure. The proof pressure is the test pressure that pressurized components shall sustain without detrimental deformation. The proof pressure is used to give evidence of satisfactory workmanship and material quality, and/or establish maximum initial flaw sizes. It is equal to the product of maximum expected operating pressure, proof pressure design factor, and a factor accounting for the difference in material properties between test and design temperature.

Propellant storage tank. Any container of propellants greater than one gallon. Application of the requirements of this document to storage tanks will normally vary with the size of the tank and associated hazards. Containers less than one gallon will also be subject to operational controls, as appropriate, as would any container of flammable liquid.

Public. All persons not in the launch essential personnel category; see also *neighboring operations personnel* and *general public*.

Public safety. Safety involving risks to the general public of the US or foreign countries and/or their property (both on- and off-base); includes the safety of people and property that are not involved in supporting a launch along with those that may be within the boundary of a launch site.

Qualification tests. The required tests conducted under specified conditions, by, or on behalf of the government, using items representative of the production configuration in order to determine compliance with item design requirements as a basis for production approval.

Radiation source. Materials, equipment, or devices that generate or are capable of generating ionizing radiation including naturally occurring radioactive materials, by-product, source materials, special nuclear materials, fission products, materials containing induced or deposited radioactivity, nuclear reactors, radiographic and fluoroscopic equipment, particle generators and accelerators, radio frequency generators such as certain klystrons and magnetrons that produce X-rays, and high voltage devices that produce X-rays.

Rf silence. A period of time where radio frequency (RF) transmitters/emitters, either fixed-in-place or transient, are prohibited from emitting RF energy in a specified area. It is acceptable for approved RF transmitter/emitter to be located outside of this zone and emit RF energy.

Radioactive material. Materials that generate, or are capable of generating, ionizing radiation including naturally occurring radioactive materials, by-product materials, source materials, special nuclear materials, fission products, materials containing induced or deposited radioactivity, and nuclear reactors.

Range or ranges. In this publication, range or ranges refers to the Eastern Range at Cape Canaveral Space Force Station, Kennedy Space Center, and Patrick Space Force Base, and the Western Range at Vandenberg Space Force Base.

Range safety program. A program implemented to ensure that launch and flight of launch vehicles and payloads present no greater risk to the general public than that imposed by the over-flight of conventional aircraft; such a program also includes launch complex and launch area safety and protection of national resources.

Range safety representative. A government employee or member of the US Space Force assigned to the SLD 30/45 /Range Safety office or a contractor employee designated and authorized by SLD 30/45/Range Safety to act on behalf of the organization.

Rated load. An assigned weight that is the maximum load the device or equipment shall operationally handle and maintain. This value is marked on the device indicating maximum working capacity. This is also the load referred to as "safe working load" or "working load limit." If the device has never been downrated or uprated, this also is the "manufacturer's rated load."

Recertification file. A file that contains data showing that a specific piece of material handling equipment/material ground support equipment meets the periodic test and inspection requirements of this document.

Redundant. A situation in which two or more independent means exist to perform a function.

Referee fluid. A compatible fluid, other than that used during normal system operations, that is used for test purposes because it is safer due to characteristics such as less (or non-) explosive, flammable, or toxic and/or easier to detect.

Remote control. Control of a system from a remote and safe location.

Render safe. An action to bring to a safe condition.

Required (in reference to instrumentation or capability). A system that must be made operationally ready to support Range Safety.

Residual stress. The stress that remains in a structure after processing, fabrication, assembly, testing, or operation; for example, welding induced residual stress.

Resource safety. The protection of facilities, support equipment, or other property from damage due to mishaps; also known as resource protection.

Rest period. The period of time immediately prior to the beginning of the duty period; for launch-essential personnel, it is mandatory that the rest period include the time necessary for meals, transportation, and 8 hours of uninterrupted rest prior to reporting for duty. Rest periods in preparation for launch operations will start no earlier than 2 hours after the assigned personnel are released from an earlier launch or range operations. Only the Chief of Safety or the SLD Commander has the authority to waive the safety rest period requirements for Mission Ready (Category A) personnel; see also *crew rest*.

Reusable launch vehicle. Launch vehicle that is designed to return to earth substantially intact and therefore may be launched more than one time or that contains vehicle stages that may be recovered by a launch service provider for future use in the operation of a substantially similar launch vehicle.

Risk. A measure that takes into consideration both the probability of occurrence and the consequence of a hazard to a population or installation. Risk is measured in the same units as the consequence such as number of injuries, fatalities, or dollar loss. For Range Safety, risk is expressed as casualty expectation or shown in a risk profile; see also *collective risk* and *individual risk.*

Risk analysis. A study of potential risk.

Safe and arm device (S&A). A device that provides mechanical interruption (safe) or alignment (arm) of the explosive train and electrical interruption (safe) or continuity (arm) of the firing circuit.

Safety clearance zones. The restricted areas designated for day-to-day prelaunch processing and launch operations to protect the public, launch area, and launch complex personnel; these zones are established for each launch vehicle and payload at specific processing facilities, including launch complexes; includes hazard clearance area and hazardous launch area.

Safety critical. A term applied to a condition, event, operation, process, or item whose mishap severity consequence is either Catastrophic or Critical (e.g., safety-critical function, safety-critical path, and safety-critical component).

Safety-critical function (SCF). A function whose failure to operate or incorrect operation will directly result in a mishap of either Catastrophic or Critical severity.

Safety-critical item (SCI). A hardware or software item that has been determined through analysis to potentially contribute to a hazard with Catastrophic or Critical mishap potential, or that may be implemented to mitigate a hazard with Catastrophic or Critical mishap potential. The definition of the term "safety-critical item" in this Standard is independent of the definition of the term "critical safety item" in Public Laws 108-136 and 109-364.

Safety critical procedure. A designation for a particular type of Range User procedure; a document containing steps in sequential order used to reliably process safety critical systems or conduct safety critical operations; non-hazardous safety critical procedures have no specific content requirements but do require Range Safety review and approval.

Safety critical software. Is defined, in accordance with NASA-STD-8739.8, NASA Software Assurance and Software Safety Standard, as software that meets at least one of the following criteria: (a) causes or contributes to a system hazardous condition/event, b) provides control or mitigation for a system hazardous condition/event, c) controls safety-critical functions, d) mitigates damage if a hazardous condition/event occurs, e) detects, reports, and takes corrective action if the system reaches a potentially hazardous state.

Safety device. Also known as safety feature or safety control. A safety device is levied on the system design to control the cause of an identified hazard or to mitigate the effect of the hazard. As a result, the probability and/or severity of a hazard can be reduced to an acceptable level. Safety devices can take numerous forms in a design. No matter what form a safety device takes, its purpose is to prevent an undesirable (hazardous) event from occurring. Safety devices may be wholly or partly mechanical, electrical, or software in nature. A safety device may inherently be part of the system or be specifically added to a system. Safety devices may include the following: (1) Barriers - a physical means to keep personnel away from hazardous energy or to contain/deflect hazardous energy if it were released. (2) Fail-safe design - a design feature in which a system reacts to a failure by switching to or maintaining a safe operating mode that may include system shutdown. (3) Inhibit - a device that prevents system operation if a predetermined condition is not satisfied. (4) Interlock - a device that may be inserted into the system to prevent system operation (often used in maintenance). (5) Interrupt - a device that disrupts system operation if a predetermined condition is violated. (6) Redundancy/fault tolerance - the built-in ability of a system to provide continued correct operation in the presence of a specific number of faults or failures. (7) Special system features - systems or devices, such as fire suppression and hazardous gas detection, which control and/or warn of system hazards.

Safety factor. For pressure systems, the ratio of design burst pressure over the maximum allowable working pressure or as design pressure; for mechanical systems, it can also be expressed as the ratio of tensile or yield strength over the maximum allowable stress of the material.

Safety holds. The hold-fire capability, emergency voice procedures, or light indication system of each launch system used to prevent launches in the event of loss of Range Safety critical systems or violations of mandatory Range Safety launch commit criteria.

Safing procedures. The process of taking a system that is in a hazardous configuration and performing those tasks necessary to bring it to a condition which is safe for further activities; safing procedures are part of the backout procedures for a system.

Separate power source. A dedicated and independent source of power.

Service life. (1)The total life expectancy of a part or structure; service life starts with the manufacture of the structure and continues through all acceptance testing, handling, storage, transportation, operations, refurbishment, retesting, and retirement; (2) The period of time between the initial lot acceptance testing and the subsequent age surveillance testing for ordnance.

Shall. as used in requirements documents, denotes a mandatory action.

Shield (RF). a metallic barrier that completely encloses a device for the purpose of preventing or reducing induced energy.

Should. As used in requirements documents, denotes a good practice and is recommended, but not required.

Single failure point. An independent element of a system (hardware, software, or human) the failure of which would result in loss of objectives, hardware, or crew; in general, a component that, if failed, could lead to the overall failure of the system (for example, in a mechanical system, a component such as a lug, link, shackle, pin, bolt, rivet, or a weld that, if failed, could cause a system inability to support a load using load path analysis).

Single point ground. The one interconnection for a grounded circuit with other circuits.

Single point of contact. The Range User's one point of contact for range operations.

Sling. A lifting assembly and associated hardware used between the actual object being lifted (load) and the hoisting device hook.

Soft goods. The nonmetal materials in a pressure system that are used to form a seal or seat for metal-to-metal contact or between other hard surfaces.

Software design description. A representation of a software system created to facilitate analysis, planning, implementation, and decision-making; a blueprint or model of the software system; used as the primary medium for communicating software design information.

Space launch delta commander. In this document, the term Space Launch Delta Commander refers exclusively to the commanders of Space Launch Delta 30 and Space Launch Delta 45; the term Range Commander refers to the commander of the Eastern or Western Range in accordance with Department of Defense Directive 3200.11 and is the same individual as the Space Launch Delta Commander; the terms Range Commander and Spacelift Commander refer to tasks or functions performed by the Space Launch Delta Commander.

Space launch delta safety. The Space Launch Delta organization is responsible for launch and range safety functions; headed by the Space Launch Delta Chief of Safety; this office ensures that the Launch and Range Safety Program meets range and range user needs and does not impose undue or overly restrictive requirements on a program; also known as Range Safety.

Space systems command. A United States Space Force organization that develops and acquires space launch vehicles, satellites, and range systems for the United States Space Force.

Standard operating procedure (SOP). A procedure prepared for operation of a facility or performance of a task on a routine basis.

Stress-corrosion cracking. A mechanical-environmental induced failure process in which sustained tensile stress and chemical attack combine to initiate and propagate a crack or a crack-like flow in a metal part.

Stress intensity factor. A parameter that characterizes the stress-strain behavior at the tip of a crack contained in a linear elastic, homogeneous, and isotropic body.

Structural component. A component such as a bolt, lug, hook, shackle, pin, rivet, or weld in a piece of material handling equipment.

Surface inspection. A nondestructive examination method, other than visual, used for detection of surface and near surface discontinuities.

Structural sling. A rigid or semi-rigid fixture that is used between the actual object being lifted and hoisting device hook (e.g., spreader bars, equalizer bars, and lifting beams).

System hazard. A hazard associated with a hardware system and that generally exists even when no operation is occurring; system hazards that may be found at a launch site include, but are not limited to, explosives and other ordnance, solid and liquid propellants, toxic and radioactive materials, asphyxiants, cryogens, and high pressure.

System Safety Plan. A written plan defining the approach to accomplish the project safety activities, including safety management, identification of safety tasks, roles and responsibilities, and the coordination and communication with project/systems engineers and approving authorities. It is also known the System Safety Program Plan defined in USSF SSCMAN 91-710, Range Safety User Requirements.

Telemetry. Vehicle systems measurements made available to ground based users via S-band downlinks.

Testing laboratory (nationally recognized). Laboratories such as Underwriters Laboratories, Inc., or Factory Mutual Engineering Corporation, that use nationally recognized testing standards and provide bench mark(s) to certified products as evidence of successful testing.

Threshold limit value. Time weighted average concentrations that must not be exceeded during any 8-hour work shift of a 40-hour work week as determined the American Conference of Governmental Industrial Hygienists.

To safe. To bring to a safe condition.

Toxic hazard zone. A generic term that describes an area in which predicted concentration of propellant or toxic byproduct vapors or aerosols may exceed acceptable tier levels; predictions are based on an analysis of potential source strength, applicable exposure limit, and prevailing meteorological conditions; toxic hazard zones are plotted for potential, planned, and unplanned propellant releases, and launch operations.

Ultimate load. The product of the limit load and the design ultimate load factor. It is the load that the structure must withstand without rupture or collapse in the expected operating environment.

Ultimate strength. The maximum stress developed by the material before rupture, based on the original area, in tension, compression, or shear; see ***Modern Steels and Their Properties, Carbon and Alloy Steel Bars and Rods*** in References.

Vehicle. Launch vehicle and/or payload.

Visible damage. For composite pressure vessels, Anomalies that are visible to the naked eye under not less than 15-foot candles at a distance no greater than 24 inches and no less than a 30 degree angle. Lighting up to 50-foot candles may be used for the detection or study of small anomalies.

Waiver. A variance that authorizes departure from a specific safety requirement where a certain level of risk has been documented and accepted; a designation used when, through an error in the manufacturing process or for other reasons, a hardware noncompliance is discovered after hardware production, or an operational noncompliance is discovered after operations have begun at the Eastern or Western ranges.

Western range. Part of the National Launch Range facilities, operated by Space Launch Delta 30, United States Space Force, Space Systems Command, and located at Vandenberg Space Force Base, California; the range includes the operational launch and base support facilities located at Vandenberg Space Force Base and those radar tracking sites and ground stations located on sites up-range and downrange along the Pacific Coast, including United States Navy facilities at Point Mugu.

Yield factor of safety. See *factor of safety, yield*.

Yield point. See *yield strength*.

Yield strength. The stress at which there is an appreciable increase in strain with no increase in stress; typically defined as the stress that will induce a specified permanent set (yield point, usually 0.2 percent strain offset); see ***Mechanics of Materials*** **and** ***Modern Steels and Their Properties, Carbon and Alloy Steel Bars and Rods*** in References.