NASA TECHNICAL STANDARD National Aeronautics and Space Administration Washington, DC 20546	**ANNEX Revision A to NASA-STD-8719.24** Approved: 2015-09-30 Superseding: NASA-STD-8719.24 Annex with Change 2

ANNEX TO NASA-STD 8719.24
NASA EXPENDABLE LAUNCH VEHICLE PAYLOAD SAFETY REQUIREMENTS:

REQUIREMENTS TABLE

Measurement System Identification:
Metric (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 electric 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.

FOREWORD

This Annex to NASA-STD 8719.24 is published by the National Aeronautics and Space Administration (NASA) as the template and starting point for developing project range safety requirements. This Annex provides technical safety requirements for unmanned orbital and unmanned deep space payloads that fly onboard Expendable Launch Vehicles (ELVs). The requirements contained in this Annex to NASA-STD 8719.24 were developed jointly by NASA and U.S. Air Force Range Safety representatives (30th and 45th Space Wings) using Air Force Space Command Manual (AFSPCMAN) 91-710, Range Safety User Requirements, and NASA safety standards. The requirements of this document comply with the requirements of AFSPCMAN 91-710 and are acceptable to NASA and the Air Force ranges. As such, they provide a streamlined starting point for the safety requirements tailoring process. These requirements are provided in a matrix format that was developed to facilitate project-specific tailoring of the safety requirements for each NASA ELV payload project.

Requests for information, corrections, or additions to this publication should be submitted to the National Aeronautics and Space Administration, Director, Safety and Assurance Requirements Division, Office of Safety and Mission Assurance, Washington, DC 20546 or via "Feedback" in the NASA Standards and Technical Assistance Resource Tool at http://standards.nasa.gov.

Terrence W. Wilcutt
Chief, Safety and Mission Assurance

9/30/2015
Approval Date

TAILORED REQUIREMENTS FOR PROJECT *Name*

From: NASA-STD-8719.24
Annex Rev. A



Logo

PROJECT NAME XXX

XX Month 201X
Revision: *X*

PROJECT NAME SAFETY REQUIREMENTS

Prepared for: *NASA Center* **Under contract:** *Contract Number*

Prepared by:

Company's Name
Company's Address
Company's Phone Number

_____
Prepared by *(Name)*
Preparer Title
Organization
Date: _____

_____
Name
Project Manager
NASA Center
Date: _____

_____
Name
Project SMA Technical Authority
NASA Center
Date: _____

_____
Name
Launch Services Program SMA Technical Authority
NASA Center
Date: _____

_____
Name
Range Safety Authority
Organization
Date: _____

_____
Name
Payload Safety Working Group Chairperson
NASA Center
Date: _____

FOREWORD

The Original Text column of the following requirements matrix contains the NASA Expendable Launch Vehicle (ELV) payload safety requirements that are to be tailored for each NASA ELV payload project, as required by NPR 8715.7, "Expendable Launch Vehicle Payload Safety Program." The NASA ELV payload safety requirements are the result of a joint effort by NASA and U.S. Air Force Range Safety representatives (30th and 45th Space Wings) to establish an approved baseline from AFSPCMAN 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 ELV payload safety requirements apply to all NASA ELV payload projects launched from an Air Force, NASA, or other range/launch site.

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

The NASA ELV payload safety requirements (as tailored for each specific project) are mandatory for each NASA ELV 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 Air Force, NASA, or other organizations participating in a NASA ELV payload project. As outlined in ASPCMAN 91-710, the Space Wing Commanders have overall launch authority and responsibility for public safety at Air Force ranges. The Director, NASA Wallops Flight Facility has similar authority and responsibility for launches originating from Wallops Flight Facility.

AFSPCMAN 91-710 requirements not applicable to NASA ELV payloads were eliminated from the following NASA ELV payload safety requirements tailoring matrix. This results in irregular numbering of paragraphs where certain paragraph(s) may appear to be skipped or missing because they were not applicable. Additionally, in some cases entire inapplicable volumes or chapters may be missing and are not included in the tailoring matrix. The absence of these requirements does not alter the Air Force Range Safety authority. The project may add back any AFSPCMAN 91-710 requirements that are pertinent to their project upon agreement by the project's Payload Safety Working Group (PSWG) and 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 ELV 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 ELV Payload Safety Manager is responsible for maintaining and keeping the NASA ELV payload safety requirements current and coordinating all changes with the NASA ELV Payload Safety Agency Team and the Air Force Range Safety 30th and 45th Space Wing Safety Offices. The NASA ELV Payload Safety Manager contact information and the NASA ELV payload safety requirements tailoring matrix are available on the NASA ELV Payload Safety Program website at: http://kscsma.ksc.nasa.gov/ELVPayloadSafety.

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

TABLE OF CONTENTS[1]

VOLUME 1: POLICIES AND PROCEDURES 13

CHAPTER 1 INTRODUCTION 13
1.1 Objective 13
1.2 Applicability 14
1.3 Basis for the Requirements 15

CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES 16
2.1 General 16
2.2 Headquarters Air Force Space Command Responsibilities 16
2.3 Space Wing Responsibilities 16
2.4 Federal Aviation Administration Responsibilities 17
2.5 Payload Project Responsibilities 17

CHAPTER 3 RANGE SAFETY POLICY 19
3.1 General 19
3.2 Prelaunch and Launch Operations: 19
3.3 Launch Area Safety 19
3.4 Launch Complex Safety 21

CHAPTER 4 PSWG and RANGE SAFETY PROCESSES 22
4.1 Range Safety and Payload Projects Interface Process 22
4.6 Equivalent Level of Safety (ELS) Determinations and Waivers 22

CHAPTER 5 SAFETY AUTHORIZATIONS, SAFETY APPROVALS, AND DOCUMENTATION 24
5.1 General 24

CHAPTER 6 INVESTIGATING AND REPORTING MISHAPS AND INCIDENTS 25
6.1 Mishaps and Incidents Involving Air Force Personnel and Resources 25
6.2 Non-Air Force Personnel and Resources on Air Force Property 25
6.3 Reporting Space Launch System Anomalies 25

CHAPTER 7 CHANGES TO THIS PUBLICATION 26

ATTACHMENT 1 THE NASA ELV PAYLOAD SAFETY REQUIREMENTS TAILORING PROCESS 27
A1.1 Introduction: 27
A1.2 Tailoring Process 29

[1] This document follows the paragraph numbering used in AFSPCMAN 91-710 for applicable payload requirements. AFSPCMAN 91-710 requirements that are not applicable to NASA ELV payloads were eliminated, which resulted in an irregular numbering of paragraphs. In some cases, entire inapplicable volumes or chapters were not included in this document.

ATTACHMENT 2 SYSTEM SAFETY PROGRAM REQUIREMENTS....32
A2.1 Introduction....32
A2.2 System Safety Program Tasks....32

ATTACHMENT 3 SUBMITTING NONCOMPLIANCE REQUESTS....44
A3.1 Introduction....44
A3.2 Submitting Noncompliance Requests....45

ATTACHMENT 4 ACCEPTABLE RISK CRITERIA....47
A4.1 Introduction....47

ATTACHMENT 5 PAYLOAD SAFETY INTRODUCTION BRIEFING....48
A5.1 Introduction....48
A5.2 Payload safety introduction briefing (PSIB)....48

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS....50

CHAPTER 1 INTRODUCTION....50
1.1 General....50
1.2 Organization of the Volume....50

CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES....52
2.1 Payload Safety Working Group (PSWG)....52
2.2 Payload Project Responsibilities.....52

CHAPTER 3 GENERAL DESIGN POLICY....54
3.1 General....54
3.2 Systems Without Specific Design Criteria....54

CHAPTER 4 DOCUMENTATION REQUIREMENTS....55
4.1 System Safety Plan Hazard Analyses....55
4.2 Safety Data Package (SDP) (MSPSP)....55
4.3 SDP Associated Test Plans and Test Results....56
4.4 Nondestructive Examination Plans....56

CHAPTER 6 MATERIAL HANDLING EQUIPMENT AND PERSONNEL WORK PLATFORMS....58
6.1 Material Handling Equipment....58
6.3 Removable, Extendible, and/or Hinged Personnel Work Platforms....67
6.4 Lifting Personnel with a Crane....68
6.5 Flight Hardware Used to Lift Critical Loads and Clampbands....68

CHAPTER 7 ACOUSTIC HAZARDS....70
7.1 Acoustic Design Standards....70
7.2 Acoustic Data Requirements....70

CHAPTER 8 NON-IONIZING RADIATION SOURCES....71
8.1 Radio Frequency Emitters....71

8.2 Laser Systems 73

CHAPTER 9 RADIOACTIVE (IONIZING) RADIATION SOURCES 78
9.1 Radioactive Source Design Standards and Controls 78
9.2 Radioactive Sources Carried on Payloads 79

CHAPTER 10 HAZARDOUS MATERIALS 82
10.1 Hazardous Materials Selection Criteria 82
10.2 Hazardous Materials Test Requirements 82
10.3 Hazardous Materials Environmental Requirements 83
10.4 Hazardous Materials Data Requirements 83
10.5 Process Safety Management and Risk Management Plan 83

CHAPTER 11 GROUND SUPPORT PRESSURE, VACUUM, AND HAZARDOUS STORAGE SYSTEMS 84
11.1 Ground Support Pressure Vacuum and Storage Systems Requirements 84
11.2 Ground Support Pressure Systems Requirements 84
11.3 Ground Support Pressure Systems Certification and Recertification 119

CHAPTER 12 FLIGHT HARDWARE PRESSURE SYSTEMS AND PRESSURIZED STRUCTURES 124
12.1 Flight Hardware Pressure System and Pressurized Structure General Requirements 124
12.2 Flight Hardware Pressure Vessel Design, Analysis, and Test Requirements 147
12.4 Flight Hardware Special Pressurized Equipment Design, Analysis, and Test Requirements 161
12.5 Flight Hardware Pressure System Component Design and Test Requirements 167
12.6 Flight Hardware Pneumatic System Design Requirements. 179
12.7 Flight Hardware Hydraulic System Design and Test Requirements. 182
12.8 Flight Hardware Hypergolic Propellant System Design and Test Requirements 184
12.9 Flight Hardware Cryogenic Systems Design and Test Requirements 187
12.10 Flight Hardware Pressure Systems Data Requirements 192

CHAPTER 13 ORDNANCE SYSTEMS 195
13.1 Ordnance Hazard Classification 195
13.2 Ordnance System General Requirements 196
13.3 Ordnance Electrical Circuits 197
13.4 Initiator Electrical Circuits 201
13.5 Ordnance Safety Devices 202
13.6 Ordnance Initiating Devices 209
13.7 Explosive Transfer Systems and Receptor Ordnance 213
13.8 Ordnance Test Equipment 214
13.9 Ordnance and Non-Explosive Initiator Data Requirements 216

CHAPTER 14 ELECTRICAL AND ELECTRONIC EQUIPMENT 217
14.1 Electrical and Electronic Ground Support Equipment and Flight Hardware General Design Requirements and Standards 217
14.2 EGSE Design Requirements 222
14.3 Electrical and Electronic Flight Hardware 227

CHAPTER 15 MOTOR VEHICLES 230
15.1 General 230
15.2 Motor Vehicles Other Than Lift Trucks 230
15.3 Lift Trucks 231

CHAPTER 16 COMPUTER SYSTEMS AND SOFTWARE 233
16.1 General 233
16.2 Determination of Safety Critical Computer System Functions 234
16.3 Hardware and Software Safety Design Requirements 234
16.4 Software Requirements 238
16.5 Computer System and Software Data Requirements 240

CHAPTER 17 WESTERN RANGE SEISMIC DESIGN 241
17.1 Applicability of Design and/or Anchorage or Restraint Requirements 241
17.2 Basis for Design 241
17.3 WR Seismic Data Requirements 243
17.4 Earthquake Emergency Planning and Post Recovery Response 243

CHAPTER 18 SOLID ROCKET MOTORS, ROCKET MOTOR SEGMENTS, AND ROCKET MOTOR COMPONENTS 244
18.1 General 244
18.2 Failure Modes, Effects, and Criticality Analysis (FMECA) and Operational Hazards Analysis (OHA) 244
18.3 Lightning Effects Hazard Analysis 244
18.4 Solid Rocket Motor and Motor Segment Data Requirements 244

ATTACHMENT 1 SAFETY DATA PACKAGE (MISSILE SYSTEM PRELAUNCH SAFETY PACKAGE) 245
A1.1 Introduction 245
A1.2 Preparation Instructions 245
A1.4 Modifications to the Safety DATA PACKAGE (SDP) 273

ATTACHMENT 2 HANDLING STRUCTURES INITIAL AND PERIODIC TEST REQUIREMENT FLOW PATH 274

ATTACHMENT 3 HAZARD AREA CLASSIFICATION 279

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS, AND MATERIAL OPERATIONS SAFETY REQUIREMENTS 283

CHAPTER 1 INTRODUCTION 284
1.1 Applicability 284
1.2 Organization of the Volume 284
1.3 Compliance Documents 285

CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES 286
2.1 Payload Safety Working Group 286
2.2 Payload Project Responsibilities 288

CHAPTER 3 GROUND OPERATIONS POLICIES 292
3.1 Personnel Safety 292
3.2 Stopping Unsafe Operations 292

CHAPTER 4 DOCUMENTATION REQUIREMENTS 293
4.1 Ground Operations Plans 293
4.2 Test and Inspection Plans 293
4.3 Safety and Emergency Plans 294
4.4 Procedures 294
4.5 Range User Training Plan 295
4.6 Mishap Reporting 295
4.7 Safety For Return-to Earth Payloads or Sample Returns 296

CHAPTER 5 GROUND OPERATIONS SAFETY REQUIREMENTS 298
5.1 Ground Operations Personnel Requirements 298
5.2 Hazardous Ground Operations General Requirements 300
5.3 Personal Protective Equipment 303
5.4 Fall Protection 304
5.5 Smoking Areas 305
5.6 Operating Restrictions Due to Adverse Weather 306
5.7 Operating Restrictions Due to High Winds 308
5.8 Facility Use 308
5.9 Hazardous Operation Support Requirements 310

CHAPTER 6 MATERIAL HANDLING EQUIPMENT, CRANE AND HOIST, PERSONNEL PLATFORM, POWERED INDUSTRIAL TRUCK, AND ELEVATOR OPERATIONS 311
6.1 Material Handling Equipment Operations 311
6.2 Crane and Hoist Operations 315
6.3 Personnel Work Platform Operations 322
6.4 Powered Industrial Trucks 323
6.5 Elevator Usage 324

CHAPTER 7 ACOUSTIC HAZARD OPERATIONS 325
7.1 Acoustic Hazard Operating Standards 325
7.2 Acoustic Hazard Operations Personnel Protection Requirements 325
7.3 Acoustic Operations 325

CHAPTER 8 NON-IONIZING RADIATION OPERATIONS 326
8.1 Non-Ionizing Radiation Operating Standards 326
8.2 Radio Frequency Procedures 326
8.3 RF Operations 326
8.4 Optical/Laser Operations 328

CHAPTER 9 RADIOACTIVE (IONIZING) RADIATION SOURCES OPERATIONS 330

CHAPTER 10 HAZARDOUS MATERIALS OPERATIONS 331
10.1 Hazardous Materials Operating Standards 331
10.2 Hazardous Materials Operations Personal Protective Equipment (PPE) 331

10.3 Hazardous Materials Procedures....331
10.4 Hazardous Materials Operations....331
10.5 Restrictions on the Use of Plastic Films, Foams, and Adhesive Tapes (PFAs) and other Static-Producing and Flammable Materials....332
10.6 Hazardous Commodity Lockers....334
10.7 Disposal of Contaminated Liquid Propellant, Gas, or Other Regulated Wastes....334

CHAPTER 11 GROUND SUPPORT AND FLIGHT HARDWARE PRESSURE SYSTEMS OPERATIONS....336
11.1 Pressure Systems Operating Standards....336
11.2 Pressure Systems Personnel Requirements....336
11.3 Pressure Systems Procedures....339
11.4 Pressure Systems Test, Inspection, and Maintenance Requirements....340
11.5 Pressure Systems Operating Requirements....342

CHAPTER 12 RESERVED....353

CHAPTER 13 ORDNANCE OPERATIONS....353
13.1 Ordnance Operations Procedure Requirements....353
13.2 Ordnance Transportation, Receipt, and Storage....353
13.3 Ordnance Systems Grounding....355
13.4 Ordnance Operations....360
13.5 Explosive Ordnance Disposal....367
13.6 Ordnance Facilities Operations....367

CHAPTER 14 ELECTRICAL SYSTEMS OPERATIONS....368
14.1 Electrical Systems Operating Standards and Definitions....368
14.2 Electrical Systems Operations Personnel and Special Insulated Equipment....371
14.3 Electrical Systems Procedures....372
14.4 Electrical Equipment and Systems Test, Inspection, and Maintenance Requirements....372
14.5 Electrical Systems Operating Requirements....374
14.6 Battery Operations....376

CHAPTER 15 MOTOR VEHICLE OPERATIONS....378
15.1 Motor Vehicle Operating Standards....378
15.2 Motor Vehicle Operating Requirements....378

CHAPTER 16 CONVOY OPERATIONS....380
16.1 General....380
16.2 Convoy Operations Procedures....380
16.3 Convoy Operations Requirements....380

CHAPTER 17 LAUNCH OPERATIONS....382

CHAPTER 18 SOLID ROCKET MOTORS AND ROCKET, ROCKET MOTOR SEGMENTS, AND ROCKET MOTOR OPERATIONS....382
18.1 Solid Rocket Motors And Rocket Motor Segments Operations General Requirements....382
18.2 Solid Rocket Motor and Rocket Motor Segment Transportation....382
18.3 Solid Rocket Motor and Rocket Motor Segment Inspections....383

18.4 Solid Rocket Motor and Rocket Motor Segment Processing and Handling 384

ATTACHMENT 1 GROUND OPERATIONS PLANS.....388

A1.1 Introduction.....388
A1.2 Preparation Instructions.....388

ATTACHMENT 2 HAZARDOUS AND SAFETY CRITICAL PROCEDURES 392

A2.1 Introduction.....392
A2.2 Preparation Instructions.....393
A2.3 Examples of Hazardous Procedures.....397
A2.4 Changes.....397

ATTACHMENT 3 INDEX OF OPERATIONS/AREAS SAFETY PLANS.....398

ATTACHMENT 4 INDEX OF EXPLOSIVE (OPERATING AND AREA) SAFETY PLANS 400

ATTACHMENT 5 MISCELLANEOUS SAFETY PLANS.....401

ATTACHMENT 7 LAUNCH COMMIT CRITERIA.....401

VOLUME 7: GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION...402

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 1 INTRODUCTION	I		
1.1 OBJECTIVE The objective of this publication is to establish and enforce NASA ELV payload project requirements to ensure the safety of the public, launch area, payload processing facility, and launch complex personnel and resources and to ensure that all aspects of prelaunch and launch operations adhere to applicable public laws. These safety requirements safeguard people and resources (including flight hardware, ground support equipment (GSE) and facilities) from hazards associated with payloads that will fly on unmanned Expendable Launch Vehicles (ELVs) (i.e. ELV payloads), including hazards associated with payload related GSE. This document is a baseline and shall be tailored for each NASA payload project (mission). The contents of this publication are to be used in conjunction with NASA Procedural Requirements (NPR) 8715.7, Expendable Launch Vehicle Payload Safety Program by the payload project to develop and process their payloads safely throughout the project's life cycle. The requirements of this document comply with the requirements of AFSPCMAN 91-710 and are acceptable to NASA and the Air Force ranges. The Payload Safety Working Group (PSWG) is the payload project's primary interface for the safety review and approval process, where all documentation required by this publication and safety concerns or issues start. 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 (or equivalent) who typically chairs the PSWG, 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 ELV 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 publication, 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 paragraph numbers of this document follow the same paragraph numbering of AFSPCMAN 91-710. The mutual goal of NASA, the payload project, and Range Safety shall be to conduct their 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.*	C		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
1.2 APPLICABILITY	**I**		
1.2.1. Payload Projects. The requirements, policies, processes, procedures, and approvals defined in this publication and NPR 8715.7 shall be applicable to all NASA ELV 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. Center payload activities fall under NPR 8715.3 NASA General Safety Program Requirements and their local safety requirements. 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, AFSPCMAN 91-710, and local safety requirements shall be applied as determined by the PSWG and Range Safety.	**C**		
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., AFSPCMAN 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 1 of this volume, for further tailoring instructions. See NPR 8715.7 for the overall tailoring process.	**I**		
1.2.2.2. Developing a tailored edition of this document. The tailored edition should look like this document with the following exceptions:	**C**		
1.2.2.2.1. The tailored edition shall be constructed in the following manner:	**C**		
1.2.2.2.1.1. Insert a document heading/title that reads, "NASA ELV Payload Safety Requirements" for Project Name, date of the applicable contract/agreement/ etc.", centered at the top of each page.	**C**		
1.2.2.2.1.2. Date of tailored edition.	**C**		
1.2.2.2.1.3. Insert "PROPRIETARY" at the top, centered directly over heading material, and at the bottom of each page (if requested by the payload project).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
1.2.2.2.2. Remaining heading information shall be left justified.	**C**		
1.2.3. New Programs. This publication and NPR 8715.7 are applicable to all NASA ELV payload projects under all new programs.	**C**		
1.2.4. Previous Approvals. All new NASA ELV 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.	**C**		
1.3 BASIS FOR THE REQUIREMENTS This publication is based on, but not limited to, the responsibilities or standards contained in or applied by NPR 8715.7 Preface and AFSPCMAN 91-710 Volume 1 Section1.3.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES	I		
2.1 GENERAL The roles, responsibilities, and authorities for ensuring safety for NASA ELV payload projects are provided in NPR 8715.7, AFSPCMAN 91-710, and below. For NASA ELV payload safety roles, responsibilities and safety review and approval processes, see NPR 8715.7. For Air Force Range Safety roles, responsibilities, and safety review and approval processes, see AFSPCMAN 91-710.	C		
2.2 HEADQUARTERS AIR FORCE SPACE COMMAND RESPONSIBILITIES The Headquarters Air Force Space Command (HQ AFSPC) operates the AFSPC ranges, including providing base support, personnel, and other government assets. The AFSPC Commander (AFSPC/CC) is responsible for establishing range safety policy for AFSPC ranges as outlined in AFSPCMAN 91-701, Range Safety Program Policy and Requirements. HQ AFSPC is also responsible for establishing common range safety user requirements as outlined in this publication for the AFSPC space wings to implement and enforce.	I		
2.3 SPACE WING RESPONSIBILITIES	I		
2.3.1. Commanders, 30th Space Wing and 45th Space Wing:	I		
2.3.1.1. The Space Wing Commanders (SW/CCs) have overall authority and responsibility for public safety at AFSPC ranges as directed by the AFSPC/CC. This delegation is provided via the MAJCOM chain of command and AFI 91-202, as supplemented.	I		
2.3.5. Range Safety Offices. Unless otherwise noted, the use of the term Range Safety in this publication refers to 30 SW/SE, 45 SW/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 adequately 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 AF 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 ER and WR.	I		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
2.4 FEDERAL AVIATION ADMINISTRATION RESPONSIBILITIES In accordance with 49 U.S.C., Subtitle IX, Commercial Space Transportation, Chapter 701, Commercial Space Launch Activities, U.S.C. §§ 70101 - 70121, the FAA has responsibility for public safety of licensed launches. The Range Safety requirements in this publication have been written with the intent of achieving commonality with the FAA requirements. The FAA performed launch site safety assessments of the two AFSPC national launch ranges and determined the level of safety obtained by the existing range safety process to be adequate. The FAA will not require a license applicant to demonstrate the adequacy of the range services it proposes to use if the applicable launch site safety assessment included those services and if those services remain adequate. SW Commander discretion to accept higher risk for the launch of government payloads does not apply to licensed launches without a Range User obtaining relief from the FAA. ("Memorandum of Agreement between the Department of the Air Force and Federal Aviation Administration on Safety for Space Transportation and Range Activities," dated 16 January 2001). FAA documents can be found on the FAA/AST web site at http://www.faa.gov/about/office_org/headquarters_offices/ast/.	**I**		
2.5 PAYLOAD PROJECT RESPONSIBILITIES Projects are responsible for complying with NPR 8715.7 and the requirements identified in this publication.	**I**		
2.5.2. System Safety Program. 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 ELV 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 2 of this volume.	**C**		
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:	**C**		
2.5.3.1. Providing safe systems, equipment, facilities, and materials in accordance with this publication.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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 adequate contractual direction and monitor subcontractor performance to verify compliance.	**C**		
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.	**C**		
2.5.4. Radioactive Material Launches. Payload projects shall be responsible for notifying the PSWG and Range Safety and ensuring compliance with PD/NSC 25 as outlined in DoD 3100.10, with implementation through AFI 91-110 and any Space Wing supplements and providing certification as detailed in AFSPCMAN 91-710, NPR 1800.1, Chapter 4, NPR 8715.3 Chapter 6, and local requirements.	**C**		
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:	**C**		
2.5.5.1. Conducting their operations in a safe manner.	**C**		
2.5.5.2. Planning and conducting hazardous and safety critical operations only in accordance with approved procedures and the current edition of the applicable operations safety plan (OSP).	**C**		
2.5.5.3. Observing, evaluating, and enforcing compliance with safety requirements.	**C**		
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 in accordance with OSHA regulations/standards, NPR 1800.1, NASA Occupational Health Program Procedures, NPR 8715.1, NASA Occupational Safety And Health Programs, and other federal and state safety and health regulations. 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. Air Force Range Safety shall assume no liability for payload project or contractor compliance or noncompliance with OSHA requirements.	**C**		
2.5.8. Resource Safety. Payload projects are responsible for resource safety of their owned or leased facilities, equipment, and flight hardware.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 3 RANGE SAFETY POLICY	**I**		
3.1 GENERAL	**I**		
3.1.1. Each project shall have a risk management plan consistent with AFSPC 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 2.	**C**		
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 California Occupational Safety and Health Administration (CAL-OSHA).	**I**		
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.	**I**		
3.3 LAUNCH AREA SAFETY 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.)	**I**		
3.3.1. The ranges shall ensure that all personnel and USAF or third party resources located on any AFSPC range, including CCAFS or VAFB or on any supporting site within the ER or WR, are provided an acceptable degree of protection from the hazards associated with range operations.	**C**		
3.3.2. Figure 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 Figure 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS

HAZARD SEVERITY		POTENTIAL CONSEQUENCES				PROBABILITY*				
Category		Personnel Illness/Injury	Equipment Loss($)	Unit Downtime	Data Compromise	A	B	C	D	E
I	Catastrophic	May cause death.	>2,000,000	> 4 months	Data is never recoverable or primary program objectives are lost.					
II	Critical	May cause severe injury or severe occupational illness.	200,000 to 500,000	2 weeks to 4 months	May cause repeat of test program.					
III	Marginal	May cause minor injury or minor occupational illness.	500,000 to 50,000	1 Day to 2 Weeks	May cause repeat of test period.					
IV	Negligible	Will not result in injury or occupational illness.	<50,000	< 1 Day	May cause repeat of data point, or data may require minor manipulation or computer rerun.					

RISK PRIORITY: Unacceptable | Waiver or deviation required | Operation permissible

Figure 3.2: Acceptability Guidelines for Prelaunch Launch Area/Launch Complex Hazard Consequences and Probability Categories

Figure 3.2: Acceptability Guidelines for Prelaunch Launch Area/Launch Complex Hazard Consequences and Probability Categories

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS

**Probability* refers to the probability that the potential consequence will occur in the life cycle of the system (test/activity/operation). Use the following list to determine the appropriate Risk Level.

	DESCRIPTION**	THRESHOLD LEVEL	PROBABILITY VALUE	SPECIFIC INDIVIDUAL ITEM	FLEET OR INVENTORY***
A	Frequent		$3X10^{-1}$	Likely to occur repeatedly	Continuously experienced
	----------	$8X10^{-2}$		----------	----------
B	Reasonably probable		$3X10^{-2}$	Likely to occur several times	Will occur frequently
	----------	$8X10^{-3}$		----------	----------
C	Occasional		$3X10^{-3}$	Likely to occur sometime	Will occur several times
	----------	$8X10^{-4}$		----------	----------
D	Remote		$3X10^{-4}$	Unlikely to occur, but possible	Unlikely, but can reasonably be expected to occur
	----------	$8X10^{-5}$		----------	----------
E	Extremely Improbable		$3X10^{-5}$	The probability of occurrence cannot be distinguished from zero.	Unlikely to occur, but possible

** Definitions of descriptive words may have to be modified based on quantity involved.
*** The size of the fleet or inventory and system life cycle should be defined.

Figure 3.2 (Continued): Acceptability Guidelines for Prelaunch Launch Area/Launch Complex Hazard Consequences and Probability Categories

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.	**C**		
3.4 LAUNCH COMPLEX SAFETY 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 SW Commander has the ultimate responsibility to ensure proper safety through an appropriate level of oversight into payload project operations.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 4 PSWG AND RANGE SAFETY PROCESSES	**I**		
4.1 RANGE SAFETY AND PAYLOAD PROJECTS INTERFACE PROCESS The safety review and approval process is 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 5 of this Volume.	**I**		
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 non-compliance requests can be found in Attachment 3 of this volume.	**C**		
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 AFSPC 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.	**C**		
4.6.3.3. Waivers shall always have the effectivity designated. A "get-well" plan shall be required except for those with lifetime effectivity.	**C**		
4.6.3.4. The FAA shall be included in the waiver process for licensed programs at AFSPC ranges per the memorandum of agreement between HQ AFSPC and FAA/AST on Resolving Requests for Relief from Common Launch Safety Requirements.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
4.6.3.5. The SW Commanders shall approve or disapprove all waivers affecting public safety as defined in Figure 3.1 and Figure 3.2 of AFSPCMAN 91-710 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 SW Commanders shall advise the 14 AF/CC. Refer to AFSPCI 91-701 for risk approval levels. The latest prescribed Air Force Noncompliance Request format shall be used.	**C**		
4.6.3.6. The Chiefs of Safety or their designated representatives shall approve or disapprove all Air Force waivers other than those affecting public safety.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 5 SAFETY AUTHORIZATIONS, SAFETY APPROVALS, AND DOCUMENTATION	**I**		
5.1 GENERAL The overall safety review and approval process for NASA ELV payloads is contained in NPR 8715.7.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 6 INVESTIGATING AND REPORTING MISHAPS AND INCIDENTS	**I**		
6.1 MISHAPS AND INCIDENTS INVOLVING AIR FORCE PERSONNEL AND RESOURCES 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 an Air Force range AFI 91-204, Safety Investigations and Reports, also applies and the ranges shall investigate and report all mishaps and incidents involving USAF personnel and resources.	**C**		
6.2 NON-AIR FORCE PERSONNEL AND RESOURCES ON AIR FORCE PROPERTY	**I**		
6.2.1. The AFSPC ranges shall not report or investigate non-Air Force mishaps under AFI 91-204 auspices. However, Range Safety shall assist and participate in non-Air Force mishap investigations that affect or could affect public safety, launch area safety, or Air Force resources and may assist in non-Air Force mishap investigations that affect or could affect launch complex safety or non-Air Force third party resources.	**I**		
6.2.2. The PSWG and Range Safety shall be provided with the investigation results of any mishaps or incidents occurring on the ranges.	**C**		
6.2.3. Regardless of the payload project or Range User, the SW Commander may conduct formal investigations into any mishap and incident on Air 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 Air Force personnel and resources.	**I**		
6.3 REPORTING SPACE LAUNCH SYSTEM ANOMALIES Any anomaly with potential safety implications and close calls shall be reported in accordance with NPR 8621.21, 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 7 CHANGES TO THIS PUBLICATION	**I**		
7.1. This publication shall be updated as needed to coincide with updates to AFSPCMAN 91-710 and NASA requirements and to incorporate document improvements. The latest version with any changes shall be provided on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety.	**C**		
7.2. Recommended changes to this document shall be sent to the NASA ELV Payload Safety Manager.	**C**		
7.4. All changes to this publication shall first be coordinated jointly among the NASA ELV Payload Safety Agency Team and the Air Force Space Command Ranges (30th and 45th Space Wing Safety Offices). All affected NASA payload projects shall be informed of any changes to this publication. The NASA ELV Payload Safety Manager is responsible for keeping this document current and incorporating changes.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 1 THE NASA ELV PAYLOAD SAFETY REQUIREMENTS TAILORING PROCESS	**I**		
A1.1 INTRODUCTION:	**I**		
A1.1.1. Purpose. The tailoring approval process is provided in NPR 8715.7. 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.	**C**		
A1.1.2. Content. This attachment describes the rationale for tailoring, the tailoring process, and the requirements for documenting tailored editions of the publication. This NASA ELV Payload Safety Requirements tailoring matrix baseline document may be found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety.	**I**		
A1.1.3. Applicability. The tailoring process is applicable to all NASA ELV payload projects.	**C**		
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.	**C**		
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.	**C**		
A1.1.5.1. Deletion of a Requirement:	**I**		
A1.1.5.1.1. 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.	**C**		
A1.1.5.1.2. 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.	**C**		
A1.1.5.2. Change to a Requirement:	**I**		
A1.1.5.2.1. ELS determinations may be provided and approved by the PSWG and Range Safety through the change process.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.1.5.2.2. 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**		
A1.1.5.2.3. 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 Equivalent Level of Safety 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 ELV Payload Safety Post Tailoring Equivalent Level of Safety (ELS) Request NASA Form NF 1826 found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayload Safety under the "ELV Payload Safety Forms" button or an equivalent form that contains all information required on NF 1826. 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.	**C**		
A1.1.5.2.4. The existing numbering system shall remain the same to the maximum extent possible.	**C**		
A1.1.5.2.5. Additional paragraphs may be added; however, using the remaining unaffected paragraph numbers is not allowed.	**C**		
A1.1.5.2.6. 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.	**C**		
A1.1.5.3. Addition to a Requirement:	**I**		
A1.1.5.3.1. 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.	**C**		
A1.1.5.3.2. 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.	**C**		
A1.1.5.3.3. 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 marked with underline.	**C**		
A1.1.5.4. Payload Project Information Only:	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.1.5.4.1. 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.	**C**		
A1.1.5.5. Waivers. 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 ELV Payload Safety Waiver Request may be found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety. This form is used for all waivers. Additionally, if the waiver is impacting Air Force property and resources, then the LSRRR (Launch Safety Requirements Relief Request) form shall be submitted and the AFSPCMAN 91-710 waiver process will be followed.	**C**		
A1.1.5.6. Risk-Cost Benefit Analysis:	**I**		
A1.1.5.6.1. 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**		
A1.1.5.6.2. If desired, a risk-cost benefit analysis, based on the criteria defined in AFSPCMAN 91-710, Volume 1, Chapter 3 and Figure 3.1 and Figure 3.2 may be submitted to Range Safety.	**I**		
A1.1.5.6.3. 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**		
A1.1.5.6.4. If the application of an AFSPCMAN 91-710 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**		
A1.2 TAILORING PROCESS	**I**		
A1.2.1. Preparation of a Project Specific Draft Tailored Edition of NASA ELV Payload Safety Requirements document:	**I**		
A1.2.1.1. The payload project shall produce a payload project mission specific draft edition of this document per NPR 8715.7 and this standard. The NASA ELV Payload Safety Requirements tailoring matrix is found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety.	**C**		
A1.2.1.2. 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.	**C**		
A1.2.1.3. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.3. Publication of the Project Specific NASA ELV Payload Safety Requirements:	**I**		
A1.2.3.1. Final Publication:	**I**		
A1.2.3.1.1. 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.	**C**		
A1.2.3.1.2. The tailoring process and delivery schedule is found in NPR 8715.7.	**I**		
A1.2.3.2. The tailored edition shall look like this NASA ELV Payload Safety Requirements tailoring matrix with the following exceptions:	**C**		
A1.2.3.2.1. The document title/heading shall read, "PROJECT Name SAFETY REQUIREMENTS". This title shall be centered at the top of each page.	**C**		
A1.2.3.2.2. The date of the applicable contract/CSOSA/agreement/etc. shall be listed under the title and centered at the top of each page.	**C**		
A1.2.3.2.3. The date of the tailored edition shall be on the cover page of the document.	**C**		
A1.2.3.2.4. The term "PROPRIETARY" shall be placed at the top and bottom of each page, centered directly over the title/heading (if requested by the payload project).	**C**		
A1.2.3.2.10. All deleted information shall be marked as "N/A" under the STATUS column of the project's tailored version of this document.	**C**		
A1.2.3.3. Effectivity of Tailored Project Specific NASA ELV Payload Safety Requirements document:	**I**		
A1.2.3.3.1. Each project specific version of the NASA ELV Payload Safety Requirements document shall contain a preface paragraph detailing its effectivity.	**C**		
A1.2.3.3.2. At a minimum, the payload and the time period to which the project specific NASA ELV Payload Safety Requirements applies shall be addressed.	**C**		
A1.2.3.4. Assumptions:	**I**		
A1.2.3.4.1. Each project specific tailored version of the NASA ELV Payload Safety Requirements tailoring matrix shall contain a preface paragraph detailing the critical assumptions that were made in writing the tailored edition.	**C**		
A1.2.3.4.2. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.3.4.3. 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.	**C**		
A1.2.4. Approvals:	**I**		
A1.2.4.1. Once completed and finalized the project specific ELV Payload Safety Requirements shall be approved and signed by the Project Manager (PM), the preparer, the project's NASA SMA Technical Authority, the Launch Services Program NASA SMA Technical Authority (or equivalent), 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 ELV Payload Safety Post-Tailoring Equivalent Level of Safety (ELS) Request or an equivalent form that contains all information required on NF 1826. Waivers (increased risk changes) shall be recorded on the NF 1827 NASA ELV Payload Safety Waiver Request. If deemed necessary by the Air Force, an Air Force Relief request will also be required. The NASA ELV Payload Safety ELS and Waiver Requests as well as the Air Force Range Safety Relief Request are found on the NASA ELV Payload Safety Program website under Forms at http://kscsma.ksc.nasa.gov/ELVPayloadSafety.	**C**		
A1.2.4.4. Each complete, final project-specific tailored document affecting public safety shall be approved and signed by the SW Commander.	**C**		
A1.2.5.2. Any revisions to the project-specific tailored version of the NASA ELV Payload Safety Requirements document shall be made in accordance with NPR 8715.7 and AFSPCMAN 91-710 change processes.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 2 SYSTEM SAFETY PROGRAM REQUIREMENTS	**I**		
A2.1 INTRODUCTION	**I**		
A2.1.1. Purpose. This attachment establishes the minimum requirements for a payload project's System Safety Program as required per NPR 8715.7. Such a program is consistent with MIL-STD-882C, Department of Defense Standard Practice for System Safety. The program includes 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 System Safety Plan (SSP) and identifies hazard analysis and risk assessment requirements.	**I**		
A2.1.2. Tailoring. Tailoring of this attachment and the requisite SSP is highly recommended. The tailoring process is defined in Attachment 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.	**C**		
A2.1.4. 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.	**C**		
A2.2 SYSTEM SAFETY PROGRAM TASKS 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.	**C**		
A2.2.1. Task 1: Establish a Payload Project Safety Program. By the time of the payload project's Payload Safety Introduction, the payload project shall have established a Safety Program documented in the project's SSP (see A.2.2.2) that meets the tailored requirements of this publication which includes the following:	**C**		
A2.2.1.1. Establishing a safety management system. The payload Project Manager (PM) shall be responsible for the following:	**C**		
A2.2.1.1.1. Establishing, controlling, incorporating, directing, and implementing the system safety program policies.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.1.1.2. 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 ELV Payload Safety Hazard Report (see A2.2.1.8.1) or an equivalent form that contains all information required on NF 1825.	**C**		
A2.2.1.1.3. 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 Air Force personnel and resources.	**C**		
A2.2.1.1.4. 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.	**C**		
A2.2.1.2. 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:	**C**		
A2.2.1.2.1. 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.	**C**		
A2.2.1.2.2. Reviewing and approving all hazardous and safety critical test plans and procedures and verifying that all safety requirements are incorporated.	**C**		
A2.2.1.3. 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.	**C**		
A2.2.1.4. Establishing a system safety organization or function and lines of communication within the project organization and with associated organizations (government and contractor).	**C**		
A2.2.1.5. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.1.6. Designating the organizational unit responsible for executing each safety task.	**C**		
A2.2.1.7. Establishing the authority for resolution of identified hazards.	**C**		
A2.2.1.8. 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.	**C**		
A2.2.1.8.1. 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 ELV Payload Safety Hazard Report Form and instructions found on the NASA ELV Payload Safety Program website http://kscsma.ksc.nasa.gov/ELVPayloadSafety under "ELV Payload Safety Forms" 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), of which an example is also found on the NASA ELV Payload Safety Program website, to track identified hazards to closure.	**C**		
A2.2.1.9. Establishing the order of precedence for satisfying system safety requirements and resolving identified hazards as follows:	**C**		
A2.2.1.9.1. 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**		
A2.2.1.9.2. Incorporating Safety Devices. If identified hazards cannot be eliminated or their associated risk adequately 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.	**C**		
A2.2.1.9.3. Providing Warning Devices. When neither design nor safety devices can effectively eliminate identified hazards or adequately reduce associated risk, devices shall be used to detect the condition and to produce an adequate 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.	**C**		
A2.2.1.9.4. Developing Procedures and Training. Where it is impractical to eliminate hazards through design selection or adequately 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.	**C**		
A2.2.1.10. Defining system safety program milestones and relate them to major program milestones, project element responsibility, and required inputs and outputs.	**C**		
A2.2.1.11. Establishing System Safety Program reviews and audits.	**C**		
A2.2.1.11.1. Conducting, documenting, and making the following documentation available to the PSWG and Range Safety upon request:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.1.11.1.1. The payload project range safety program plan and supporting risk assessment data.	**C**		
A2.2.1.11.1.2. Associate contractor system safety plan and supporting risk assessment data.	**C**		
A2.2.1.11.1.3. Support contractor system safety plan and supporting risk assessment data.	**C**		
A2.2.1.11.1.4. Subcontractor system safety plan and supporting risk assessment data.	**C**		
A2.2.1.11.2. Providing support for the following:	**C**		
A2.2.1.11.2.1. Safety reviews and audits performed by representatives of the PSWG, Agency Team, or others.	**C**		
A2.2.1.11.2.2. Presentations to government certifying activities such as phase safety reviews, munitions safety boards, nuclear safety boards, 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.	**C**		
A2.2.1.11.2.3. 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:	**C**		
A2.2.1.11.2.3.1. Program systems and operations overview.	**C**		
A2.2.1.11.2.3.2. Presentation of required documentation and hazard analyses.	**C**		
A2.2.1.11.2.3.3. Noncompliances to the project specific tailored requirements.	**C**		
A2.2.1.11.2.3.4. Open safety issues.	**C**		
A2.2.1.12. Establishing an incident alert and notification, investigation and reporting process, to include notification of the PSWG Chairperson and Range Safety.	**C**		
A2.2.1.13. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.2. Task 2: Develop a System Safety Program 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 Safety Program 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:	**C**		
A2.2.2.1. System Safety Organization. The System Safety Organization section shall describe the following:	**C**		
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.	**C**		
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.	**C**		
A2.2.2.1.3. Review and approval authority of applicable tasks by key system safety personnel.	**C**		
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.	**C**		
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.	**C**		
A2.2.2.1.6. Identification of the organizational unit responsible for executing each task.	**C**		
A2.2.2.1.7. Identification of the authority in regard to resolution of all identified hazards.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.2.2. System Safety Program Milestones. The SSP shall:	**C**		
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.	**C**		
A2.2.2.2.2. Provide and maintain a program schedule of safety tasks, including start and completion dates, reports, and reviews.	**C**		
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 system safety program but specified in other engineering studies and development efforts to preclude duplication.	**C**		
A2.2.2.3. System Safety Data. The SSP shall:	**C**		
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 good sources for identifying the initial Data Item Descriptions and deliverables. Electronic submittals are preferred and secure websites shall be used to allow for PSWG and Range Safety review.*	**C**		
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.	**C**		
A2.2.2.4. System Safety Interfaces. The SSP shall identify, in detail:	**C**		
A2.2.2.4.1. The interface between system safety and all other applicable safety disciplines such as nuclear safety, Range Safety, NASA Center safety, local facility safety, explosive and ordnance safety, chemical and biological safety, laser safety, and any others.	**C**		
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.	**C**		
A2.2.2.4.3. The interface between system safety and all system integration and test disciplines.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 I 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 NF1825 NASA ELV Payload Safety Hazard Report found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety or an equivalent form that contains all information required on NF 1825. At a minimum, the PHA shall consider the following for identification and evaluation of hazards:	**C**		
A2.2.3.1. Hazardous components such as fuels, propellants, lasers, explosives, toxic substances, hazardous construction materials, pressure systems, and other energy sources.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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).	**C**		
A2.2.3.6. Those test unique hazards that will be a direct result of the test and evaluation of the article or vehicle.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.3.8. Training and certification pertaining to hazardous and safety critical operations and maintenance of hazardous and safety critical systems.	**C**		
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.	**C**		
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.	**C**		
A2.2.4. Task 4: Perform and Document Subsystem, System, Facility, and Operating and Support Hazard Analyses:	**C**		
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 ELV Payload Safety Hazard Report found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety or an equivalent form that contains all information required on NF 1825. The analysis shall include a determination of the following:	**C**		
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.	**C**		
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.	**C**		
A2.2.4.1.3. That the safety design criteria in the hardware, software, and facilities specifications have been satisfied.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.4.1.6. Test plan and procedure recommendations to integrate safety testing into the hardware and software test programs.	**C**		
A2.2.4.1.7. That system level hazards attributed to the subsystem are analyzed and that adequate control of the potential hazard is implemented in the design.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
A2.2.4.1.9.4. Safety critical software, as defined per the litmus test in NASA-STD-8719.13, that have problems identified during or after software verification (and prior to launch) shall be reported to the PSWG and Range Safety.	**C**		
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.	**C**		
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 1 of Volume 3).	**C**		
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. This analysis shall include a review of subsystem interrelationships to determine the following:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.4.2.1. Compliance with specified safety design criteria.	**C**		
A2.2.4.2.2. 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.	**C**		
A2.2.4.2.3. Degradation in the safety of a subsystem or the total system from normal operation of another subsystem.	**C**		
A2.2.4.2.4. Design changes that affect subsystems.	**C**		
A2.2.4.2.5. Effects of reasonable human errors.	**C**		
A2.2.4.2.6. 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.	**C**		
A2.2.4.2.7. That the safety design criteria in the hardware, software, and facilities specifications have been satisfied.	**C**		
A2.2.4.2.8. 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.	**C**		
A2.2.4.2.9. 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.	**C**		
A2.2.4.2.10. SHA Software:	**I**		
A2.2.4.2.10.1. Software used to control safety critical computer system functions shall be developed in accordance with Volume 3, Chapter 16 of this publication.	**C**		
A2.2.4.2.10.2. Payload projects shall identify all safety critical computer system functions in accordance with Volume 3, Chapter 16 and develop an SHA for each.	**C**		
A2.2.4.2.10.3. 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.	**C**		
A2.2.4.2.10.4. 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.	**C**		
A2.2.4.2.11. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.4.2.12. 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 Attachment 1 of Volume 3).	**C**		
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 ELV Payload Safety Hazard Report found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety or an equivalent form that contains all information required on NF 1825. The analysis shall identify the following:	**C**		
A2.2.4.3.1. Activities that occur under hazardous conditions, their time periods, and the actions required to minimize risk during these activities and time periods.	**C**		
A2.2.4.3.2. 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.	**C**		
A2.2.4.3.3. Requirements for safety devices and equipment, including personnel safety and life support equipment.	**C**		
A2.2.4.3.4. 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.	**C**		
A2.2.4.3.5. Requirements for packaging, handling, storage, transportation, maintenance, and disposal of hazardous materials.	**C**		
A2.2.4.3.6. Requirements for safety training and personnel certification.	**C**		
A2.2.4.3.7. Effects of non-developmental hardware and software across the interface with other system components or subsystems.	**C**		
A2.2.4.3.8. Potentially hazardous system states under operator control.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.4.3.9. 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.	**C**		
A2.2.4.3.10. 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.	**C**		
A2.2.4.3.11. Updating the O&SHA. The payload project shall update the O&SHA as a result of any system design or operational changes.	**C**		
A2.2.4.3.12. 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 1 of Volume 6).	**C**		
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:	**C**		
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.	**C**		
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 Figure 3.2 of this volume.	**C**		
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.	**C**		
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.	**C**		
A2.2.5.5. Recommendations applicable to hazards at the interface of payload project systems with other systems, as required.	**C**		
A2.2.5.6. A formal request for approval to conduct operations at the payload processing facility and the range.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 AFSPCMAN 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.	**C**		
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 Air Force Range Safety responsibilities shall be submitted to the PSWG to be processed and approved by the Air Force in accordance with the following:	**C**		
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.	**C**		
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 AFSPC ranges, including CCAFS and VAFB and may be extended to KSC. Launch area safety involves multiple licensed users, government tenants, or USAF squadrons.	**C**		
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.	**C**		
A3.1.6. Effectivity of Noncompliances: Duration of the noncompliance (if approved) shall be stated on the noncompliance request.	**C**		
A3.1.7. Conditions for Issuance of ELSs and Waivers:	**I**		

ORIGINAL TEXT	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.	**C**		
A3.1.7.2. Get Well Plans. Payload projects shall provide a plan to meet the requirements in question by the time the approved effectivity expires.	**C**		
A3.1.8. Risk-Cost Benefit Analysis: If desired, a risk-cost benefit analysis, based on the criteria defined in AFSPCMAN 91-710 Figure 3.1 and Figure 3.2 of Chapter 3 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 ELV Payload Safety Requirements tailoring do not require the submittal of NF 1826 NASA ELV Payload Safety Post-Tailoring Equivalent Level of Safety (ELS) Request (See Attachment A1 of this Volume). Payload projects shall submit noncompliances to the PSWG in writing per NPR 8715.7 using the approved NASA noncompliance forms, NF 1826 NASA ELV Payload Safety Post-Tailoring Equivalent Level of Safety (ELS) Request or an equivalent form that contains all information required on NF 1826, and NF 1827 NASA ELV Payload Safety Waiver Request. Additionally, the payload project shall submit the appropriate Air Force noncompliance Relief Request for all noncompliances to AFSPCMAN 91-710 impacting Air Force Ranges. These forms are found on the ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety under the "ELV Payload Safety Forms" button.	**C**		
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 Air Force noncompliance process is as follows:	**C**		
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 AF Range Safety shall be submitted through the PSWG to the office of the appropriate Space Wing Chief of Safety as early as they are known to be necessary.	**C**		
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 Space Wing Commander (waivers) approval or design change before manufacture of the booster, spacecraft, FTS, or other system in question.	**I**		
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. The Space Wing shall coordinate all noncompliance requests with affected agencies, as appropriate. A coordinated review and resolution of requests for relief from common AF-FAA launch safety requirements shall be per procedures developed between the AFSPC and the FAA. The Space Wing 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
NASA noncompliances shall be approved in accordance with NPR 8715.7. The Air Force noncompliances approvals are as follows:			
A3.2.4.1. Programs launching from only the ER or WR require only the appropriate 30 SW/SE or 45 SW/SE approvals.	**C**		
A3.2.4.2. Programs launching from both ranges require approvals from 30 SW/SE and 45 SW/ SE.	**C**		
A3.2.4.3. Waivers dealing with public safety shall be approved by the SW Commanders.	**C**		
A3.2.4.4. Waivers other than public safety shall be approved by the Chiefs of Safety or their designated representatives.	**C**		
A3.2.4.5. ELSs shall be approved by appropriate 45 SW/SE or 30 SW/SE Chiefs of Safety or their designated representatives.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 4 ACCEPTABLE RISK CRITERIA	I		
A4.1 INTRODUCTION 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 AFSPCMAN 91-710 for risks impacting Air Force Ranges. *Note: See Volume 1 Chapter 3 of this document and NASA ELV Payload Safety Hazard Report NF 1825 for additional guidance.*	C		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
A5.2.1.1. Overview of the System Safety Program as defined by the project's DRAFT System Safety Plan (see Volume 3, paragraph 4.1.1.).	**C**		
A5.2.1.2. Identification of organizational roles and responsibilities.	**C**		
A5.2.1.3. Description of payload, instruments, and anticipated ground support equipment.	**C**		
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.	**C**		
A5.2.1.5. Identification of potential mission-unique ground support equipment required for pad operations.	**C**		
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.	**C**		
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.	**C**		
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 ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety under the "Forms" button.	**C**		
A5.2.1.9. A list of any known tailoring issues, previously approved noncompliances (i.e., waivers, ELS), and previously approved alternative approaches.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A5.2.1.10. Any potential hazardous failure modes, failure probability, and performance characteristics of the payload during ground operations.	**C**		
A5.2.1.11. Identification of planned studies and analyses that support safety requirements, including scheduled completion.	**C**		
A5.2.1.12. Description of processing flow and anticipated schedule, integrated with major project milestones.	**C**		
A5.2.1.13. Identification of facility requirements, including launch complex, hazardous assembly and checkout areas, and ordnance and propellant storage requirements.	**C**		
A5.2.1.14. Identification and discussion of potential contingency operations, for example, depressurization, propellant offload, and accessibility after fairing installation.	**C**		
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.	**C**		
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 ELV Payload Safety Program.*	**C**		
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.	**C**		

VOLUME 3: PAYLOADS AND GROUND SYSTEMS REQUIREMENTS

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 1 INTRODUCTION	I		
1.1 GENERAL	I		
1.1.1. All NASA ELV 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. 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 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		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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**		
1.2.3.3. The payload project always has the option to propose alternatives to the bordered paragraph solutions. 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.	**C**		

ORIGINAL TEXT	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) in accordance with NPR 8715.7. 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 ELV 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 manual. PSWG activities typically conclude with the signing of the Certificate of ELV 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.	**C**		
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.	**C**		
2.2 PAYLOAD PROJECT RESPONSIBILITIES. Payload projects are responsible for establishing and maintaining a system safety program in accordance with Volume 1, Attachment 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:	**C**		
2.2.1. Timely submission of an SSP.	**C**		
2.2.2. Timely submission of hazard analyses.	**C**		
2.2.3. Timely submission of all required SDPs/MSPSPs including Hazard Reports.	**C**		
2.2.4. Timely submission of all SDPs (MSPSP) associated Test Plans and Test Reports.	**C**		
2.2.5. Coordinating with and supporting local safety authorities in carrying out tasks necessary for approval of design, inspection, and testing.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
2.2.6. Timely submission of safety data deliverables per NPR 8715.7 and this document.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 3 GENERAL DESIGN POLICY	**I**		
3.1 GENERAL	**C**		
3.1.1. All systems shall be designed to tolerate a minimum number of credible failures.	**C**		
3.1.2. The number of design 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. *Note: 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.*	**C**		
3.2 SYSTEMS WITHOUT SPECIFIC DESIGN CRITERIA Those systems that do not have specific design criteria or systems not addressed in this volume shall be designed to the following general criteria:	**C**		
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).	**C**		
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).	**C**		
3.2.3. If a system failure may lead to a marginal hazard, the system shall have a single inhibit (no failure tolerant).	**C**		
3.2.5. Systems shall be able to be brought to a safe state with the loss of an inhibit.	**C**		
3.2.6. Independent and Verifiable Inhibits.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
3.2.7. Design inhibits shall consist of electrical and/or mechanical hardware.	**C**		
3.2.8. Operator controls shall not be considered a design inhibit. Operator controls are considered a control of an inhibit.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 4 DOCUMENTATION REQUIREMENTS	**I**		
4.1 SYSTEM SAFETY PLAN HAZARD ANALYSES	**I**		
4.1.1. Documentation requirements and submittal timeframes are provided in NPR 8715.7 and this publication. A preliminary SSP shall be developed in accordance with Volume 1, Attachment 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 5) shall be provided at the PSIB.	**C**		
4.1.2. The final SSP shall be developed in accordance with Volume 1, Attachment 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.*	**C**		
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 2 of this publication.	**C**		
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 ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety under "ELV 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.	**C**		
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. Hazard Reports shall be prepared on NF 1825 NASA ELV Payload Safety Hazard Report Form found on the ELV Payload Safety Program's website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety under "ELV Payload Safety Forms" or an equivalent form that contains all information required on NF 1825.	**C**		
4.2 SAFETY DATA PACKAGE (SDP) (MSPSP)	**I**		
4.2.1. SDP Submittal, Review, and Approval Process:	**I**		
4.2.1.1. Payload projects shall submit an SDP (MSPSP) for each project to the PSWG in accordance with NPR 8715.7 and this publication.	**C**		
The NASA SDP is equivalent to the AFSPCMAN 91-710 Missile System Prelaunch Safety Package (MSPSP).	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
4.2.2. SDP Preparation. A Safety Data Package (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 1 of this volume.	**C**		
4.3 SDP ASSOCIATED TEST PLANS AND TEST RESULTS	**I**		
4.3.1. Test plans shall be identified and summarized in the SDP (MSPSP). 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.	**C**		
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.	**C**		
4.3.3. Test reports shall be submitted at least 45 calendar days before intended system use.	**C**		
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.	**C**		
4.4 NONDESTRUCTIVE EXAMINATION PLANS	**I**		
4.4.1. 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, a nondestructive examination (NDE) plan shall include the following:	**C**		
4.4.1.1. NDE technique and acceptance criteria to be used on each single failure point (SFP) component or SFP weld after initial and periodic proof 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.	**C**		
4.4.1.2. Detailed engineering rationale for each technique and acceptance criteria.	**C**		
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.	**C**		
4.4.1.4. The environment and/or conditions under which the equipment will be used and stored.	**C**		
4.4.1.5. The existence of any SFP component and weld materials susceptible to stress corrosion.	**C**		
4.4.1.6. Corrosion protection and maintenance plans.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 6 MATERIAL HANDLING EQUIPMENT AND PERSONNEL WORK PLATFORMS	**I**		
This chapter is divided into two major types of equipment: Material Handling Equipment (MHE) and Personnel Work Platforms. If the payload project is providing a crane or hoist for payload processing use, then AFSPCMAN 91-710, Section 6.2 shall be tailored into this document, as applicable.	**C**		
6.1 MATERIAL HANDLING EQUIPMENT The payload projects shall comply with the design and test requirements of NASA-STD-8719.9 and those included below for MHE for handling (lifting, supporting, or manipulating) critical and non-critical hardware to be used at the payload processing facility and launch site area.	**C**		
MHE is comprised of below-the-hook lifting devices (BTHLD), handling structures, support structures, slings, load cells, hydrasets, and rigging hardware. Initial and recurring data requirements are provided in Attachment 1 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.	**I**		
6.1.1. MHE General Requirements:	**I**		
6.1.1.1. MHE Requirements Validation:	**I**		
6.1.1.1.1. The payload project certifies the design is in accordance with the requirements, and provides documentation verifying compliance through Safety Data Package submittal or reference documents.	**C**		
6.1.1.1.2. Supporting data for leased and/or commercial-off-the-shelf (COTS) equipment shall include the following information:	**C**		
6.1.1.1.2.1. Equipment name, description, model number, and part number.	**C**		
6.1.1.1.2.2. Rated capacity.	**C**		
6.1.1.1.2.3. Any applicable certifications or approvals; for example, Underwriters' Laboratories (UL) listing.	**C**		
6.1.1.1.2.4. Applicable operating and maintenance (O&M) information, data, and/or manuals.	**C**		
6.1.1.2. MHE Single Failure Tolerance:	**C**		
6.1.1.2.1. Critical MHE shall be designed without single failure points (SFPs).	**I**		
6.1.1.2.2. 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.)	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.1.2.2.1. A list of all identified SFPs.	**C**		
6.1.1.2.2.2. Risk assessment.	**C**		
6.1.1.2.2.3. Risk mitigation considerations and inhibits.	**C**		
6.1.1.2.2.4. A map of SFP locations (for example, weld map, system components).	**C**		
6.1.1.2.2.5. Inspection and NDE requirements.	**C**		
6.1.1.2.3. SFP components and welds shall be accessible for nondestructive inspection, maintenance, and repair.	**C**		
6.1.1.3. MHE Inspection and Test Requirements:	**I**		
6.1.1.3.1. MHE Test Weights and Load Test Devices:	**I**		
6.1.1.3.1.1. Load tests shall be conducted with certified weights and/or certified weight fixtures.	**C**		
6.1.1.3.1.2. These weights shall be identified and permanently and clearly marked with the total weight and owner or agency identification number.	**C**		
An example of marking requirements for test weights can be found in KSC-DE-512-SM, Facility, System and Equipment General Design Requirements, Section 3.3.5.6.	**I**		
6.1.1.3.1.3. Reinforcing steel (rebar) shall not be used for lift points.	**C**		
6.1.1.3.1.4. Calibrated load devices such as dynamometers may be used to test slings and other lifting devices except cranes and hoists.	**C**		
6.1.1.3.2. MHE NDE:	**I**		
6.1.1.3.2.1. NDE plans shall be developed for MHE used to handle critical systems and equipment and MHE containing SFPs.	**C**		
6.1.1.3.2.2. 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.	**C**		
6.1.1.3.2.3. 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.	**C**		
6.1.1.4. MHE Marking and Tagging Requirements:	**I**		
6.1.1.4.1. Marking Requirements. All equipment (new and modified) shall be permanently marked in accordance with applicable codes and standards and have a permanently attached identification tag with the following information:	**C**		
6.1.1.4.1.1. Manufacturer.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.1.4.1.2. Part number.	**C**		
6.1.1.4.1.3. Serial number.	**C**		
6.1.1.4.1.4. Date of manufacture or initial acceptance.	**C**		
6.1.1.4.1.5. Rated capacity.	**C**		
6.1.1.4.1.6. Weights of the top assembly and separate subassemblies.	**C**		
6.1.1.4.2. Tagging Requirements:	**I**		
6.1.1.4.2.1. Systems/equipment requiring testing shall be tagged and test data included in its data package.	**C**		
6.1.1.4.2.2. 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:	**C**		
6.1.1.4.2.2.1. Part number, serial number, and other unique identifier (reference designator).	**C**		
6.1.1.4.2.2.2. Date of most recent test.	**C**		
6.1.1.4.2.2.3. Test load.	**C**		
6.1.1.4.2.2.4. Date of next load test.	**C**		
6.1.1.4.2.2.5. Date of most recent NDE (if applicable).	**C**		
6.1.1.4.2.2.6. Date of next NDE (if applicable).	**C**		
6.1.1.4.2.2.7. A quality assurance or quality control indication certifying the data on the tag.	**C**		
6.1.1.4.2.3. The tags shall be accessible for inspection.	**C**		
6.1.1.4.2.4. If the assembly is to be disassembled after proof testing, 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.	**C**		
Load-bearing components not traceable to a load test will invalidate the load test of the whole assembly.	**I**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.1.4.2.4.1. 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 per AFSPCMAN 91-710, Vol. 6, paragraph 5.2.6 are always applicable in the prevention of a dropped object hazard.	**C**		
6.1.1.5. 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.	**C**		
6.1.2. Slings:	**C**		
A sling is a flexible lifting assembly used between the load and hoisting device hook, comprised of alloy steel chain, wire rope, natural or synthetic webbing, synthetic rope , or metal mesh, with supporting fittings and attachment hardware.	**I**		
6.1.2.1. Sling Design Standards and Requirements:	**C**		
6.1.2.1.1. Slings shall be designed and manufactured in accordance with American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) B30.9, Slings, and 29 CFR 1910.184, Slings. Sling design shall maintain the following minimum design factors listed in Table 6-1.	**C**		
6.1.2.1.2. Carbon steel or wrought iron chain slings shall not be used.	**C**		
6.1.2.1.3. Wire rope slings shall be formed with swaged or zinc-poured sockets or spliced eyes.	**C**		
6.1.2.1.4. Wire rope clips or knots shall not be used to form slings.	**C**		
6.1.2.1.6. Natural fiber rope or natural fiber web slings shall not be used.	**C**		
6.1.2.1.7. Rotation resistant rope shall not be used for fabricating slings.	**C**		
6.1.2.2. Sling Inspection and Test Requirements:	**I**		
6.1.2.2.1. Before their first operational use at the payload processing facility and launch site area, and following modifications or repairs, slings shall be inspected and tested. Sling testing will be in accordance with Table 6-1.	**C**		
6.1.2.2.2. Before every use, slings shall be visually inspected in accordance with ASME B30.9 methodology. Slings showing evidence of damage or rejectable criteria shall not be used in operations.	**C**		
6.1.2.2.3. Slings used to support noncritical operations shall be inspected and load tested within four years of intended use. Inspection shall be completed in accordance with the methodology in ASME B30.9. Testing shall be completed in accordance with NASA-STD 8719.24 Annex Table 6-1.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.2.2.4. Slings used to support critical operations shall be inspected and load tested within one year of intended use. The inspection and load testing shall be in accordance with ASME B30.9 methodology and shall follow the Range Safety approved NDE plan. Testing shall be completed in accordance with NASA-STD-8719.9 and shall follow the PSWG and Range Safety approved NDE plan.	**C**		
NASA-STD 8719.9 identifies the test and inspection requirements for slings used infrequently and/or for non-critical lifts.	**I**		

Table 6-1: Sling 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	Lesser of 3 times yield or 5 times ultimate	2.0[2]	1.0
Shackles, D-rings, Turnbuckles, Eye Bolts, Lifting Lugs, Safety Hoist Rings, etc.[5]	5	2.0	1.0

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.
4. Proof load test shall be performed only by manufacturer or an equivalent entity approved by the responsible Lifting Device Equipment Manager (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: 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 sling in question to understand when a test might be harmful or otherwise inappropriate for that sling, and of required points of inspection.
   - Note: Periodic load test shall be accomplished within 1 year prior to use. 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.

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5. Shackles, D-rings, turnbuckles, eye bolts, lifting lugs , safety hoist rings, etc. are considered rigging hardware and used as below-the-hook lifting devices (see Volume 3 paragraph 6.1.3) or may be considered part of a sling assembly.			
6.1.2.2.5 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.	**C**		
6.1.3. Below-the-Hook Lifting Devices (BTHLDs):	**I**		
BTHLD are all structural and mechanical lifting devices and equipment, except for slings, hydrasets, 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.	**I**		
6.1.3.1. BTHLD Design Standards and Requirements:	**I**		
6.1.3.1.1. BTHLDs shall be designed and manufactured in accordance with ANSI/ASME B30.20, *Below Hook Lifting Devices*. Structural BTHLDs shall be designed by a structural engineer. A structural analysis that qualifies the unit for 125 percent initial load test and an NDE plan shall be submitted to the PSWG for PSWG and Range Safety review and approval.	**C**		
6.1.3.1.2. 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.	**C**		
6.1.3.2. BTHLD Inspection and Test Requirements:	**I**		
6.1.3.2.1. 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 tested in accordance with ANSI/ASME B30.20 methodology and the PSWG and Range Safety approved NDE plan.	**C**		
6.1.3.2.2. Before every use, BTHLDs shall be visually inspected in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan. BTHLDs showing evidence of damage or rejectable criteria shall not be used in operations.	**C**		
6.1.3.2.3. All BTHLDs shall be inspected and load tested to 125 percent of the rated load within 4 years of intended use in accordance with ANSI/ASME B30.20 methodology and the PSWG and Range Safety approved NDE plan.	**C**		
6.1.3.2.4. All BTHLDs used to support critical operations shall be inspected and load tested within one year of intended use in accordance with Option 1 or 2 of Attachment 2 of this volume and the PSWG and Range Safety approved NDE plan. *Note: Such testing is to be performed only by or with the permission of the manufacturer, or by an Equivialent Entitiy approved by the responsible LDEM.*	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.3.2.5. A BTHLD 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 PSWG, Range Safety, the center LDEM and the appropriate local safety authority on a case-by-case basis. Subject to PSWG, Range Safety, and the center's LDEM review and approval, such structures may be verified using an alternate approach based on fracture mechanics and proof-test logic. (See Attachment 2 of this volume, Option 1 or 2.)	**C**		
6.1.4. Handling Structures:	**I**		
Handling structures are those structures used to handle and manipulate hardware or equipment, such as spin tables and rotating devices.	**I**		
6.1.4.1. Handling Structure Design Standards and Requirements:	**I**		
6.1.4.1.1. Handling structures shall be designed with a yield factor of safety of 3 based on rated loads.	**C**		
6.1.4.1.2. 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.	**C**		
6.1.4.1.3. Handling structures shall be designed to accommodate the seismic load as specified by that location's building code and approving authorities.	**C**		
6.1.4.1.4. 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.	**C**		
6.1.4.1.5. Handling structures whose materials of construction do not meet the ductile material failure criteria above shall be designed to ultimate factor of safety of 5 based on rated load. Also, the design analysis shall include a fracture mechanics analysis to show a service life cycle factor of safety of 100:1 and detailed NDE surface and/or volumetric requirements.	**C**		
6.1.4.2. Handling Structure Inspection and Test Requirements:	**I**		
6.1.4.2.1. 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 200 percent of the rated load.	**C**		
6.1.4.2.2. Handling structures designed to a factor of safety less than 3, but greater than or equal to 2, shall be inspected and load tested to 150 percent of rated load.	**C**		
6.1.4.2.3. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.4.2.4. Handling structures shall be inspected and load tested to 125 percent of the rated load within 4 years of intended use in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan.	**C**		
6.1.4.2.5. Handling structures used to support critical operations shall be inspected and load tested to the same load level used in the initial testing within one year of intended use in accordance with Option 1 or 2 of Attachment 2 of this volume and the PSWG and Range Safety approved NDE plan.	**C**		
6.1.4.2.6. Handling structures 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 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. See Attachment 2 of this volume, Option 1 or 2.	**C**		
6.1.5. Support Structures:	**I**		
Support structures are those structures used to support hardware or equipment, such as payload support stands.	**I**		
6.1.5.1. Support Structure Design Standards and Requirements:	**I**		
6.1.5.1.1. Support structures shall be designed with a yield factor of safety of 3 based on rated loads.	**C**		
6.1.5.1.2. 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 limit loads.	**C**		
6.1.5.1.3. 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.	**C**		
6.1.5.1.4. 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 detailed NDE surface and/or volumetric requirements.	**C**		
6.1.5.1.5. 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.	**C**		
6.1.5.2. Support Structure Inspection and Test Requirements:	**I**		
6.1.5.2.1. Before their first operational use, all new, altered, modified, or repaired support structures shall be inspected and load tested in accordance with applicable industry methodology and the PSWG and Range Safety approved NDE plan to 200 percent of rated load at a minimum.	**C**		
6.1.5.2.2. Support structures designed to a factor of safety less than 3 but greater than or equal to 2 shall be inspected and load tested to 150 percent of rated load.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.5.2.3. 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.	**C**		
6.1.5.2.4. 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.	**C**		
6.1.5.2.5. Support structures used to support critical operations shall be 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.	**C**		
6.1.5.2.6. 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.	**C**		
6.1.6. Hydrasets and Load Cells:	**I**		
Hydrasets are mechanical devices, attached to a crane/hoist hook and BTHLD, used to make fine adjustments to the load position during lifting operations. Load cells are devices, attached to a crane/hoist hook and BTHLD, used to measure the weight of the load being lifted.	**I**		
6.1.6.1. Operator Training. Hydraset operators shall be trained and certified.	**C**		
6.1.6.2. Hydraset and Load Cell Design Requirements:	**I**		
6.1.6.2.1. Hydraset and load cell 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.	**C**		
6.1.6.2.2. Failure of the Hydraset or load cell shall not result in dropping or uncommanded movement of the suspended or supported load.	**C**		
6.1.6.2.3. All Hydrasets and load cells shall be designed with an ultimate factor of safety of 5.	**C**		
6.1.6.2.4. A Hydraset and/or load cell 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.	**C**		
6.1.6.3. Hydraset and Load Cell Inspection and Test Requirements:	**I**		
6.1.6.3.1. Before their first operational use, new, altered, repaired, or modified hydrasets and load cells shall be inspected and load tested to 200 percent of rated load to verify controls and performance (for example, structural, mechanical, electrical). Hydrasets and load cells shall be load tested by the manufacturer or if authorized, in accordance with the manufacturer instructions to prevent system damage.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.6.3.2. NDE shall be performed during inspection and test per the NDE plan.	**C**		
6.1.6.3.3. Before every use, hydrasets and load cells shall be visually inspected for proper function, loose hardware, excessive wear and contamination, corrosion, cracks, or damage, and hydraulic system deterioration. Hydrasets or load cells showing evidence of damage or rejectable criteria shall not be used in operations.	**C**		
6.1.6.3.4. Hydrasets and load cells used to support critical operations shall be inspected and load tested to 125 percent of the rated load within 1 year of intended use and calibrated in accordance with manufacturer instructions. Load testing to 125 percent shall be authorized by the manufacturer and performed in accordance with the manufacturer instructions to prevent system damage.	**C**		
6.1.6.3.5. Hydrasets and load cells used to support critical operations shall undergo operational tests in conjunction with proof and periodic load tests and at least once per year. The hydraset shall be operated to approximately the midstroke position with a test load of 50 to 100 percent of the hydraset's 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.	**C**		
NASA-STD 8719.9 provides test and inspection requirements of hydrasets and load measuring devices used infrequently and/or for non-critical lifts.	**I**		
6.1.7. 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.	**C**		
6.3 REMOVABLE, EXTENDIBLE, AND/OR HINGED PERSONNEL WORK PLATFORMS Requirements for the design, inspection, and test of personnel work platforms are included below.	**I**		
6.3.1. Removable, Extendible, and/or Hinged Personnel Work Platform Design Requirements:	**I**		
6.3.1.1. 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.	**C**		
6.3.1.2. 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.	**C**		
6.3.1.3. 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.	**C**		
6.3.1.4. A minimum of 2,000 pounds shall be used for concentrated loading (point loading).	**C**		
6.3.1.5. Guardrail systems and toe boards shall be provided and designed in accordance with 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.3.1.6. 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.	**C**		
6.3.1.7. Movable platform structures shall be grounded with the bonding conductor size in accordance with the NEC Article 250-102, Bonding Jumpers.	**C**		
6.3.2. Removable, Extendible, and Hinged Personnel Work Platform Marking Requirements.	**I**		
6.3.2.1. All platforms shall be clearly marked with two-inch letters minimum indicating maximum load capacity.	**C**		
6.3.2.2. The following information shall be imprinted on a metal tag attached to the platform:	**C**		
6.3.2.2.1. Maximum distributed load.	**C**		
6.3.2.2.2. Maximum concentrated load (point load).	**C**		
6.3.3. Removable, Extendible, and/or Hinged Personnel Work Platform Inspection and Test Requirements. At a minimum, the following tests shall be performed:	**C**		
6.3.3.1. 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.	**C**		
6.3.3.2. Visual inspection shall be performed annually on all hinges, attaching points, and other high stress or abuse prone components on all platforms.	**C**		
6.3.4. 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.	**C**		
6.4 LIFTING PERSONNEL WITH A CRANE 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.	**C**		
6.4.1 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, and ASME B30.23, Personnel Lifting Systems for all lifts of personnel.	**C**		
6.5 FLIGHT HARDWARE USED TO LIFT CRITICAL LOADS AND CLAMPBANDS.	**I**		
6.5.1. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.5.2. 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.	**C**		
6.5.3. 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:	**C**		
6.5.3.1. 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.	**C**		
6.5.3.2. After the load test, volumetric and surface NDE testing shall be performed on all clampbands, lift fitting SFP components and SFP welds.	**C**		
6.5.4. 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, A1.2.5.6.2.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. 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 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.	**C**		
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.	**C**		
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 (f ft) shall not exceed 65 dBA.	**C**		
7.1.4. Payload project shall coordinate with local authorities to ensure that potential acoustic hazards are evaluated by qualified personnel.	**C**		
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.	**C**		
7.2 ACOUSTIC DATA REQUIREMENTS Acoustic data requirements shall be submitted in accordance with Attachment 1, A1.2.4.12.2 of this volume.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 8 NON-IONIZING RADIATION SOURCES	**I**		
8.1 RADIO FREQUENCY EMITTERS The following requirements apply to radio frequency (RF) emitters unless exempted by the local authorities as identified by the PSWG in conjunction with Range Safety.	**C**		
The following general categories of RF and microwave radiation devices are typically exempt from review, unless the results of a hazard analysis indicate that a 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. RF Emitter Design Standards:	**I**		
8.1.1.1. RF 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, and local guidance and requirements as identified by the PSWG and Range Safety. *Note: Kennedy NASA Procedural Requirement (KNPR) 1860.2, KSC Nonionizing Radiation Protection Program, and 45 SWI 40-201 or 30 SWI 48-102, Control of Radiofrequency Radiation, provide local requirements for KSC, CCAFS, and VAFB.*	**C**		
8.1.1.2. Where total protection is not possible through the design process, clearance areas and access controls shall be established.	**C**		
8.1.1.3. The payload project shall contact the local range and/or facility authorities with responsibility for RF safety and deconflicting RF transmissions as identified by the PSWG in conjunction with Range Safety and provide RF system design data as needed for the authorities to evaluate RF levels, determine the hazard potential for personnel, and ultimately provide approval of the RF system.	**C**		
8.1.2. RF Emitter Design:	**I**		
8.1.2.1. RF Emitter General Design Requirements:	**I**		
8.1.2.1.1. RF 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
8.1.2.1.2. Where necessary, safety devices shall be provided to protect operating personnel and exposed initiators during ground operations	**C**		
Interlocks and interrupts are examples of safety devices that may be used to protect operating personnel and exposed initiators during RF emitter ground operations.	**I**		
8.1.2.1.4. Fail-safe systems shall be incorporated so that inadvertent operation of any hazardous RF emitting system is prevented.	**C**		
8.1.2.2. Special Considerations for Electroexplosive and Critical Subsystem Exposure to RF Radiation:	**I**		
8.1.2.2.1. Electroexplosive subsystems shall not be exposed to RF radiation that is capable of firing the electroexplosive device (EED) by pin-to-pin bridgewire heating or pin-to-case arcing.	**C**		
8.1.2.2.2. RF power at the EED shall not exceed 20 dB below the pin-to-pin direct current (DC) no-fire power of EED.	**C**		
8.1.2.2.3. The use of RF emitters in proximity to electro-explosive subsystems shall be in accordance with AFMAN 91-201, Explosives Safety Standards, DoD 6055.9-STD, DoD Ammunition and Explosives Safety Standards and NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics. Category A non-explosive actuator circuits and other critical circuits that control safety inhibits, or circuits that could result in personnel injury, payload or launch vehicle system damage or loss, shall be designed to provide a 6 dB safety margin. *Note: NASA Standard 7002, Payload Test Requirements, defines EMI test program requirements.*	**C**		
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.	**C**		
8.1.3. RF Emitter Initial Test Requirements:	**I**		
8.1.3.1. All RF emitters shall have their RF hazard area verified by the RPO/RSO or a designated representative before the first operation and/or test.	**C**		
8.1.3.2. Safety features shall be tested, verified and documented before first operation/test.	**C**		
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.	**C**		
8.1.3.2.2. Test results shall be submitted to local safety authorities as identified by the PSWG and Range Safety.	**C**		
8.1.4. RF Emitter Data Requirements:	**I**		
8.1.4.2. RF Emitter Design and Test Data. The RF emitter design and test data requirements shall be submitted in accordance with Attachment 1, A1.2.4.10.2.2 of this volume.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
8.2 LASER SYSTEMS	**I**		
8.2.1. Laser System Design Standards:	**C**		
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, and local guidance as defined by the appropriate local authorities as identified by the PSWG and Range Safety.	**C**		
8.2.1.2. Where total protection against exposure is not possible through the design process, clearance areas and access controls shall be established.	**C**		
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 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.	**C**		
8.2.2. Laser System General Design Requirements. 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	**C**		
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 KHB 1860.2, KSC Nonionizing 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.	**C**		
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.	**C**		
8.2.2.3. Automatic, independent, redundant controls shall be provided to positively prohibit harmful radiation from areas outside the intended operating area.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
8.2.2.4. In addition to automatic controls, emergency laser shutdown or shuttering capability shall be provided.	**C**		
8.2.2.5. Emergency shutdown or shuttering shall be fail-safe or redundant.	**C**		
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.	**C**		
8.2.2.7. Laser system mounts installed on moving or airborne vehicles shall be designed to compensate for the motion of the vehicle.	**C**		
8.2.2.8. Heating effects on unprotected laser platforms shall be considered when siting and setting elevation and azimuth stops.	**C**		
8.2.2.9. Hazardous materials used in laser systems shall meet the ground support requirements of Chapter 10 of this volume.	**C**		
8.2.2.10. Laser systems with pressurized subsystems such as cryogenic fluids shall meet the requirements of Chapter 11 of this volume.	**C**		
8.2.2.11. Electrical ground systems used in laser systems shall meet the requirement of Chapter 14 of this volume.	**C**		
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.	**C**		
8.2.3.2. Safety features shall be verified before first operational use or test at the payload processing facility and launch site area.	**C**		
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.	**C**		
8.2.4. Laser System Data Requirements:	**I**		
8.2.4.1. Laser system data requirements shall be submitted in accordance with Attachment 1, A1.2.4.10.3.6 of this volume.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.*	**C**		
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:	**C**		
8.2.5.1. Protective Housings shall be provided for all classes of lasers or laser systems, except as provided 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:* • *access restrictions* • *eye protection* • *area controls* • *barriers, beam stops, shrouds, etc.* • *administrative and procedural controls* • *education and training.*	**C**		
8.2.5.2 A master switch shall be operated by a key, or by coded access (computer code).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
8.2.5.4 Viewing Portals, Collecting Optics and Display Screens	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 insure personnel safety.*	**C**		
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.*	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
8.2.5.7 Laser Activation and Warning Systems	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
8.2.5.8 Remote Firing and Monitoring	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 9 RADIOACTIVE (IONIZING) RADIATION SOURCES	**I**		
9.1 RADIOACTIVE SOURCE DESIGN STANDARDS AND CONTROLS	**I**		
9.1.1. Radioactive Source Design Standards:	**C**		
9.1.1.1. Radioactive systems shall conform to the requirements from 10 CFR, *Energy*, 49 CFR, *Transportation*, and local authorities as specified by the PSWG and Range Safety. *Note: Some references for Air Force property are AFI 40-201, Managing Radioactive Materials In The USAF, and AFI 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems, DODD 3100.10, and for Kennedy Space Center KNPR 1860.1, KSC Ionizing Radiation Protection Program is used.*	**C**		
9.1.1.2. Radioactive sources shall be designed to prevent the release of radioactive material.	**C**		
9.1.1.3. 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.	**C**		
9.1.1.4. Radiation hazard warning signs and/or labels shall be fixed to the container or housing as directed by the appropriate RPO.	**C**		
9.1.1.5. High voltage sources shall be evaluated to determine their capability of producing X-rays.	**C**		
9.1.1.6. High voltage sources shall be properly shielded and shall use interlocks on cabinet doors to interrupt power when a door is open.	**C**		
9.1.1.7. Control measures for flight systems shall be handled on a case-by-case basis.	**C**		
9.1.1.8. Payload projects shall comply with local environmental policy and the NEPA, National Environmental Policy Act, requirements and provide compliance documentation to the RPO/RSO (or the Radiation Safety Committee (RADSAFCOM) on the WR).	**C**		
9.1.1.9. Application for ionizing radiation permits shall be submitted in accordance with local radiation requirements as directed by the PSWG and Range Safety . USAF permits shall be submitted in accordance with AFI 40-201 and any range-specific requirements of 30 SWI 40-101 for the WR or 45 SWI 40-201 for the ER.	**C**		
9.1.1.10. The license holder or the payload project shall submit 3 copies of the NRC or State radioactive materials license with the appropriate permits to appropriate local safety authority as identified by the PSWG and Range Safety at least 90 calendar days before planned entry to the range.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Licensing and permitting requirements and procedures are specified in 10 CFR. For USAF, AFI 40-201, Managing Radioactive Materials in the USAF, and 45 SWI 40-201, Radiation Protection Program. For KSC Requirements are provided in KNPR 1860.1, KSC Ionizing Radiation Protection Program.	**I**		
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 CCAFS is provided by the 45 SW 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 45 SWI 40-201.	**C**		
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.	**C**		
9.1.2.2. Additional WR Design Controls:	**I**		
9.1.2.2.1. Written approval for use of radioactive materials on VAFB is provided by the 30 SW 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 30 SWI 40-101 and 30 SW Supplement 1 to AFI 91-110.	**C**		
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 AFI 40-201.	**C**		
9.1.2.2.3. The final Safety Analysis Summary (SAS) and AFI 91-110 Radiation Protection Plan shall be submitted 120 days before source arrival on the range.	**C**		
9.2 RADIOACTIVE SOURCES CARRIED ON PAYLOADS In addition to the design requirements noted in 9.1.1, radioactive materials carried on payloads shall meet the following requirements:	**C**		
9.2.1. Radioactive Sources Carried on Payloads General Design Requirements:	**C**		
9.2.1.1. 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 FTSs.	**C**		
9.2.1.2. 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 45 SWI 40-201 and 30 SWI 40-101) while performing other tasks on payloads.	**C**		
9.2.2. Radioactive Sources Carried on Payloads Test Requirements:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
9.2.2.1. General. To launch radioactive materials, adequate 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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 AFI 91-110.	**C**		
9.2.3.2. The payload projects shall also comply with 30 SW Supplement 1 to AFI 91-110 and 30 SWI 40-101 on the WR or 45 SWI 40-201 on the ER.	**C**		
9.2.3.3. Certification of compliance with an equivalent government agency safety review and launch approval process is required for all payload projects.	**C**		
9.2.3.4. Payload projects using radioactive sources are subject to NPR 8715.3, Chapter 6, and Presidential Directive/National Security Council (NSC) 25, dated 08 May 1996, Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space.	**C**		
PD/NSC-25 establishes an Interagency Nuclear Safety Review Panel (INSRP) for major sources. Range Safety is a member to provide launch abort data and evaluation; therefore, some failure mode, breakup, and blast data may be obtained from Range Safety.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 10 HAZARDOUS MATERIALS	**I**		
10.1 HAZARDOUS MATERIALS SELECTION CRITERIA 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.	**I**		
10.1.1. Hazardous Materials Flammability and Combustibility:	**I**		
10.1.1.1. The least flammable material shall be used.	**C**		
10.1.1.2. Materials that will not burn readily upon ignition shall be used.	**C**		
10.1.2. Hazardous Materials Toxicity:	**I**		
The NASA Material and Process Technical Information System (MAPTIS) contains material codes and ratings for materials, standard and commercial parts, and components. 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, is recommended.	**I**		
10.1.2.1. The least toxic material shall be used.	**C**		
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)	**C**		
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.	**C**		
10.1.3.2. Compatibility shall be determined on a case-by-case basis.	**C**		
10.1.3.3 Non-Flight materials used in processing and testing of flight hardware shall not cause degradation of the flight hardware.	**C**		
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.	**C**		
10.2 HAZARDOUS MATERIALS TEST REQUIREMENTS	**I**		
10.2.1. Plastic Materials Test Requirements:	**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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
10.2.2.2. Toxicity, reactivity, compatibility, flammability and/or combustibility testing requirements shall be determined on a case-by-case basis.	**C**		
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.	**C**		
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.	**C**		
10.3.3. Payload project business plans shall comply with the range Hazardous Materials (HAZMAT) Plan.	**C**		
10.4 HAZARDOUS MATERIALS DATA REQUIREMENTS Hazardous materials data requirements shall be submitted in accordance with Attachment 1, A1.2.4.13 of this volume.	**C**		
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, Risk Management Program, for Process Safety Management (PSM) and Risk Management Plan (RMP) and will be identified in the System Safety Plan (SSP).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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) and ground support equipment (GSE).	**I**		
Ground support hazardous pressure systems are defined as follows: *(1) 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) systems that are identified as safety critical.*	**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 NPD 8710.5 Policy for Pressure Vessels and Pressurized Systems, NASA-STD-8719.17, and with accepted national industry standards such as NFPA, UL, American Petroleum Institute (API), ASME, Department of Transportation (DOT), T.O. 00-25-223, Integrated Pressure Systems and Components (Portable and Installed), and federal, state, and local environmental regulations.	**C**		
11.1.1.1. Negative pressure protection shall be provided for systems not designed to withstand pressure below 1 atmosphere. This can be accomplished by the use of 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.	**C**		
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.	**C**		
11.2 GROUND SUPPORT PRESSURE SYSTEMS REQUIREMENTS	**I**		
11.2.1. Generic Ground Support Pressure System Requirements	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. 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, API (American Petroleum Institute), etc.	**C**		
11.2.1.1.2. Other components shall be designed to have a service life of not less than 5,000 cycles.	**C**		
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 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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 MIL-HDBK-5, Metallic Materials and Elements for Aerospace Vehicle Structures, MIL-HDBK-17, Plastic for Aerospace Vehicles, Part 1, Referenced Plastics, 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.	**C**		
11.2.1.4.5. Compatible materials selection shall be obtained from one of the following sources:	**C**		
11.2.1.4.5.1. Integrated Pressure Systems and Components (Portable and Installed) T.O. 00-25-223.	**C**		
11.2.1.4.5.2. Chemical Propulsion Information Agency (CPIA) 394, Hazards of Chemical Rockets and Propellants.	**C**		
11.2.1.4.5.3. Marshall Space Flight Center Handbook (MSFC-HDBK)-527, Material Selection for Space Hardware, Volume 1.	**C**		
11.2.1.4.5.4. KTI-5210, NASA/KSC Material Selection List for Oxygen and Air Services.	**C**		
11.2.1.4.5.5. The NASA Material and Process Technical Information System (MAPTIS).	**C**		
11.2.1.4.5.6. KTI-5212, NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes.	**C**		
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.	**C**		
11.2.1.4.5.8. Others approved by PSWG and Range Safety sources and documents.	**C**		
11.2.1.4.6. Compatibility Testing	**C**		
11.2.1.4.6.1. Materials shall be tested for compatibility if data does not exist.	**C**		
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.	**C**		
11.2.1.4.7. Compatibility Analysis. A compatibility analysis containing the following information shall be prepared:	**C**		
11.2.1.4.7.1. List of all materials used in system.	**C**		
11.2.1.4.7.2. Service fluid in contact with each material.	**C**		
11.2.1.4.7.3. Materials that may come in contact with leaking fluid.	**C**		

<table>
<tr><th>ORIGINAL TEXT</th><th>STATUS</th><th>TAILORED TEXT</th><th>RATIONALE/ COMMENTS</th></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>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. See Table 11.1.</td><td>C</td><td></td><td></td></tr>
<tr><td>PSWG and Range Safety approved materials that provide adequate strength and material compatibility may be used for metallic components of pressure vessels, pipes, valves, and fittings.</td><td>I</td><td></td><td></td></tr>
<tr><td colspan="4">Table 11.1. Sheet/Plate Material Stainless Steel Properties.
<table>
<tr><th>Property</th><th>Requirement</th></tr>
<tr><td>Tensile strength</td><td>Minimum 75 ksi</td></tr>
<tr><td>Yield strength (0.2 percent offset)</td><td>Minimum 25 ksi</td></tr>
<tr><td>Minimum elongation in 2 inches</td><td>Longitudinal 35 percent</td></tr>
<tr><td>Minimum elongation in 2 inches</td><td>Transverse 25 percent</td></tr>
<tr><td>C maximum</td><td>0.03 percent for 304L, 316L and 0.08 percent for 304</td></tr>
<tr><td>Mn maximum</td><td>2.00 percent</td></tr>
<tr><td>P maximum</td><td>0.045 percent</td></tr>
<tr><td>S maximum</td><td>0.03 percent</td></tr>
<tr><td>Si</td><td>0.75 percent to 1.00 percent</td></tr>
<tr><td>Ni</td><td>8.00 percent to 16.00 percent</td></tr>
<tr><td>Cr</td><td>16.00 percent to 20.00 percent</td></tr>
</table></td></tr>
<tr><td>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:</td><td>C</td><td></td><td></td></tr>
</table>

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.1.6.8. Filter design shall permit easy servicing and ready accessibility.	**C**		
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:	**C**		
11.2.1.7.2. Portable and mobile pressure vessels shall be marked in accordance with the applicable DOT specifications.	**C**		
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.	**C**		
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):	**C**		
11.2.1.7.6.1. Manufacturer and/or contractor name.	**C**		
11.2.1.7.6.2. Manufacturer part number.	**C**		
11.2.1.7.6.3. Applicable design pressure rating.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.1.7.6.4. Service media.	**C**		
11.2.1.7.6.5. Month and year of most recent calibration for gauges and transducers.	**C**		
11.2.1.7.6.6. Flow direction arrow, if applicable.	**C**		
11.2.1.7.6.7. System reference designation for the component, such as CV1, CV2.	**C**		
11.2.1.7.6.8. Unique serial number.	**C**		
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.	**C**		
11.2.1.7.8. The system shall be designed or marked to prevent incorrect installation of filters.	**C**		
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 (MSPSP):	**C**		
11.2.1.7.9.1. Manufacturer name.	**C**		
11.2.1.7.9.2. Manufacturer and/or contractor part number.	**C**		
11.2.1.7.9.3. Hose size, date of manufacture, and effective shelf/use life.	**C**		
11.2.1.7.9.4. Maximum allowable working pressure (MAWP) or manufacturer rated working pressure.	**C**		
11.2.1.7.9.5. Service media.	**C**		
11.2.1.7.9.6. Month and year of most recent hydrostatic test and test pressure.	**C**		
11.2.1.7.9.7. System reference designation for the hose, such as FH1, FH2.	**C**		
11.2.1.7.9.8. Unique serial number.	**C**		
11.2.1.7.10. An identification tag that is permanently and legibly marked with the month and year of the most recent set pressure calibration shall be attached to the relief valve.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
11.2.1.8.1. Any single joint measurement shall exhibit a DC resistance of 1.0 ohm or less.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.1.8.8. Tubing sections joined with fittings that seat metal-to-metal are considered adequately bonded.	**C**		
11.2.1.8.9. All mobile equipment shall be equipped for connection to bonding and grounding stations.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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).	**C**		
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).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.1.9.7. Pipes containing liquids shall not be attached or secured to electrical lines or conduit.	**C**		
11.2.1.9.8. A two-inch space shall be maintained between electrical conduits and pressure lines.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.1.9.13. Pipe or flex hose routing shall not block personnel egress routes.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.1.9.15. Valves carrying hazardous liquids shall not be located overhead in the area of an operating station.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.1.9.19. Systems shall be designed with accessibility to perform end-to-end static ground system checks.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.1.9.24. Components shall be located and lines routed to minimize the risk of ignition should a leak or rupture occur.	**C**		
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.*	**C**		
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.	**C**		
11.2.2. Ground Support Pressure System Hardware Design Requirements	**I**		
11.2.2.1. All systems components such as valves, regulators, flexible hoses, pipe line sections, and fittings shall be subjected to a hydrostatic test of 1.5 times the system maximum operating pressure (MOP)/MAWP. Where hydrostatic testing is not desirable, a pneumatic test at 1.25 times the MOP/MAWP may be performed as an alternative test with PSWG, Range Safety, and Center Pressure Systems Manager approval.	**C**		
11.2.2.2. Propellant systems shall be designed to ensure separation of fuels and oxidizers to prevent inadvertent mixing during operations.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.3. All calibration adjustments shall be designed so that the setting, position, or adjustment cannot be inadvertently altered.	**C**		
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.	**C**		
11.2.2.4.13. All pressure vessels shall be designed to allow for a minimum 10-percent ullage space at full-load conditions.	**C**		
11.2.2.5. Portable or Mobile Pressure Vessels	**I**		
11.2.2.5.1. Mobile equipment for public and range highway use shall be designed, fabricated, inspected, and tested to meet the requirements in 49 CFR, Subpart 6, Parts 1000 through 1199, Surface Transportation Board, Department of Transportation. A copy of any DOT-approved exemptions shall be provided to the appropriate local safety authority as identified by the PSWG and Range Safety.	**C**		
11.2.2.5.2. DOT pressure vessels shall be protected against overpressure in accordance with 49 CFR.	**C**		
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 code.	**C**		
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:	**C**		
11.2.2.6.1. Pipe material shall be in accordance with ASTM A312, 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.	**C**		
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.	**C**		
Butt-weld fittings should be constructed of ASTM A403, grade WP-316L or WP-304Lwrought stainless steel.	**I**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.6.4.1. NPT connectors may be used for small (1-inch Nominal Pipe Size or less) connections on selected supply components for 6,000 psig gaseous nitrogen (GN2) and helium (GHe) metering and letdown stations. Selected components are sample ports, vent/ blowdown valves, pressure indicators, thermowells, and pressure regulation sensors.	**I**		
11.2.2.6.4.2. 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.	**I**		
11.2.2.6.4.6. 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.	**C**		
11.2.2.6.5. Socket welded flanges shall not be used in hazardous pressure system piping.	**C**		
11.2.2.6.6. All piping welds shall be of the full penetration butt-weld type.	**C**		
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.	**C**		
11.2.2.6.8. Cryogenic piping systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.	**C**		
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.	**C**		
11.2.2.6.11. Cryogenic Pipe Weld Inspection	**C**		
11.2.2.6.11.1. All inner pipe welds shall be 100 percent radiographically inspected.	**C**		
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..	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.2.7.4. Tubing used with AN or MS fittings shall be flared per MS33584, Tubing End, Standard Dimensions for Flared, and tubing used with KSC-GP-425 fittings shall be flared per KSC-GP-425. "Crush" washers are prohibited.	**C**		
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.	**C**		
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.	**C**		
11.2.2.7.7. Tube fittings with NPT connectors shall not be used in hazardous pressure systems.	**C**		
11.2.2.7.8. The number of mechanical joints in tubing systems shall be kept to a minimum.	**C**		
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, or KSC-SPEC-Z-0007, Tubing, Steel, Corrosion Resistant, Seamless, Types 304 and 316.	**C**		
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.	**C**		
11.2.2.8.2. Manually operated regulators shall be selected so that over torqueing the regulator cannot damage soft seats to the extent that seat failure occurs.	**C**		
11.2.2.8.3. Regulators shall be designed so that a functional failure cannot create a hazard to personnel.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.2.8.9. Regulator designs using uncontained seats shall not be used.	**C**		
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.	**C**		
11.2.2.8.11. Remote readout pressure transducers are required to monitor hazardous operations from a remote location.	**C**		
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.	**C**		
11.2.2.9.2. Remotely operated valves shall be designed to be fail-safe if pneumatic or electric control power is lost.	**C**		
11.2.2.9.3. Designs using uncontained seats shall not be used.	**C**		
11.2.2.9.4. Use of metal-to-metal seats without prior PSWG, Range Safety, and Center Pressure Systems Manager concurrence is prohibited.	**C**		
11.2.2.9.5. Inlet and outlet isolation valves (shutoff valves) and appropriate intermediate vent valves shall be provided for shutdown and maintenance.	**C**		
11.2.2.9.6. Valve stem travel shall be limited by a positive stop at each extreme position.	**C**		
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.	**C**		
11.2.2.9.8. Manually operated valves shall be designed so that overtorqueing the valve stem cannot damage soft seats to the extent that seat failure occurs.	**C**		
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.	**C**		
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.	**C**		
11.2.2.9.11. Systems shall have shutoff valves located as close to the supply vessel as practical and be readily accessible.	**C**		
11.2.2.9.12. Remotely controlled valves shall provide for remote monitoring of open and closed positions.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.2.9.15. Valves used in flared tubing system applications shall be designed for panel or other rigid mounting.	**C**		
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.	**C**		
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.	**C**		
11.2.2.9.17.1. Check valves shall be provided where back flow of fluids would create a hazard.	**C**		
11.2.2.9.17.2. Check valves shall be the spring-loaded type with soft seats.	**C**		
11.2.2.9.18. The use of sheathed flexible actuators, such as push/pull wires and cables, for valve control is prohibited.	**C**		
11.2.2.9.19. All electrical control circuits for remote activation shall be shielded or otherwise protected from hazardous stray energy.	**C**		
11.2.2.9.20. Balanced manual valves that use external balancing ports or vents open to the atmosphere shall not be used.	**C**		
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.	**C**		
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.	**C**		
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.*	**C**		
11.2.2.10.2. Vent system outlets shall be in a location normally inaccessible to personnel and shall be conspicuously identified.	**C**		
11.2.2.10.3. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.10.4. Oxidizer and fuel vent outlets to the atmosphere shall be separated sufficiently to prevent mixing of vented fluids/gases.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.2.10.8. Incompatible fluids shall not be discharged into the same vent or drain system.	**C**		
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.	**C**		
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.	**C**		
11.2.2.10.11. Personnel and critical equipment shall be protected from potential venting hazards.	**C**		
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.	**C**		
11.2.2.10.13. Test points shall be provided on pressure systems so that disassembly for test is not required.	**C**		
11.2.2.10.14. Test points shall be easily accessible for attachment of ground test equipment.	**C**		
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.	**C**		
11.2.2.10.16. Sample ports shall be provided at cryogenic system low points.	**C**		
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.	**C**		
11.2.2.10.18. Gauge calibration ports shall be designed to limit potential impingement of contaminated gas on personnel.	**C**		
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.	**C**		
11.2.2.11. Ground Support Pressure System Indicating Devices	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.11.1. All pressure gauges shall conform to the requirements of ANSI/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.*	**C**		
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.	**C**		
11.2.2.11.3. Gauges shall be sized to accurately display the pressure to be used in the system.	**C**		
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.	**C**		
11.2.2.11.5. Gauges shall be securely attached to a panel or other rigid mounting.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.2.11.9. Remote readout pressure transducers shall be used when it is necessary to monitor hazardous operations from a remote location.	**C**		
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.	**C**		
11.2.2.11.11. Liquid system liquid sensors suitable for indicating the presence or absence of liquid shall be provided.	**C**		
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.	**C**		
Low carbon stainless steels such as type 304L or 316L should be used for welded parts.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.2.11.14. Liquid system sight glasses used for liquid level indicators shall be protected from physical damage.	**C**		
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.	**C**		
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 $inch^3$.	**C**		
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.	**C**		
11.2.2.12. Ground Support Pressure System Flexible Hoses	**I**		
11.2.2.12.1. 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.	**C**		
11.2.2.12.2. Flexible hoses shall consist of a flexible inner pressure carrier tube (compatible with the service fluid) constructed of elastomeric [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.	**C**		
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**		
11.2.2.12.3. 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 ANSI B16.5 flange or KC159 hub. Other end fittings may be used for unique applications, with prior PSWG and Range Safety approval.	**C**		
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.	**C**		
11.2.2.12.5. Hoses over 2 feet long pressurized to 150 psig or greater shall meet the following restraint requirements:	**C**		
11.2.2.12.5.1. Flexible hoses shall have safety chains or cables securely attached across each union or splice and 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 whiplash in the event of a failure.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.2.12.5.3. Flexible hose restraint devices shall be capable of withstanding not less than 6 times the open line pressure force. See Table 11.2 below.	**C**		
11.2.2.12.5.4. The design safety factor for restraint devices shall not be less than 3 on material yield strength.	**C**		
11.2.2.12.5.5. Temporary flexible hose installations may be weighted with 50-pound sand bags, lead ingots, or other suitable weights at intervals not to exceed 6 feet.	**C**		
11.2.2.12.5.6. Hose clamp-type restraining devices shall not be used.	**C**		

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)	

11.2.2.12.6. Flexible hose installation shall be designed to avoid abrasive contact with adjacent structures or moving parts.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.2.12.10. Flexible hoses shall not be exposed to temperatures that exceed the rated temperature of the hose.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
A guidance document for performing the flow-induced vibration analysis is MSFC 20MO2540, Assessment of Flexible Line and Flow-Induced Vibration.	**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.	**C**		
11.2.2.12.15. A means of plugging or capping flexible hoses shall be provided when the hose is not in use.	**C**		
11.2.2.12.16. Ground Support Cryogenic System Flexible Hoses:	**C**		
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.	**C**		
11.2.2.12.16.2. Flexible hoses shall be of the single-wall, double-wall, or double-wall vacuum-jacketed type.	**C**		
11.2.2.12.16.3. All convoluted portions of flexible hoses shall be covered with stainless steel wire braid.	**C**		
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 Code, Section VIII, Division 1. Rupture disks alone shall not be used to protect against overpressure.	**C**		
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 Code, Section VIII, Division 1, Paragraphs UG-127(a)(3)(b) and UG 127(a)(3)(c) are met.	**C**		
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.	**C**		
11.2.2.13.4. All rupture discs installed in hazardous fluid systems shall be replaced every two years.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Providing a screen between the rupture disc and the valve to prevent rupture disc contamination of the relief valve should be considered.	**I**		
11.2.2.13.5. Installation of the pressure relief devices shall be in accordance with ASME Code, Section VIII, Division 1.	**C**		
11.2.2.13.6. The flow capacity for all relief devices shall be certified in accordance with ASME Code, Section VIII, Division 1, Paragraph UG-127, UG-129, UG-131, and UG-132, as applicable.	**C**		
11.2.2.13.7. The total relieving capacity of pressure relief devices shall be determined in accordance with ASME Code, Section VIII, Division 1, Paragraph 9.1, as applicable. The required relieving capacity shall be provided by a single valve where possible.	**C**		
11.2.2.13.8. Pressure relief devices shall be set to operate at a pressure not to exceed the MAWP of the vessel. See ASME Code, Section VIII, Division 1, Paragraphs UG-134(A), UG-134(b), UG-134(c), and UG-134(d)(1).	**C**		
11.2.2.13.9. The relieving capacity of the relief valve shall be equal to or greater than the maximum flow capability of the upstream pressure reducing device or pressure source and shall prevent the pressure from rising more than 20 percent above the system MOP or that allowed by ASME B31.3, whichever is less.	**C**		
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.	**C**		
11.2.2.13.11. Negative pressure protection shall be provided for vessels not designed to withstand pressures below one atmosphere.	**C**		
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 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 shutoff valve is allowed in accordance with ASME Code, the valve type shall have provisions for being locked in the open or closed position.	**C**		
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).	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
11.2.2.13.17. All relief devices shall be vented separately unless the following can be positively demonstrated:	**C**		
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.	**C**		
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 Code, Section VIII, Division 1, Appendix M, Paragraph M-7. The analysis shall assume that all relief valves connected to the vent system are open and flowing full capacity.	**C**		
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.	**C**		
11.2.2.13.19. Pressure relief valves shall be tested for proper setting before installation and annually thereafter.	**C**		
11.2.2.13.20. Pressure relief devices shall be marked in accordance with ASME Code, Section VIII, Division 1, Paragraphs UG-129, UG-130, UG-131, and UG-132 as applicable.	**C**		
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.	**C**		
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.	**C**		
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 shutoff 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).	**C**		
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**		

<table>
<tr><th>ORIGINAL TEXT</th><th>STATUS</th><th>TAILORED TEXT</th><th>RATIONALE/ COMMENTS</th></tr>
<tr><td>11.2.2.14.1. All piping supports, anchors, hangers, and other restraints shall conform to the requirements of ASME B31.3, Paragraph 321.</td><td>C</td><td></td><td></td></tr>
<tr><td>11.2.2.14.2. Line Restraints</td><td>I</td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>11.2.2.14.2.3. Line restraints shall be designed to withstand the thrust, torsional forces, and load conditions of operation.</td><td>C</td><td></td><td></td></tr>
<tr><td>11.2.2.14.2.4. Line restraints shall contain the line in case of line failure.</td><td>C</td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>11.2.2.14.3. All relief valves and attached vent piping shall be designed to withstand any thrust caused by venting fluids.</td><td>C</td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>11.2.2.14.5. Tubing supports within consoles or modules shall be spaced according to the maximum spacing listed in Table 11.3.</td><td>C</td><td></td><td></td></tr>
<tr><td colspan="4">Table 11.3. Spacing for Tubing Supports Within Consoles or Modules.
<table>
<tr><th>Nominal Tubing Diameter (inches)</th><th>Maximum Distance Between Tubing Support (inches)</th></tr>
<tr><td>1/8 through 3/8</td><td>18</td></tr>
<tr><td>1/2 through 3/4</td><td>25</td></tr>
<tr><td>1 and over</td><td>30</td></tr>
</table></td></tr>
<tr><td>11.2.2.14.6. Tubing supports between consoles and modules shall be spaced according to the maximum spacing listed in Table 11.4.</td><td>C</td><td></td><td></td></tr>
</table>

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 7/8** / **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.	**C**		
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.	**C**		
11.2.2.15. Reserved	**I**		
11.2.2.16. Ground Support Pressure System Pumps	**I**		
11.2.2.16.1. The Standards of the Hydraulic Institute should be used as a guide in selecting a safe pump.	**C**		
11.2.2.16.2. Gear pumps shall not be used for high pressure applications involving flammable and/or hazardous fluids.	**C**		
11.2.2.16.3. The inlet pressure of hydraulic pumps shall be controlled to prevent cavitation effects in the pump passage or outlets.	**C**		
11.2.2.16.4. Hydraulic pumps required to provide emergency power shall not be used for any other function.	**C**		
11.2.2.16.5. Hydraulic pressure systems shall have regulators with a pressure relieving or self-bleeding feature.	**C**		
11.2.2.16.6. Pumps used in hypergolic propellant systems shall be of the centrifugal type specifically designed for pumping hypergolic propellants.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.17.1.3. The ambient operating temperature for hydraulic systems shall not exceed 275°F for systems using petroleum-based fluids.	**C**		
11.2.2.17.1.4. Fluids for systems operating at temperatures higher than 275°F shall be fire resistant or fireproof for the intended service.	**C**		
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.	**C**		
11.2.2.17.1.6. All hydraulic piping installations shall be designed, installed, and tested in accordance with ASME B31.3.	**C**		
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.	**C**		
11.2.2.17.1.8. A gauge indicating accumulator gas pressure shall never be used to indicate equivalent hydraulic pressure.	**C**		
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.	**C**		
11.2.2.17.1.10. When a shutoff valve is allowed in accordance with the ASME code, the valve type shall have provisions for being secured in the open or closed position.	**C**		
11.2.2.17.1.11. The shutoff valve shall have permanent marking clearly identifying its position (OPEN or CLOSED).	**C**		
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.	**C**		
11.2.2.17.1.13. The thermal relief valve setting shall not exceed either the system test pressure or 120 percent of the system MOP.	**C**		
11.2.2.17.2. Ground Support Hydraulic System Accumulators and Reservoirs	**I**		
11.2.2.17.2.1. Accumulators and reservoirs that are pressurized with gas to pressures greater than 150 psig shall be designed, constructed, tested, certified, and code stamped in accordance with ASME Code, Section VIII, Division 1 or Division 2.	**C**		
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.	**C**		
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 160°F unless adequate fire and explosion resistance is demonstrated.	**C**		
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.	**C**		
11.2.2.17.2.5. Hydraulic systems having reservoir filling caps shall include design provisions that will automatically vent the reservoir opening.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 [N2O4], Hydrazine [N2H4,] Unsymmetrical Dimethylhydrazine [UDMH], Aerozine 50 [A-50], Monomethylhydrazine [MMH]) shall comply with NASA-STD-5005 Standard for The Design and Fabrication of Ground Support Equipment and the requirements described below.	**C**		
11.2.2.18.3. Components used in any fuel or oxidizer system shall not be interchanged after exposure to the respective media.	**C**		
11.2.2.18.4. Lubricants for hypergolic propellant systems shall be approved compatible lubricants only.	**C**		
See KSC-SPEC-Z-0006, Standard for Design of Hypergolic Propellants Ground Support Equipment, for guidance on compatible lubricants and design of hypergolic propellants GSE.	**I**		
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.	**C**		
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:	**C**		
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 hypergol system of each check valve to indicate the pressure in the hypergolic propellant system.	**C**		
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).	**C**		
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.	**C**		
11.2.2.18.6.4. Hypergolic propellant system GSE shall be designed to interface with facility scrubber or incinerator.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
11.2.2.18.11. All hypergolic fuel and oxidizer transportation and storage containers shall have the capability to be grounded.	**C**		
11.2.2.19. Ground Support Cryogenic System Hardware. The minimum design requirements for all mobile, and portable equipment used to handle liquid oxygen (LO2 or LOX), or liquid hydrogen (LH2), liquid helium (LHe), liquid nitrogen (LN2) and their respective vent gases are as follows:	**C**		
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.	**C**		
11.2.2.19.2. Cryogenic fuel and oxidizer systems shall have the capability of loading and off-loading one commodity at a time.	**C**		
11.2.2.19.3. Vacuum-jacketed systems shall be capable of having the vacuum verified.	**C**		
11.2.2.19.4. Purge gas for LH2 and cold gaseous hydrogen (GH2) lines shall be gaseous helium (GHe). Neither GN2 nor LN2 shall be introduced into any LH2 line that interfaces with a liquid storage tank cold port.	**C**		
11.2.2.19.5. Cryogenic systems shall be designed to ensure the separation of fuels and oxidizers and to prevent inadvertent mixing.	**C**		
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.	**C**		
11.2.2.19.7. Cross connection of GN2 and GHe systems is prohibited.	**C**		
11.2.2.19.8. All permanently installed cryogenic vessels shall consist of an inner and an outer shell.	**C**		
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: LH2 and LHe vessels shall be vacuum-jacketed.*	**C**		
11.2.2.19.10. The inner shell shall be designed, constructed, tested, certified, and code stamped on the exterior of the vessel in compliance with ASME Code, Section VIII, Division 1 or Division 2.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
An additional nameplate marked "DUPLICATE" may be attached to the support structure.	**I**		
11.2.2.19.12. The outer shell shall be designed for 0.0 pounds per square inch absolute (psia) internal pressure and 15.0 psia external pressure.	**C**		
11.2.2.19.13. For nonvacuum-jacketed vessels, the annular space shall be protected by means of a vacuum breaker.	**C**		
11.2.2.19.14. Local and remote readout liquid level indicators shall be provided for LH2 and LO2 (LOX) storage vessels.	**C**		
11.2.2.19.15. At a minimum, local readout capability shall be provided for all other cryogenic storage vessels.	**C**		
11.2.2.19.16. Cryogenic piping systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.	**C**		
11.2.2.19.17. Cryogenic systems shall be designed to ensure icing does not render any valve or system component inoperable.	**C**		
11.2.2.19.18. Cryogenic valves with extended stems shall be installed with the actuator approximately vertical above the valve.	**C**		
11.2.2.19.19. GH2 shall be vented to the atmosphere through a burner system.	**C**		
11.2.2.19.20. GH2 burner design and testing requirements shall be approved by the appropriate local safety authority as identified by the PSWG and Range Safety.	**C**		
11.2.2.19.21. Pressure vessels shall be designed with an opening for inspection purposes.	**C**		
11.2.2.19.22. All inner shell 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.	**C**		
11.2.2.19.23. All inner shell 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.	**C**		
11.2.2.19.24. Welded attachments to the inner vessel such as stiffening rings or supports shall be continuously welded.	**C**		
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 Code, Section VIII, Division 1, Paragraph UW-3.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation.	**C**		
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.	**C**		
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 commonly bonded and grounded during propellant transfer operations.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.2.20.3. Butt-welded joint designs shall meet the requirements of ANSI/ASME B16.9.	**C**		
11.2.2.20.4. Flanged joints shall be either weld neck or lap joint, raised face type conforming to ANSI B16.5 and shall be constructed of forged ASTM A182 304L or 316L material. The use of slip-on flanges shall be avoided.	**C**		
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.	**C**		
11.2.2.20.6. LH2 vent system flanged joints shall be metal-to-metal and shall be seal-welded unless otherwise approved by the PSWG and Range Safety.	**C**		
11.2.2.20.7. Flange bolting and studs shall conform to ANSI/ASME B18.2.1, Square and Hex Bolts and Screw Inch Series recommended dimensions with rolled threads conforming to ANSI/ASME B1.1, Unified Inch Screw Threads.	**C**		
11.2.2.20.8. Bolt materials shall be per ASTM A193 or ASTM A320.	**C**		
11.2.2.20.9. Nuts for flange bolting and studs shall be ASTM A194, conforming to ANSI/ASME B18.2.2, Square and Hex Nuts (Inch Series), heavy hex type and shall use ANSI/ASME B1.1 threads.	**C**		
Type 304 or 316 stainless steel are the preferred materials for nuts, bolts, and studs used for flange bolting.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 ANSI/ASME B16.9 and ASTM A403.	**C**		
ASTM A403 grade WP304L or WP316L wrought stainless steel is the preferred materials for pipe fittings.	**I**		
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.	**C**		
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.	**C**		
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.	**C**		
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 hydrostatically tested to a minimum of 1.5 times the components MAWP for a minimum of 5 minutes.	**C**		
11.2.3.1.3. Pressure vessels designed to meet DOT specifications shall undergo qualification and hydrostatic testing in accordance with DOT requirements.	**C**		
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.	**C**		
11.2.3.1.5. The following inspections shall be performed after hydrostatic testing:	**C**		
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.	**C**		
11.2.3.1.5.2. A component functional and leak test shall be performed at the MAWP of the component.	**C**		
11.2.3.1.6. Pressure relief devices, gauges and transducers shall be calibrated before installation and yearly thereafter.	**C**		
11.2.3.1.7. Pneumatic testing to a test pressure of 1.25 times MAWP in lieu of hydrostatic testing is permissible if hydrostatic testing is impractical, impossible, or jeopardizes the integrity of the component or system. Prior approval shall be obtained from the PSWG, Range Safety, and the Center Pressure Systems Manager for pneumatic proof testing at the payload processing facility and launch site area.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.3.1.8. Certain critical system components may require further testing (mass spectrometer) in accordance with ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination, Article 10, Appendix IV, Helium Mass Spectrometer Test – Detector Probe Technique or Appendix V, Helium Mass Spectrometer Test-Tracer Probe and Hood Techniques.	**C**		
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.	**C**		
11.2.3.1.9.1. No external leakage is allowed (bubble-tight).	**C**		
11.2.3.1.9.2. Internal leakage of valves shall not exceed limits specified in the valve performance specification.	**C**		
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.	**C**		
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 MOP before use. 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 1.25 times the MOP is acceptable in lieu of hydrostatic testing at 1.5 times the MOP. Prior approval of the plan for pneumatic testing shall be obtained from the PSWG, Range Safety, and the Center Pressure Systems Manager.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.3.2.1.5. The following inspections shall be performed on vacuum-jacketed systems:	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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 times 1.0E-09 std cm3/sec/div in accordance with Article 10 of the ASME Code.	**C**		
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 .	**C**		
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.	**C**		
11.2.3.2.2.5. Minimum test requirements:	**I**		
11.2.3.2.2.5.1. The gas or fluid used during the leak test shall be the same as the system fluid media except those used 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).	**C**		
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-L-25567, Leak Detection Compound, Oxygen Systems, Type 1 or equivalent leak test solution.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.3.2.3.3. Minimum test requirements:	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.3.2.3.3.1. Tests shall demonstrate the functional capability of all components such as valves, regulators, orifices, pumps, flex hose connections, and gauges.	**C**		
11.2.3.2.3.3.2. All operational sequences for the system shall be executed including emergency shutdown and safing procedures.	**C**		
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.	**C**		
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.	**C**		
11.2.3.2.3.3.5. Systems shall be tested to verify bonding and grounding.	**C**		
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. Installed flexible hoses in functional use shall be hydrostatically tested to 1.5 times their MAWP once a year. Flexible hoses shall be verified to be within their usable shelf life prior to testing.	**C**		
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.	**C**		
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.	**C**		
11.2.3.3.4. Pressure relief valves shall be tested for proper setting and operation once a year.	**C**		
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.	**C**		
11.2.3.4.2. Any pressure system component, including piping, tubing, fittings, or welds, that has been repaired, modified, or possibly damaged, before having been hydrostatically or pneumatically tested, shall be retested hydrostatically to 1.5 time MAWP or pneumatically to 1.25 times MAWP before reuse. Pneumatic testing requires prior approval by the PSWG, Range Safety, and the Center Pressure Systems Manager.	**C**		
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.	**C**		
11.2.3.4.4. After hydrostatic testing, modified or repaired systems shall be functionally tested at the system MOP before reuse.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.2.3.4.6. Gaskets shall not be reused.	**C**		
11.2.4. Ground Support Pressure System Analysis and Documentation Requirements	**I**		
11.2.4.1. Ground Support Pressure System Hazard Analysis	**I**		
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.)	**C**		
11.2.4.1.2. At a minimum, the hazard analysis shall include the analysis requirements in AFMAN 32-4013, Hazardous Materials Emergency Planning and Response Program, 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.	**C**		
11.2.4.2. Engineering Assessment, Data, and Analysis Requirements	**I**		
11.2.4.2.1. An engineering assessment and analysis shall be performed before the start of the first recertification period.	**C**		
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.	**C**		
11.2.4.2.3. Discrepancies with the latest requirements shall be resolved by repair, modification, analysis, inspection, or test.	**C**		
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:	**C**		
11.2.4.2.4.1. Design deficiencies such as design notches, weld joint design, and reinforcements.	**C**		
11.2.4.2.4.2. Material deficiencies such as laminations, laps, seams, cracks, hardness variations, and notch brittleness.	**C**		
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.	**C**		
11.2.4.2.4.4. Installation deficiencies such as fit up, alignment, attachments, and supports.	**C**		
11.2.4.2.4.5. Operation and Maintenance Deficiencies. At a minimum, the following potential operation and maintenance deficiencies shall be assessed:	**C**		
11.2.4.2.4.5.1. Refurbishment damage.	**C**		
11.2.4.2.4.5.2. Modification and/or repair deficiencies.	**C**		
11.2.4.2.4.5.3. Operation beyond allowable limits or improper sequence.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.4.2.4.5.4. Maintenance deficiencies.	**C**		
11.2.4.3. Inservice Operating, Maintenance, and Inspection Plan. The payload project responsible for the design of hazardous pressure systems shall prepare an inservice operating, maintenance, and inspection plan. This plan shall be referred to as the Inservice Inspection (ISI) Plan. The ISI Plan shall address and provide the following:	**C**		
11.2.4.3.1. Credible failure mechanisms that may cause service-related failures of the system during its service life shall be analyzed.	**C**		
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.	**C**		
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:	**C**		
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.	**C**		
11.2.4.3.3.2. Maintenance plans shall address corrosion protection, maintenance schedule, soft-good replacement program, refurbishment, calibration, and other maintenance requirements.	**C**		
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.	**C**		
11.2.4.3.3.4. Hazardous pressure systems shall be maintained and periodically inspected in accordance with the ISI Plan.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.4.4.1.1. Hazard analysis of hazardous pressure systems in accordance with the SSP (Volume 1, Attachment 2).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.4.4.1.2. A compliance checklist of all design, test, analysis, and data submittal requirements in this volume.	**C**		
11.2.4.4.1.3. The material compatibility analysis in accordance with the 11.2.1.4 of this chapter.	**C**		
11.2.4.4.1.4. Inservice operating, maintenance, and inspection plan in accordance with 11.2.4.3 of this chapter.	**C**		
11.2.4.4.1.5. Physical and chemical properties and general characteristics of propellants, test fluids, and gases data.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.2.4.4.4. Ground Support Pressure System Test Procedures and Reports	**C**		
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.	**C**		
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.	**C**		
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:	**C**		
11.3.1.1. Vessels and packaging designed to 49 CFR specifications shall be retested to DOT requirements.	**C**		
11.3.1.2. All systems shall be hydrostatically tested at ambient temperatures to 150 percent of the system MOP or pneumatically tested at ambient temperatures to 125 percent of the system MOP with the concurrence of the PSWG and Range Safety.	**C**		
11.3.1.3. Vessels designed to ASME Code, Section VIII, Division 2 that are prohibited from hydrostatic testing to 150 percent of the MOP shall be hydrostatically tested to 125 percent of system MOP at a minimum.	**C**		
11.3.1.4. Cryogenic systems shall be retested in accordance with 11.2.3.2 of this volume.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.3.1.6.1. Any sign of corrosion, dents, or other damages shall be identified and annotated on permanently maintained recertification documents.	**C**		
11.3.1.6.2. For corroded areas, the corrosion shall be removed.	**C**		
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.	**C**		
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.	**C**		
11.3.1.6.5. The susceptibility effects of corrosion such as cracking, delamination, or intergranular attack should be addressed.	**C**		
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 inspected.	**C**		
11.3.1.7.1. Radiographic examination shall be used to the maximum extent possible.	**C**		
11.3.1.7.2. UT shall be used if radiographic testing (RT) is determined to be ineffective.	**C**		
11.3.1.7.3. Surface and volumetric testing shall be performed after the hydrostatic/pneumatic pressure test.	**C**		
11.3.1.8. All components and systems shall be leak checked and functionally tested.	**C**		
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.	**C**		
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:	**C**		
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.	**C**		
11.3.2.1.2. Twenty years for systems and for vessels that can be 100 percent inspected both internally and externally.	**C**		
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.	**C**		
11.3.2.1.4. Five years for systems and for vessels that cannot be 100 percent inspected either internally or externally.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.3.2.1.5. Manufacturer recommendations.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.3.3.1.2. Certification files shall be updated within 90 calendar days of completion of periodic inspections and tests.	**C**		
11.3.3.1.3. Updated information shall include any changes to the current certification files and the following:	**C**		
11.3.3.1.3.1. Temperature, pressurization history, and pressurizing fluid for both the tests and operations.	**C**		
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.	**C**		
11.3.3.1.3.3. Maintenance and corrective actions performed from the time of manufacture throughout operational life, including refurbishment.	**C**		
11.3.3.1.3.4. Sketches and photographs to show areas of structural damage and extent of repairs.	**C**		
11.3.3.1.3.5. Certification and recertification tests performed, including test conditions and results.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.3.3.2.2. The data shall include, but not be limited to, the following:	**C**		
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.	**C**		
11.3.3.2.2.3. In-process fabrication and construction inspection plans and results.	**C**		
11.3.3.2.2.4. Pressure vessel manufacturer data reports (ASME Form U-1 or Form U-1A).	**C**		
11.3.3.2.2.5. Specification drawings and documents for all components.	**C**		
11.3.3.2.2.6. If available, maintenance manuals for all components.	**C**		
11.3.3.2.2.7. If available, component operating manual.	**C**		
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.	**C**		
11.3.3.2.2.9. System operating and maintenance plans and procedures.	**C**		
11.3.3.2.2.10. Certification that welding and weld NDE meet applicable standards such as ASME and ANSI.	**C**		
11.3.3.2.2.11. Unique qualification and acceptance test plans and test reports.	**C**		
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.	**C**		
11.3.3.2.2.13. Certification that all components, including pipe and tube fittings have successfully passed a hydrostatic or pneumatic pressure test.	**C**		
11.3.4. Ground Support Pressure System Analyses. An engineering analysis shall be performed as follows:	**C**		
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.	**C**		
11.3.4.2. The number of stress cycles experienced by the vessel during the certification period shall be determined.	**C**		
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.	**C**		
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:	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 MSFC-STD-1249, Standard NDE Guidelines and Requirements for Fracture Control Program) and locations such as boss transition area, heat affected area, weld joint, and membrane section within the vessel.	**C**		
11.3.4.4.3. The appropriate stress component in the vessel shall be used in the analysis.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.3.4.4.7. Fracture mechanics shall only be used to predict the subcritical crack propagation life before unstable crack growth.	**C**		
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.	**C**		
11.3.4.4.9. Failure mode determination shall consider any potential hazardous are classification concerns per Attachment 3 of this volume.	**C**		
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.	**C**		
11.3.4.4.11. Corrosion allowance and the remaining wall shall be determined based on MIL-HDBK-729, Corrosion and Corrosion Prevention Metals.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.1.1.2. The design shall provide for access, inspection, and pre-launch servicing as required.	**C**		
Throughout this chapter there are numerous specific design requirements that allow for safe access, inspection and pre-launch servicing (i.e. 12.1.10.1.1 addresses design of hypergolic propellant systems to allow for fill and drain operations by individuals dressed in SCAPE or other approved propellant handling ensembles; 12.1.10.2.1 addresses handling and hoisting attachment points; 12.2.5.3.2 addresses COPV pre-launch pressure test and inspection; 12.5.2.4 addresses remotely operated shutoff valves for hydraulic tanks and reservoirs; 12.8.1.1 covers hypergolic propellant system low point drains; 12.8.3.5 covers monitoring of remotely controlled hypergolic propellant system valves; etc.). 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**		
12.1.1.4. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.2. Flight Hardware Pressure System and Pressurized Structure Failure Tolerance	**I**		
12.1.2.1. Spaceflight hardware pressure systems shall be designed to be single failure tolerant against inadvertent actuations (including leakage) that could result in a critical hazard during prelaunch operations. See paragraph 12.1.2.6 of this Volume for exceptions.	**C**		
12.1.2.2. A pressure system shall be dual failure tolerant if the failure of two components could result in a catastrophic hazard. *Examples: The system must be dual failure tolerant if the degradation, loss or removal of all the inhibits of the system would result in any of the following:* *(1) Personnel exposure to an atmosphere that poses an immediate threat to life or immediate or delayed permanent adverse health effects or prevent escape from such an environment as defined by OSHA, NIOSH and local safety requirements.* *(2) The potential hazard exposure from a release of hazardous material exceeds the confines of the facility operating bay, or boundary of the launch complex (i.e., a public safety hazard).* *(3) A potential release could result in a flammable or explosive hazard due to incompatible materials or ignition sources present creating a potential catastrophic hazard.*	**C**		
12.1.2.3. Temporary re-configuration of a mono-propellant dual failure tolerant system to a downgraded mode with an inhibit removed (e.g. latch valve opened) requires PSWG and Range Safety concurrence and implementation of the following controls: (1) System/branch is configured in a downgraded mode for the shortest possible time. (2) Personnel access is limited to essential personnel only; no trainees or visitors are permitted. (3) Quantitative analysis shall be performed to determine personnel exposure, stay-out zones, or additional monitoring methods. (4) The removed inhibit can be immediately reinstated under emergency and nominal conditions. (5) All inhibits and system parameters remain verifiable, operational, restored remotely, and can be monitored directly via telemetry. (6) The removal of inhibit does not affect the function of the remaining inhibit(s) (i.e., independence of inhibits is required). (7) Facility vapor monitoring shall be in place. (8) Persons performing the work shall be clad in appropriate PPE (Personal Protective Equipment). (9) All material that could react with propellant is removed from the vicinity.	**C**		
12.1.2.4. Propellant tank service (fill and drain) valves that are not isolated from the storage vessel flow path shall be two failure tolerant to propellant leakage.	**C**		
12.1.2.5. For the purpose of risk assessment, potential releases of propellant or pressurant shall be supported by quantitative analysis or test, otherwise the design, operations, and hazard mitigation requirements shall be determined by a credible worst case scenario with concurrence from the PSWG and Range Safety.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.2.6. The design, fabrication, qualification, testing and hazard controls related to hazardous pressure system components and component housings such as tubing, welded joints, piping and fittings, pressure vessels, filters, venturis, other component valve bodies and pyrovalves are extremely critical to flight hardware pressure systems and safe payload processing. Provided that the requirements of this document are met and a Design for Minimum Risk (DFMR) approach is employed, structural failure of these types of components or component housings (i.e., rupture or leakage) shall not be considered mechanical single failure points. Hazardous pressure systems containing normally-closed pyrovalves as flow control devices shall comply with Category A ordnance device requirements established in Chapter 13 of this volume. At least three independent electrical inhibits shall control the opening of flow control devices in hazardous systems.	**C**		
12.1.2.6.1. All normally closed pyrovalves shall be designed, analyzed, and undergo a comprehensive development and qualifications program in accordance with approved project drawings, specifications, standards, tests, and pyrovalve requirements documents.	**C**		
12.1.2.6.1.1. The pyrovalve internal flow barrier and shear section must be fabricated from a continuous unit of nonwelded parent-metal compatible with the working fluid such as vacuum furnace remelt 304L stainless steel (Specificaiton SAE-AMS-QQ-S-763 Steel, Corrosion Resistant, Bars, Wire, Shapes, and Forgings).	**C**		
12.1.2.6.1.2. The pyrovalve's valve structure must preclude inadvertent operation as a result of exposure to all potential environmental conditions.	**C**		
12.1.2.6.1.3. Details of the pyrovalve design and test methods used to ensure system integrity shall be adequately addressed in the safety data package and appropriate hazard reports for PSWG review.	**C**		
12.1.2.6.2. When the failure of pyrovalves used in hazardous pressure systems may lead to a catastrophic hazard, at least one additional mechanical inhibit (such as a latch valve or closed thruster valve) shall be provided in series with the pyrovalve.	**C**		
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 commodities.	**C**		
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 demating 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.1.5.2.4. Items identified by the hazard analyses shall be designated safety critical and shall require the following considerations:	**C**		
12.1.5.2.4.1. Hazard identification and proposed corrective action.	**C**		
12.1.5.2.4.2. Design action.	**C**		
12.1.5.2.4.3. Safety procedures and operating requirements.	**C**		
12.1.5.2.4.4. Safety supervision.	**C**		
12.1.5.2.5. Systems analysis data shall show that:	**C**		
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.	**C**		
12.1.5.2.5.2. Redundant pressure relief devices have mutually independent pressure escape routes.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 allowable loads.	**C**		
12.1.5.3.1.5. Safety factors shall be as determined in 12.2.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.5.3.1.6. Safety factors on external (support) loads shall be as assigned to the primary structure supporting the pressurized system.	**C**		
12.1.5.3.2. Metallic Pressure Vessels and Pressurized Structures Stress Analysis	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.5.3.2.4. Minimum material gauge as specified in the design drawings shall be used in calculating stresses.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.5.3.3. Composite Hardware Stress Analysis	**I**		
12.1.5.3.3.1. For composite overwrapped pressure vessels (COPVs) and pressurized structures made of composite materials, the state-of-the-art methodology using composite laminate theory shall be used.	**C**		
12.1.5.3.3.2. Interlamination normal and shear stresses as well as in-plane stress components shall be calculated.	**C**		
12.1.5.3.3.3. Effects of ply orientation, stacking sequence, and geometrical discontinuities shall be accounted for.	**C**		
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.	**C**		
12.1.5.4.1. These data shall be taken from reliable sources or other sources approved by the payload project and the PSWG.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
12.1.5.5.2. The size of the flaws (cracks) shall be based on the appropriate NDE techniques and flaw detection capabilities.	**C**		
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.	**C**		
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.	**C**		
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, $K_{max} < K_{ISCC}$.	**C**		
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.	**C**		
12.1.5.5.7. Aspect ratio (a/2c) changes shall be accounted for in the analysis.	**C**		
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.	**C**		
12.1.5.5.9. Tensile residual stresses shall be included in the analysis.	**C**		
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.	**C**		
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.	**C**		
12.1.6.2. At a minimum, the following factors and their statistical variations shall be considered:	**C**		
12.1.6.2.1. The environmentally induced loads and pressures.	**C**		
12.1.6.2.2. The environments acting simultaneously with these loads and pressures with their proper relationships.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.6.2.3. The frequency of application of these loads, pressures, environments, and their levels and duration.	**C**		
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 expected operating pressure (MEOP) in the expected operating environments throughout their respective service lives without experiencing detrimental deformation.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.9. Flight Hardware Pressure Vessel and Pressurized Structure Thermal Requirements	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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 MIL-STD-1540, Test Requirements for Space Vehicles, or equivalent.	**C**		
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.	**C**		
12.1.10.1.2. Sufficient clearances are needed for the insertion of assembly tools.	**C**		
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.	**C**		
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.	**C**		
12.1.10.1.5. Any failure in any such adjacent system shall not result in combustion, explosion, or release of pressure fluids.	**C**		
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.	**C**		
12.1.10.2. Flight Hardware Pressure System components and Fixtures	**I**		
12.1.10.2.1. Fixtures for safe handling and hoisting with coordinated attachment points in the system structure shall be provided for equipment that cannot be hand carried and attached with fixtures and attachment points being included in the flight structures analyses.	**C**		
12.1.10.2.2. 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.	**C**		
12.1.10.2.3. Handling and hoisting loads shall be in accordance with 29 CFR 1910 requirements, Chapter 6 of this volume, Chapter 6 of Volume 6 and NASA-STD 8719.9.	**C**		
12.1.10.2.4. All incompatible propellant system connections shall be designed to be physically impossible to interconnect.	**C**		
Incompatible propellant system connections should be keyed, sized, or located so that it is physically impossible to interconnect them.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.10.2.5. Quick Disconnect Couplings	**C**		
The quick disconnect assembly consists of both the ground-half and air-half couplings.	**I**		
12.1.10.2.5.1. All quick disconnect couplings shall be designed with a factor of safety of not less than 2.5.	**C**		
12.1.10.2.5.2. 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.	**C**		
12.1.10.2.5.3. 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.	**C**		
12.1.10.2.5.4. 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.	**C**		
12.1.10.2.5.5. When coupled, the quick disconnect shall permit fluid flow in either direction.	**C**		
12.1.10.2.5.6. The quick disconnect shall not permit external leakage during any phase of coupling or uncoupling.	**C**		
12.1.10.2.5.7. The quick disconnect shall be designed so that coupling and uncoupling can be performed with simple motions.	**C**		
12.1.10.2.5.8. 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.	**C**		
12.1.10.2.5.9. 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.	**C**		
12.1.10.2.5.10. The quick disconnect shall be designed to couple/uncouple without imparting adverse loads on fluid lines that could cause flight hardware damage.	**C**		
12.1.10.2.5.11. Quick disconnects shall be designed to ensure that all incompatible fuel and oxidizer couplings cannot be inadvertently connected, causing mixing of propellants.	**C**		
12.1.10.2.5.12. All quick disconnect ground half couplings shall be identified in accordance with the requirements of 11.2.1.7.6 of this volume.	**C**		
12.1.10.2.6. Pressure fluid tanks shall be shielded or isolated from combustion apparatus or other heat sources.	**C**		
12.1.10.3. Flight Hardware Pressure System Tubing and Piping	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.1.10.3.2. Straight tubing and piping runs shall be avoided between two rigid connection points.	**C**		
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.	**C**		
12.1.10.3.4. Line bends shall be used to ease stresses induced in tubing by alignment tolerances and vibration.	**C**		
12.1.10.4. Flight Hardware Pressure System Flexible Hose Requirements	**I**		
Guidance for the handling and installation of flexible hoses can be found in KSC specification 80K51846, Flex Hose Handling and Installation Requirements.	**I**		
12.1.10.4.1. Flexible hoses shall be used only when required to provide movement between interconnecting fluid lines when no other means are available.	**C**		
12.1.10.4.2. 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.	**C**		
12.1.10.4.3. Flexible hoses shall not be supported by rigid lines or components if excessive loads from flexible hose motion can occur.	**C**		
12.1.10.4.4. 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.	**C**		
12.1.10.4.5. 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.	**C**		
12.1.10.4.6. Flexible hoses shall not be exposed to internal temperatures that exceed the rated temperature of the hose.	**C**		
12.1.10.4.7. 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.	**C**		
12.1.10.4.8. All flexible hoses that are not lined shall be subjected to a flow-induced vibration analysis.	**C**		
MSFC 20MO2540 provides guidance for performing flow-induced vibration analysis.	**I**		
12.1.10.4.9. Flexible hoses shall consist of a flexible inner pressure carrier tube (compatible with the service fluid) constructed of elastomeric [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. Flexible hoses used shall be verified to be within acceptable shelf life requirements.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 erosive 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**		
12.1.10.4.10. 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).	**C**		
12.1.10.4.10.1. The restraint design safety factor shall not be less than 3 on material yield strength.	**C**		
12.1.10.4.10.2. Hose clamp-type restraining devices shall not be used.	**C**		
12.1.10.4.11. 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.	**C**		

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)	

12.1.10.5. Flight Hardware Pressure System Valves, Vents, Vent Lines, and Drains	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.10.5.8. When lines are required for draining liquid explosive, flammable liquids or explosive waste, they shall be free of pockets or low spots so that a positive flow is achieved at all points in the drain line.	**C**		
12.1.10.5.9. The slope shall not be less than 1/4 inch per foot at any point on the drain line.	**C**		
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.	**C**		
12.1.10.6.2. The test points shall be easily accessible for attachment of ground test equipment.	**C**		
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.	**C**		
12.1.10.6.4. Individual pressure and return test connectors shall be designed to positively prevent inadvertent cross-connections.	**C**		
12.1.11. Flight Hardware Pressure System and Pressurized Structure Supports and Clamps	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.11.1. All rigid pipe and tubing assemblies shall be supported by a firm structure to restrain destructive vibration, shock, and acceleration.	**C**		
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.	**C**		
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.	**C**		
12.1.11.4. All threaded parts in safety critical components shall be securely locked to resist uncoupling forces by acceptable safe design methods.	**C**		
Safety wiring and self locking nuts are examples of acceptable safe design.	**I**		
12.1.11.5. Torque for threaded parts in safety critical components shall be specified and documented.	**C**		
12.1.11.6. Friction-type locking devices shall be avoided in safety critical applications.	**C**		
12.1.11.7. Star washers and jam nuts shall not be used as locking devices.	**C**		
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.	**C**		
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.	**C**		
12.1.11.10. Snubbers shall be used with all bourdon-type pressure transmitters, pressure switches, and pressure gauges, except air pressure gauges.	**C**		
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.	**C**		
12.1.12.2. Propellant system components and lines shall be grounded to metallic structures.	**C**		
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.	**C**		
12.1.13. Flight Hardware Pressure System and Pressurized Structure Material Compatibility and Selection	**I**		
12.1.13.1. Compatibility	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.1.13.1.2. At a minimum, material compatibility shall be determined in regard to flammability, ignition and combustion, toxicity, and corrosion.	**C**		
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.	**C**		
12.1.13.1.4. Compatible materials selection shall be obtained from one of the following sources:	**C**		
12.1.13.1.4.1. T.O. 00-25-223.	**C**		
12.1.13.1.4.2. CPIA (Chemical Propulsion Information Agency) 394.	**C**		
12.1.13.1.4.3. MSFC-HDBK-527.	**C**		
12.1.13.1.4.4. KTI-5210, NASA/KSC Material Selection List for Oxygen and Air Services.	**C**		
12.1.13.1.4.5. The NASA Material and Process Technical Information System (MAPTIS).	**C**		
12.1.13.1.4.6. KTI-5212, NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes.	**C**		
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.	**C**		
12.1.13.1.4.8. Other sources and documents approved by the PSWG and Range Safety.	**C**		
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.	**C**		
12.1.13.1.6. Compatibility Analysis. The payload project shall prepare a compatibility analysis containing the following information:	**C**		
12.1.13.1.6.1. List of all materials used in system.	**C**		
12.1.13.1.6.2. Service fluid in contact with each material.	**C**		
12.1.13.1.6.3. Source document or test results showing material compatibility in regard to flammability, toxicity, corrosion, and ignition and combustion.	**C**		
12.1.13.2. Selection	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
12.1.13.2.3. The fracture toughness shall be as high as practical within the context of structural efficiency and fracture resistance.	**C**		
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.	**C**		
12.1.13.2.5. Materials that have a low K_{ISCC} 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.	**C**		
12.1.13.2.6. If the material has a K_{ISCC} less than 60 percent of the plane-strain fracture toughness, K_{IC} under the conditions of its application, it shall be mandatory to show, by a "worst case" fracture mechanics analysis, that the low K_{ISCC} factor will not precipitate premature structural failure.	**C**		
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.	**C**		
12.1.14.2. General contamination control requirements are as follows:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.16.2. Evaluation. Metallic material evaluation shall be conducted based on the following considerations:	**C**		
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.	**C**		
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.	**C**		
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	**C**		
12.1.16.3. Characterization. Metallic material characterization shall be based on the following considerations:	**C**		
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.	**C**		
Strength and fracture properties of metallic materials selected for pressure vessels and pressurized structures are available from references such as MIL-HDBK-5, 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
12.1.16.3.3.1. Tensile yield strength, Fy, and ultimate tensile strength, Fu.	**C**		
12.1.16.3.3.2. Fracture toughness, K_{Ic}, K_{Ie}, K_c, K_{ISCC}.	**C**		
12.1.16.3.3.3. Sustained-stress crack-growth data, da/dt versus K_{max}.	**C**		
12.1.16.3.3.4. Fatigue crack growth data, da/dn versus K_I and load ratio, R.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.16.4.5. Fracture control requirements and precautions shall be defined in applicable drawings and process specifications.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.1.16.4.6. Detailed fabrication instructions and controls shall be provided to ensure proper implementation of the fracture control requirements.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.17.3. QA program Inspection Plan. At a minimum, the following considerations shall be included in structuring the quality assurance program:	**C**		
12.1.17.3.1. An inspection master plan shall be established before the start of fabrication.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.17.3.5. Acceptance and rejection standards shall be established for each phase of inspection and for each type of inspection technique.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
12.1.17.4. Inspection Techniques. At a minimum, the following considerations shall be included in determining the appropriate inspection techniques:	**C**		
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.	**C**		
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.	**C**		
12.1.17.4.3. The flaw detection capability of each selected NDE technique shall be based on past experience on similar hardware.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.17.5. Inspection Data. At a minimum, inspection data shall be dispositioned as follows:	**C**		
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.	**C**		
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.	**C**		
12.1.17.5.3. The result of this assessment shall form the basis of any required corrective action.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. 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.	**C**		
12.1.17.6. Acceptance Proof Test	**C**		
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.	**C**		
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.	**C**		
12.1.17.6.3. Proof test fluids shall be compatible with the structural materials in the pressure vessels and pressurized structures.	**C**		
12.1.17.6.4. Proof test fluids shall not pose a hazard to test personnel.	**C**		
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.	**C**		
12.1.17.6.6. Accept/reject criteria shall be formulated before the acceptance proof test.	**C**		
12.1.17.6.7. Every pressure vessel and pressurized structure shall not leak, rupture, or experience gross yielding during acceptance testing.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.18.2.7. Only qualified and trained personnel shall be assigned to work on or with high pressure systems.	**C**		
12.1.18.2.8. Warning signs with the hazard(s) identified shall be posted at the operations facility before pressurization.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.1.18.3.5. Analyses shall include prediction of remaining life and reassessment of required inspection intervals.	**C**		
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.	**C**		
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.	**C**		
12.1.18.5. Flight Hardware Pressure System and Pressurized Structure Storage Requirements	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
12.1.18.5.3. Induced stresses due to storage fixture constraints shall be minimized by suitable storage fixture design.	**C**		
12.1.18.5.4. In the event storage requirements are violated, recertification shall be required before acceptance for use.	**C**		
12.1.18.6. Flight Hardware Pressure System and Pressurized Structure Reactivation	**I**		
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.	**C**		
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.)	**C**		
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.	**C**		
12.1.19.2. At a minimum, the records shall contain the following information:	**C**		
12.1.19.2.1. Temperature, pressurization history, and pressurizing fluid for both tests and operations.	**C**		
12.1.19.2.2. Number of pressurizations experienced as well as number allowed in safe-life analysis.	**C**		
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.	**C**		
12.1.19.2.4. Storage condition.	**C**		
12.1.19.2.5. Maintenance and corrective actions performed from manufacturing to operational use, including refurbishment.	**C**		
12.1.19.2.6. Sketches and photographs to show areas of structural damage and extent of repairs.	**C**		
12.1.19.2.7. Acceptance and recertification tests performed, including test conditions and results.	**C**		
12.1.19.2.8. Analyses supporting the repair or modification that may influence future use capability.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. Two 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.	**C**		
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.	**C**		
12.2.1.1.1. Based on the results of the failure mode determination, one of two distinct verification paths shall be satisfied: (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), and (2) Brittle fracture failure mode or hazardous LBB in which, if allowed to leak, the leak would cause a hazard.	**C**		
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.	**C**		
12.2.1.2. Approach B. Approach B, Figure 12.1 shows the steps required for verification of a metallic pressure vessel designed using the ASME Boiler and Pressure Vessel Code or the DOT Pressure Vessel Codes.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS

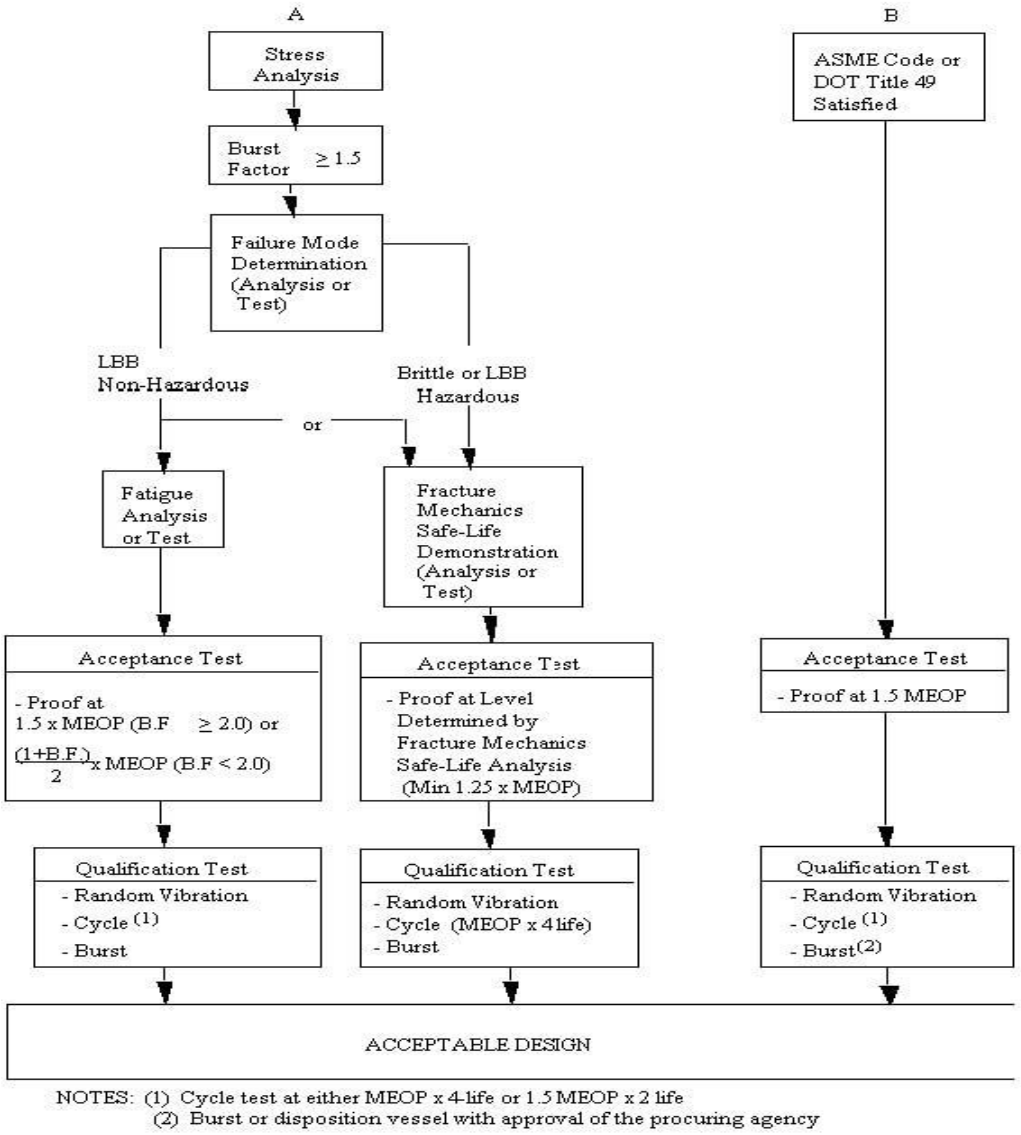


Figure 12.1. Pressure Vessel Design Verification Approach

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.2.2. 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 MEOP.	**C**		
12.2.2.2. Fracture mechanics shall be used if the failure mode is determined by analysis.	**C**		
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.	**C**		
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.	**C**		
12.2.2.4.2. Unless otherwise specified, the minimum burst factor shall be 1.5.	**C**		
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.	**C**		
12.2.2.5.2. A life factor of 4 shall be used in the analysis.	**C**		
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.	**C**		
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 in the expected operating environments for the specified test duration without rupture.	**C**		
12.2.2.5.5. The required test duration is 4 times the specified service life.	**C**		
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.	**C**		
12.2.2.6.2. The test fixtures, support structures, and methods of environmental application shall not induce erroneous test conditions.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
12.2.2.6.5. The sequences, combinations, levels, and duration of loads, pressure, and environments shall demonstrate that design requirements have been met.	**C**		
12.2.2.6.6. Qualification testing shall include random vibration testing and pressure testing. The following delineates the required tests:	**C**		
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, MIL-STD-1540 or equivalent unless it can be shown that the vibration requirement is enveloped by other qualification testing performed.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Table 12.2. Qualification Pressure Test Requirements.			

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

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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 = 1.5 x MEOP for burst factor equal or greater than 2.0. The minimum hold time at proof pressure shall be 5 minutes.	**C**		
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.	**C**		
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 MEOP 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.	**C**		
12.2.3. 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.	**C**		
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.	**C**		
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.	**C**		
12.2.3.1.4. Unless otherwise specified, the minimum burst factor shall be 1.5.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 specimens representative of the structure design.	**C**		
12.2.3.2.6. These flaws shall not be less than the flaw sizes established by the selected NDE method(s).	**C**		
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.	**C**		
12.2.3.2.8. A life factor of 4 on specified service life shall be applied in the safe-life demonstration testing.	**C**		
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:	**C**		
12.2.3.2.9.1. Fracture mechanics data (fracture toughness and fatigue crack growth rates).	**C**		
12.2.3.2.9.2. Loading spectrum and environments.	**C**		
12.2.3.2.9.3. Initial flaw sizes.	**C**		
12.2.3.2.9.4. Analysis assumptions and rationales.	**C**		
12.2.3.2.9.5. Calculation methodology.	**C**		
12.2.3.2.9.6. Summary of significant results.	**C**		
12.2.3.2.9.7. References.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 MEOP 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.	**C**		
12.2.4. 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.	**C**		
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.	**C**		
12.2.4.2. Flight Hardware Metallic Pressure Vessels Designed Using ASME Boiler and Pressure Vessel Code Acceptance Test Requirements	**C**		
12.2.4.2.1. A proof test shall be performed as specified in ASME Code pressure test at 1.5 times MAWP unless otherwise prohibited by the Code.	**C**		
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.	**C**		
12.2.5. Flight Hardware Composite Overwrapped Pressure Vessels. Flight hardware COPVs shall be designed using Approach A or Approach B shown in Figure 12.1.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.2.5.1.2. Based on the results of the failure mode determination, one of two distinct paths shall be satisfied: (1) LBB with leakage of the contents not creating a condition that could lead to a mishap (such as toxic gas venting, damage to nearby safety critical components, or pressurization of a compartment not capable of withstanding the pressure increase), and (2) Brittle fracture failure mode or hazardous LBB, in which, if allowed to leak, the leak would cause a hazard.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.2.5.1.6. For COPVs subjected to sustained load conditions, stress rupture life shall be considered. The COPV shall not be susceptible to stress rupture or sustained creep failure mechanisms. The predicted stress rupture life shall be at least 4 times the service life (for the environment and pressure versus time profile history).	**C**		
12.2.5.1.7. 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.	**C**		
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 or DOT Title 49 Exemptions with a burst factor equal to 3.0 or greater.	**C**		
12.2.5.3. COPV Prelaunch Inspection and Pressure Test Requirements	**I**		
12.2.5.3.1. 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 shall be verified and an inspection of the vessel shall be conducted to determine if there is any evidence of visible damage. A trained COPV inspector, certified in accordance with 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.	**C**		
12.2.5.3.2. Initial pressurization of a COPV at the launch site (above 1/3 design burst pressure) shall be performed remotely or behind a blast shield. Personnel will not approach the COPV for a minimum of 10 minutes following the pressurization.	**C**		
12.2.6. COPVs with Non-Hazardous LBB Failure Mode	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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 MEOP. The LBB failure mode shall be demonstrated if one or more of the cracks leak pressure from the COPV at MEOP before catastrophic failure occurs.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 Section 12.1.17.3.	**C**		
12.2.6.5.2. Proof Pressure Test. Every COPV shall be proof pressure tested in accordance with 12.2.2.7.3.2.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 specimens representative of the structure design. For non-metallic lined COPVs, safe-life demonstrations shall be performed by test.	**C**		
12.2.7.2.6. These flaws shall not be less than the flaw sizes established by the selected NDE method(s).	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
12.2.7.2.9.1. Fracture mechanics data for metal liners, including fracture toughness and fatigue crack growth on launch vehicles.	**C**		
12.2.7.2.9.2. Loading spectrum and environments.	**C**		
12.2.7.2.9.3. Initial flaw sizes.	**C**		
12.2.7.2.9.4. Analysis assumptions and rationales.	**C**		
12.2.7.2.9.5. Calculation methodology.	**C**		
12.2.7.2.9.6. Summary of significant results.	**C**		
12.2.7.2.9.7. References.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 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.	**C**		
12.2.7.5.2. Proof Pressure Test. Every COPV shall be proof pressure tested in accordance with 12.2.2.7.3.2.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.2.8.1. COPV Design Data.	**C**		
12.2.8.1.1. Design specifications.	**C**		
12.2.8.1.2. Design drawings.	**C**		
12.2.8.1.3. Design calculations.	**C**		
12.2.8.1.4. Material manufacturer's specification sheets for resin, fiber reinforcement, promoters, catalyst, and other components used in laminate construction.	**C**		
12.2.8.1.5. Properly certified documentation for parts of the vessel fabricated by other fabricators.	**C**		
12.2.8.1.6. Process specifications, giving the fabrication procedures used to fabricate both the prototype vessel(s) and all production vessels.	**C**		
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.	**C**		
12.2.8.3. COPV Test Data	**I**		
12.2.8.3.1. Qualification test report.	**C**		
12.2.8.3.2. Quality control and production test reports.	**C**		
12.2.8.3.3. Acceptance test report.	**C**		
12.2.8.3.4. Prelaunch inspection and pressure test reports.	**C**		
12.2.8.3.5. In-service inspection and recertification test reports for reusable flight COPVs.	**C**		
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	**C**		
12.2.8.4.2. A risk assessment of the COPV during ground processing.	**C**		
12.2.8.4.3. A description and the analysis of the protection system(s) used to prevent impact damage.	**C**		
12.2.8.4.4. Description of the protective coating/covers or splash shields used to guard against contact with incompatible commodities.	**C**		
12.2.8.4.5. History of pressure cycles (rate, magnitude, and duration) along with the design limitations.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.2.8.4.6. Data to verify design limits have not been exceeded for specified storage and transport environmental conditions.	**C**		
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).	**C**		
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.	**C**		
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.	**C**		
12.2.8.4.8.2. Mechanical damage mitigation plans and procedures, and inspection points, shall be defined.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4 FLIGHT HARDWARE SPECIAL PRESSURIZED EQUIPMENT DESIGN, ANALYSIS, AND TEST REQUIREMENTS. Detailed design, analysis, and test requirements for batteries, cryostats (or dewars), heat pipes, and sealed containers, which are classified as special pressurized equipment, are described below, and shall meet the requirements of AIAA/ANSI S-080.	**I**		
12.4.1. 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.	**C**		
12.4.1.1. 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.	**C**		
12.4.1.2. 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.	**C**		
12.4.1.2.1. A life factor of 5 shall be used in the analysis.	**C**		
12.4.1.2.2. 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.	**C**		
12.4.1.2.3. 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 MEOP in the expected operating environments for the specified test duration without rupture.	**C**		
12.4.1.2.4. The required test duration is 4 times the specified service life.	**C**		
12.4.1.3. Flight Hardware Batteries with LBB Failure Mode Qualification Testing	**I**		
12.4.1.3.1. Qualification tests shall be conducted on flight quality batteries to demonstrate structural adequacy of the design.	**C**		
12.4.1.3.2. The following tests are required.	**C**		
12.4.1.3.2.1. Random Vibration Testing. Random vibration testing shall be performed on batteries per the requirements of MIL-STD-1540.	**C**		
12.4.1.3.2.2. Thermal Vacuum Testing. Thermal vacuum test shall be performed on batteries per requirements of MIL-STD-1540.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4.1.3.2.3. Pressure Testing. A pressure cycle test shall be conducted on battery cells. The peak pressure shall be equal to the MEOP 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 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 For batteries having sealed cases, similar tests shall be conducted on the sealed cases, if applicable.	**C**		
12.4.1.4. Flight Hardware Batteries with LBB Failure Mode Acceptance Test Requirements	**I**		
12.4.1.4.1. Acceptance tests shall be conducted on batteries before being committed to flight.	**C**		
12.4.1.4.2. The following tests are required:	**C**		
12.4.1.4.2.1. Proof Pressure Test. Whenever feasible, battery cells shall be proof pressure tested to 1.25 times the MEOP of the cells. For sealed battery cases, pressure tests shall be performed at a level of 1.25 times the MEOP of the cases.	**C**		
12.4.1.4.2.2. Nondestructive Inspection. Surface and volumetric NDE techniques shall be performed after the proof pressure test.	**C**		
12.4.1.5. Flight Hardware Batteries with LBB Failure Mode Recertification Test Requirements	**I**		
12.4.1.5.1. 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.	**C**		
12.4.1.5.2. 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.	**C**		
12.4.1.6. 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.	**C**		
12.4.2. Flight Hardware Batteries with Brittle Fracture Failure Mode	**I**		
12.4.2.1. Batteries with battery cells exhibiting brittle fracture failure mode shall meet the requirements defined in 12.2.3.	**C**		
12.4.2.2. In addition, a thermal vacuum test shall be conducted as part of the qualification testing.	**C**		
12.4.3. Flight Hardware Cryostats or Dewars with LBB Failure Mode	**I**		
12.4.3.1. 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:	**C**		
12.4.3.1.1. The LBB failure mode shall be demonstrated analytically or by test showing that an initial surface flaw with a shape (a/2c) ranging from 0.05 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 MEOP.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4.3.1.2. Fracture mechanics shall be used if the failure mode is determined by analysis.	**C**		
12.4.3.1.3. A pressure vessel that contains non-hazardous fluid and exhibits LBB failure mode is considered as a non-hazardous LBB pressure vessel.	**C**		
12.4.3.2. 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.	**C**		
12.4.3.3. 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:	**C**		
12.4.3.3.1. Random Vibration Testing. Random vibration testing shall be performed on cryostats per the requirements of MIL-STD-1540.	**C**		
12.4.3.3.2. Pressure Testing. The cryostat (dewar) shall be pressurized to the design burst pressure that is 1.5 times MEOP 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.	**C**		
12.4.3.4. Flight Hardware Cryostats or Dewars with LBB Failure Mode Acceptance Test Requirements	**I**		
12.4.3.4.1. Acceptance tests should be conducted on every cryostat (or dewar) before being committed to flight.	**C**		
12.4.3.4.2. The following tests are required:	**C**		
12.4.3.4.2.1. Proof-Pressure Test. Cryostats shall be proof-pressure tested to 1.25 times the MEOP of the pressure container.	**C**		
12.4.3.4.2.2. Nondestructive Inspection. Surface and volumetric selected NDE techniques shall be performed after the proof-pressure test.	**C**		
12.4.3.5. Flight Hardware Cryostats or Dewars with LBB Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	**C**		
12.4.3.6. 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.	**C**		
12.4.4. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode	**I**		
12.4.4.1. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Factor of Safety Requirements	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4.4.1.1. 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.	**C**		
12.4.4.1.2. 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.	**C**		
12.4.4.1.3. 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.	**C**		
12.4.4.1.4. Unless otherwise specified, the minimum burst factor shall be 1.5.	**C**		
12.4.4.2. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Safe-Life Demonstration Requirements	**I**		
12.4.4.2.1. After completion of the stress analysis conducted in accordance with the requirements of 12.1.16, 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.	**C**		
12.4.4.2.2. 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.	**C**		
12.4.4.2.3. 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.	**C**		
12.4.4.2.4. 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.	**C**		
12.4.4.2.5. 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 specimens representative of the structure design.	**C**		
12.4.4.2.6. These flaws shall not be less than the flaw sizes established by the acceptance proof test or the selected NDE method(s).	**C**		
12.4.4.2.7. 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.	**C**		
12.4.4.2.8. A life factor of 4 on specified service life shall be applied in the safe-life demonstration testing.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4.4.2.9. A report that documents the fracture mechanics safe-life analysis or safe-life testing shall be prepared to delineate the following:	**C**		
12.4.4.2.9.1. Fracture mechanics data (fracture toughness and fatigue crack growth rates).	**C**		
12.4.4.2.9.2. Loading spectrum and environments.	**C**		
12.4.4.2.9.3. Initial Flaw sizes.	**C**		
12.4.4.2.9.4. Analysis assumptions and rationales.	**C**		
12.4.4.2.9.5. Calculation methodology.	**C**		
12.4.4.2.9.6. Summary of significant results.	**C**		
12.4.4.2.9.7. References:	**C**		
12.4.4.2.10. This report shall be closely coordinated with the stress analysis report and shall be periodically revised and updated during the life of the program.	**C**		
12.4.4.3. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Qualification Test Requirements. Qualification testing shall meet the requirements of 12.2.2.6.	**C**		
12.4.4.4. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Acceptance Test Requirements	**I**		
12.4.4.4.1. 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.	**C**		
12.4.4.4.2. At a minimum, surface and volumetric NDE techniques shall be performed on all weld joints before and after the proof test.	**C**		
12.4.4.4.3. Cryo-proof acceptance test procedures may be required to adequately verify initial flaw size.	**C**		
12.4.4.4.4. The pressure container shall not rupture or leak at the acceptance test pressure.	**C**		
12.4.4.5. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	**C**		
12.4.4.6. Flight Hardware Cryostats or Dewars with Brittle Fracture Failure Mode Special Provisions	**I**		
12.4.4.6.1. For one-of-a-kind applications, a proof test of each flight unit to a minimum of 1.5 times MEOP 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4.4.6.2. 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.	**C**		
12.4.4.6.3. The implementation of this option needs prior approval by the payload project and the PSWG and Range Safety.	**C**		
12.4.5. Flight Hardware Heat Pipe Requirements	**I**		
12.4.5.1. Flight Hardware Heat Pipe Factor of Safety	**I**		
12.4.5.1.1. Unless otherwise specified, the minimum burst factors for heat pipes with a diameter greater than 1.5 inches shall be 2.5.	**C**		
12.4.5.1.2. For heat pipes with a diameter less than or equal to 1.5 inches, the minimum burst factor shall be 4.0.	**C**		
12.4.5.2. Flight Hardware Heat Pipe Qualification Test Requirements. Pressure testing shall be conducted to demonstrate no failure at the design burst pressure.	**C**		
12.4.5.3. Flight Hardware Heat Pipe Acceptance Test Requirements	**I**		
12.4.5.3.1. 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.	**C**		
12.4.5.3.2. A proof pressure test shall be conducted to a minimum level of 1.5 times MEOP on all heat pipes.	**C**		
12.4.5.4. Flight Hardware Heat Pipe Recertification Test Requirements. Recertification testing shall meet the requirements of 12.2.2.8.	**C**		
12.4.5.5. 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.	**C**		
12.4.6. Flight Hardware Sealed Containers	**I**		
12.4.6.1. 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.*	**C**		
12.4.6.1.1. Sealed Containers with Non-Hazardous LBB Failure Mode Factor of Safety. Unless otherwise specified, the minimum burst factor shall be 1.5.	**C**		
12.4.6.1.2. Sealed Containers with Non-Hazardous LBB Failure Mode Qualification Test Requirements	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.4.6.1.2.1. Sealed containers containing non-electronic equipment shall only be subjected to pressure testing.	**C**		
12.4.6.1.2.2. 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 MIL-STD-1540 or equivalent.	**C**		
12.4.6.1.3. 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 or MAWP.	**C**		
12.4.6.1.4. Sealed Containers with Non-Hazardous LBB Failure Mode Recertification Test Requirements	**I**		
12.4.6.1.4.1. 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.	**C**		
12.4.6.1.4.2. 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.	**C**		
12.4.6.2. Sealed Containers with Brittle Fracture or Hazardous LBB Failure Mode	**I**		
12.4.6.2.1. Sealed containers that exhibit a brittle fracture failure mode or contain hazardous fluid, or both, shall meet the requirements of 12.2.3.	**C**		
12.4.6.2.2. 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.	**C**		
12.5 FLIGHT HARDWARE PRESSURE SYSTEM COMPONENT DESIGN AND TEST REQUIREMENTS 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS

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

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.	**C**		
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.	**C**		
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.	**C**		
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 (MEOP) and rated life of the system.	**C**		
12.5.1.2.5. The Standards of the Hydraulic Institute shall be used in evaluating safety in pump selection.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.5.1.2.8. In all cases, flareless tube fittings shall be properly preset before pressure application.	**C**		
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.	**C**		
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.	**C**		
12.5.1.3.2. Oxygen systems shall require electrical grounding to eliminate the possibility of the buildup of static electrical charges.	**C**		
12.5.1.3.3. Oxygen system components, design, and material selection shall conform to ASTM MNL 36.	**C**		
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 overtorquing of the valve stem of the regulator adjustment cannot damage soft seats to the extent that failure of the seat will result.	**C**		
12.5.1.4.2. Valve designs that use uncontained seals are unacceptable and shall not be selected.	**C**		
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.	**C**		
12.5.1.5.2. The warning device shall either activate automatic response mechanisms or shall notify operational personnel of impending hazards.	**C**		
12.5.1.5.3. Warning devices to indicate hazardous over or under pressures to operating personnel shall be specified.	**C**		
12.5.1.5.4. These warning devices shall actuate at predetermined pressure levels designed to allow time for corrective action.	**C**		
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.	**C**		
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.	**C**		
12.5.1.5.7. Bleed valves shall be directed away from operating personnel.	**C**		
12.5.1.5.8. Fittings or caps for bleeding pressure are not acceptable.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.5.1.5.15. The pressure indicators shall be located to be readily visible to the operating crew.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.5.1.5.19. Positive indication of disengagement shall be provided.	**C**		
12.5.1.5.20. Safety critical pneumatic actuators shall have positive mechanical stops at the extremes of safe motion.	**C**		
12.5.1.5.21. Adjustable orifice restrictor valves shall not be used in safety critical pneumatic systems.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.)	**C**		
12.5.1.8.3. Pressure system components and lines shall be electrically grounded to metallic structures.	**C**		
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.	**C**		
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.	**C**		
12.5.1.9. Flight Hardware Pneumatic and Hydraulic System Pressure Relief Devices	**I**		
12.5.1.9.1. Pressure relief devices shall be specified on all systems having a pressure source that can exceed the maximum allowable pressure of the system or where the malfunction/failure of any component can cause the maximum allowable pressure to be exceeded.	**C**		
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.	**C**		
12.5.1.9.3. On payload 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 the ground or support system contains such devices and they cannot be isolated from the spaceflight hardware pressure system during the pressurization cycle.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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 UA-354 are met. It is mandatory that the valve be locked open when the system is repressurized.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 overpressurization of the reservoir.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.5.1.11.2. High point bleed ports shall be provided where necessary for removal of trapped gases.	**C**		
12.5.1.11.3. The bleed valve shall be directed away from operating personnel and possible ignition sources.	**C**		
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.	**C**		
12.5.1.11.5. Bleed valves used for reducing pressure on systems containing hazardous fluids shall be routed to a safe disposal area.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.5.1.11.6. Auxiliary Bleed Ports	**C**		
12.5.1.11.6.1. Auxiliary bleed ports shall be provided where necessary to allow bleed off for safety purposes.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.5.1.12.2. Control devices shall be designed to prevent overtravel or undertravel that may contribute to a hazardous condition or damage to the valve.	**C**		
12.5.1.12.3. All pressure and volume controls shall have stops, or equivalent, to prevent settings outside their nominal safe working ranges.	**C**		
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.	**C**		

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**

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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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).	**C**		
12.5.1.14. Flight Hardware Pneumatic and Hydraulic System Accumulators	**C**		
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.	**C**		
12.5.1.14.2. Accumulator gas pressure gauges shall not be used to indicate system pressure for operational or maintenance purposes.	**C**		
12.5.1.14.3. Gas type and pressure level shall be posted on, or immediately adjacent to, the accumulator.	**C**		
12.5.1.15. Flight Hardware Pneumatic and Hydraulic System Flexible Hose. Flexible hose requirements are specified in 12.1.10.4.	**C**		
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.	**C**		
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**		
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.	**C**		
12.5.1.17.1.2. Proof testing shall demonstrate that the components sustain proof pressure levels without distortion, damage, or leakage.	**C**		
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.	**C**		
12.5.1.17.1.4. The following inspections shall be performed after proof testing:	**C**		
12.5.1.17.1.4.1. Mechanical components such as valves and regulators shall be inspected for external deformation, deterioration, or damage.	**C**		
12.5.1.17.1.4.2. Damaged, distorted, or deteriorated parts shall be rejected and replaced and the test repeated.	**C**		
12.5.1.17.1.5. Functional and leak tests shall be performed at the component MAWP after the proof test.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
12.5.1.17.1.9. Pressure 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/MEOP without causing a shift in the transducer. This is dependent on the transducer's specification and manufacturer's recommendations for the transducer.*	**C**		
12.5.1.17.1.10. Pressure transducers shall be calibrated before installation and periodically thereafter as recommended by the manufacturer.	**C**		
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.	**C**		
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.	**C**		
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/MEOP 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.	**C**		
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/MEOP before first use at any payload processing facility and launch site area.	**C**		
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.	**C**		
12.5.1.17.3.3. Minimum test requirements are as follows:	**C**		
12.5.1.17.3.3.1. The media used during the leak test shall be the same as the system fluid media. For hazardous gas systems, a system-compatible, non-hazardous gas may be used that has a density as near as possible to the operating system gas; for example, helium should be used to leak test a gaseous hydrogen system.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.5.1.17.4.3. Minimum test requirements are as follows:	**C**		
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.	**C**		
12.5.1.17.4.3.2. All prelaunch operational sequences for the system shall be executed.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.5.1.17.6.2. A modified or repaired pressure system shall be leak tested at the system MOP/MEOP before its normal use. This test shall be conducted at the ranges unless prior approval from the local safety authority has been obtained.	**C**		
12.5.1.17.6.3. A modified or repaired pressure system shall be revalidated and functionally tested at its operational pressures envelope up to the system MOP before its normal use.	**C**		
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/MEOP.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
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.	**C**		
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.	**C**		
12.5.2.3. Safety critical actuators shall have positive mechanical stops at the extremes of safe motion.	**C**		
12.5.2.4. Hydraulic fluid reservoirs and supply tanks shall be equipped with remotely operated shutoff valves.	**C**		
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.	**C**		
12.5.2.6. Systems incorporating accumulators shall be interlocked to either vent or isolate accumulator fluid pressure when power is shutoff.	**C**		
12.5.2.7. Adjustable orifice restrictor valves shall not be used in safety critical systems.	**C**		
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.	**C**		
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.	**C**		
12.5.2.10. Flight Hardware Hazardous Fluid System Reservoirs:	**C**		
12.5.2.10.1. Whenever possible, the hydraulic reservoir should be located at the highest point in the system.	**C**		
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.	**C**		
12.5.2.11. Systems installations shall be limited to a maximum pressure of 15,000 psig.	**C**		
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.	**C**		
12.5.2.13. Safety critical systems shall have positive protection against breaking the fluid column in the suction line during standby.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.5.2.15. Systems that provide for manual takeover shall automatically disengage or allow by-pass of the act of manual takeover.	**C**		
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.	**C**		
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.	**C**		
12.5.2.18. Systems using power-operated pumps shall include a pressure regulating device and an independent safety relief valve.	**C**		
12.5.2.19. Flight Hardware Hazardous Fluid System Thermal Pressure Relief Valves:	**C**		
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.	**C**		
12.5.2.19.2. Internal valve leakage shall not be considered an acceptable method of providing thermal relief.	**C**		
12.5.2.19.3. Thermal relief valve settings shall not exceed 150 psi above the value for system relief valve setting.	**C**		
12.5.2.19.4. Vents shall outlet only to areas of relative safety from a fire hazard.	**C**		
12.5.2.19.5. Hydraulic blow-out fuses (soft plugs) shall not be used in systems having temperatures above 160°F.	**C**		
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.	**C**		
12.6 FLIGHT HARDWARE PNEUMATIC SYSTEM DESIGN REQUIREMENTS. 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.	**C**		
12.6.1.2. Socket-welded flanges shall not be used in hazardous pressure system piping.	**C**		
12.6.2. Flight Hardware Pneumatic System Tubing. All pipe and tube welded joints shall be 100 percent radiographically inspected. All joints shall be inspected by surface NDE techniques after system acceptance pressure testing. Where post-proof test surface NDE is impractical, visual inspection will be allowed with justification and PSWG and Range Safety approval.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
12.6.3.3. Designs using uncontained seats are unacceptable.	**C**		
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.	**C**		
12.6.4. Flight Hardware Pneumatic System Valves	**I**		
12.6.4.1. Valve actuators shall be operable under maximum design flow and pressure.	**C**		
12.6.4.2. Manually operated valves shall be designed so that overtorquing the valve stem cannot damage soft seats to the extent that seat failure occurs.	**C**		
12.6.4.3. Designs using uncontained seats are prohibited.	**C**		
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.	**C**		
12.6.4.5. All electrical control circuits for remotely actuated valves shall be shielded or otherwise protected from hazardous stray energy.	**C**		
12.6.4.6. Remotely controlled valves shall provide for remote monitoring of OPEN and CLOSED positions during prelaunch operations.	**C**		
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.	**C**		
12.6.4.8. Check valves shall be provided where back flow of fluids or media would create a hazard.	**C**		
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.	**C**		
12.6.4.10. Valve stem travel on manual valves shall be limited by a positive stop at each extreme position.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
12.6.5.2. These pressure indicating devices shall be designed to be remotely monitored during prelaunch operations.	**C**		
12.6.6. Flight Hardware Pneumatic System Flexible Hoses. Flexible hose requirements are specified in 12.1.10.4.	**C**		
12.6.7. Flight Hardware Pneumatic System Pressure Relief Devices	**C**		
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 overpressurization during prelaunch operations.	**C**		
12.6.7.2. Flight systems that require on-board pressure relief capability shall be designed to the following minimum requirements:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.6.7.2.7. All pressure relief devices shall be vented separately unless the following can be positively demonstrated:	**C**		
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.	**C**		
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.	**C**		
12.6.7.2.8. No obstructions shall be placed downstream of the relief device.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.6.7.2.9. Relief devices shall be located so that other components cannot render them inoperative.	**C**		
12.6.8. Flight Hardware Pneumatic System Vents	**I**		
12.6.8.1. Pressure systems shall be designed so that pressure cannot be trapped in any part of the system without vent capability.	**C**		
12.6.8.2. Vent system outlets should be in a location normally inaccessible to personnel or shall be conspicuously identified.	**C**		
12.6.8.3. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	**C**		
12.6.8.4. Oxidizer and fuel vent outlets to the atmosphere shall be separated sufficiently to prevent mixing of vented fluids.	**C**		
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.	**C**		
12.6.8.6. Hydrogen vents shall discharge to atmosphere through an approved burner.	**C**		
12.6.8.7. Special attention shall be given to the design of vent line supports at vent outlets due to potential thrust loads.	**C**		
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.	**C**		
12.7 FLIGHT HARDWARE HYDRAULIC SYSTEM DESIGN AND TEST REQUIREMENTS. 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.	**C**		
12.7.1. Flight Hardware Hydraulic System General Design Requirements	**C**		
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.	**C**		
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.	**C**		
12.7.1.3. Test points shall be provided on hydraulic systems so that disassembly for test is not required.	**C**		
12.7.1.4. Test points shall be easily accessible for the attachment of ground test equipment.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.7.1.6. Where system leakage can expose hydraulic fluid to potential ignition sources, fire resistant, or flameproof hydraulic fluid shall be used.	**C**		
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.	**C**		
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.	**C**		
12.7.3.2. These devices shall be designed to be remotely monitored during prelaunch operations.	**C**		
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 overpressurization during prelaunch operations.	**C**		
12.7.4.2. Flight systems that require on-board pressure relief capability shall meet the following minimum requirements:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.7.4.2.5. Relief devices shall be located so that other components cannot render them inoperative.	**C**		
12.7.4.2.6. No obstructions shall be placed downstream of the relief valve or burst disk outlet.	**C**		
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.	**C**		
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.	**C**		
12.7.7. Testing Flight Hardware Hydraulic Systems After Assembly	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.7.7.1. Tests shall meet the requirements of 12.5.1.17.2.	**C**		
12.7.7.2. Leak tests shall meet the requirements of 12.5.1.17.3.	**C**		
12.7.7.3. System validation and functional tests shall meet requirements of 12.5.1.17.4.	**C**		
12.7.7.4. Modified and repaired flight hardware shall meet the requirements of 12.5.1.17.6.	**C**		
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 off-load capability through service valves that are dual failure tolerant.	**C**		
12.8.1.2. Off-load service valves and connections 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.*	**C**		
12.8.1.3. Propellant systems shall be designed to be flushed with compatible fluids and purged with inert gas.	**C**		
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.	**C**		
12.8.1.5. Propellant systems shall also comply with the pneumatic system requirements of 12.6.	**C**		
12.8.1.6. Items used in any fuel or oxidizer system shall not be interchanged after exposure to the respective media.	**C**		
12.8.1.7. Bi-propellant systems shall have the capability of loading and/or unloading the fuel and oxidizer one at a time.	**C**		
12.8.1.8. Propellant (liquid or gas) migration into an associated pneumatic system shall be controlled.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.8.2.2. Fittings and connectors with NPT or socket weld flanges shall not be used in hypergolic propellant systems.	**C**		
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, Range Safety, and the NASA ELV Payload Safety Agency Team. 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**		
12.8.3. Flight Hardware Hypergolic Propellant System Valves	**C**		
12.8.3.1. Valve actuators shall be operable under maximum design flow and pressure.	**C**		
12.8.3.2. Flow control valves shall be designed to be fail-safe if pneumatic or electric control power is lost during prelaunch operations and shall be located as close as practical to tanks to allow for isolating the tank(s) from the rest of the system when necessary.	**C**		
12.8.3.3. Check valves shall be provided where back flow of fluids would create a hazard.	**C**		
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.	**C**		
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.	**C**		
12.8.3.6. All electrical control circuits for remotely actuated valves shall be shielded or otherwise protected from hazardous stray energy.	**C**		
12.8.3.7. Designs using uncontained seats are prohibited.	**C**		
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.	**C**		
12.8.3.9. Manually operated valves shall be designed so that overtorquing the valve stem cannot damage soft seats to the extent that seat failure occurs.	**C**		
12.8.3.10. Valve stem travel on manual valves shall be limited by a positive stop at each extreme position.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.8.3.12. All electromechanical actuator electric wiring shall be sealed to prevent fluid ignition.	**C**		
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.	**C**		
12.8.4.2. These pressure indicating devices shall be designed to be remotely monitored during prelaunch operations.	**C**		
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:	**C**		
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 elastomeric [typically poly-tetrafluoroethylene (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.	**C**		
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. Hose 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.	**C**		
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 MEOP of any component downstream of that source unless the system is single failure tolerant against overpressurization during prelaunch operation.	**C**		
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.	**C**		
12.8.8.2. Pneumatic proof testing to a proof pressure of 1.25 times MAWP or MEOP 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 the local safety authority.	**C**		
12.8.8.3. All hypergolic propellant valves shall be tested for both internal and external leakage at their MAWP.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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 x 10^{-6} cc/sec of helium gas at standard temperature and pressure (STP).	**C**		
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.	**C**		
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.	**C**		
12.8.9.1.2. Minimum test requirements are as follows:	**C**		
12.8.9.1.2.1. Test gas should use a minimum volume of 10 percent helium.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 12.5.1.17.5.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.9.1.1.2. In addition, the LH2 system shall be designed to be purged with inert fluids.	**C**		
12.9.1.2. Bi-propellant systems shall have the capability of loading the fuel and oxidizer one at the time.	**C**		
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.	**C**		
12.9.1.4. Pneumatic systems servicing cryogenic systems shall comply with the pneumatic pressure system requirements of 12.6.	**C**		
12.9.1.5. Cryogenic systems shall be designed to control liquefaction of air.	**C**		
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.	**C**		
12.9.1.7. Vacuum-jacketed systems shall be capable of having the vacuum verified.	**C**		
12.9.1.8. Purge gas for LH2 and cold GH2 lines should be gaseous helium (GHe).	**C**		
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.	**C**		
12.9.1.10. Titanium and titanium alloys shall not be used where exposure to GOX (cryogenic) or LO2 (LOX) is possible.	**C**		
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.	**C**		
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.	**C**		
12.9.3.2. The use of slip-on flanges shall be avoided.	**C**		
12.9.3.3. Flanged joints in LH2 systems shall be seal welded.	**C**		
12.9.3.4. Flanged joint gaskets shall not be reused.	**C**		
12.9.3.5. Cryogenic systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.	**C**		
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. All joints shall be inspected by surface NDE techniques after system acceptance pressure testing. Where post-proof test surface NDE is impractical, visual inspection will be allowed with justification and PSWG and Range Safety approval.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
12.9.4.2. Remotely controlled valves shall provide for remote monitoring of the open and closed positions.	**C**		
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.	**C**		
12.9.4.4. All electrical control circuits for remotely actuated valves shall be shielded or otherwise protected from hazardous stray energy.	**C**		
12.9.4.5. Manually operated valves shall be designed so that overtorquing the valve stem cannot damage seats to the extent that seat failure occurs.	**C**		
12.9.4.6. Valve stem travel on manual valves shall be limited by a positive stop at each extreme position.	**C**		
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.	**C**		
12.9.4.8. Manual or remote valve actuators shall be operable under maximum design flow and pressure.	**C**		
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.	**C**		
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.	**C**		
12.9.4.11. All electromechanical actuator electrical wiring shall be sealed to prevent fluid ignition.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.9.5.2. These pressure indicating devices shall be designed to be remotely monitored during prelaunch operations.	**C**		
12.9.6. Flight Hardware Cryogenic System Flexible Hoses. Flexible hose requirements are specified in 12.1.10.4 in addition to the following:	**C**		
12.9.6.1. Flexible hoses used in cryogenic system shall be of the single-wall, double-wall, or double-wall, vacuum-jacketed type.	**C**		
12.9.6.2. All convoluted portions of flexible hoses shall be covered with stainless steel wire band.	**C**		
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.	**C**		
12.9.7.2. Minimum design requirements are as follows:	**C**		
12.9.7.2.1. The pressure relief device shall be installed as close as practical to the cryogenic vessel or tank.	**C**		
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.	**C**		
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.	**C**		
12.9.7.3. All pressure relief devices shall be vented separately unless the following can be positively demonstrated:	**C**		
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.	**C**		
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 wide open and the system is at full pressure and volume generating capacity.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.9.7.7. Relief valves shall be located so that other components cannot render them inoperative.	**C**		
12.9.8. Flight Hardware Cryogenic System Vents	**I**		
12.9.8.1. GH2 shall be vented to atmosphere through a burner system.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
12.9.8.5. Each vent shall be conspicuously identified using appropriate warning signs, labels, and markings.	**C**		
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.	**C**		
12.9.8.7. Incompatible fluids shall not be discharged into the same vent or drain system.	**C**		
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.	**C**		
12.9.8.9. Vent outlets shall be protected against rain intrusion and entry of birds, insects, and animals.	**C**		
12.9.8.10. Special attention shall be given to the design of vent line supports at vent outlets due to potential thrust loads.	**C**		
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.	**C**		
12.9.9.2. Flight hardware cryogenic system components shall meet the test requirements of 12.5.1.17.1 before assembly.	**C**		
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.	**C**		
12.9.10.2. All newly assembled cryogenic systems shall be leak tested.	**C**		
12.9.10.3. The system shall be pressurized to the system MOP using gaseous helium for LH2 systems and GN2 for LO2 (LOX) systems.	**C**		
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.	**C**		
12.9.10.5. Minimum test requirements are as follows:	**C**		
12.9.10.5.1. The intended service fluid (LO2[LOX], LH2) shall be used as the validation test fluid.	**C**		
12.9.10.5.2. The functional capability of all components and subsystems shall be validated.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.9.10.5.3. All prelaunch operational sequences for the system shall be exercised, including emergency shutdown, safing, and unloading procedures.	**C**		
12.9.10.5.4. Vacuum readings of all vacuum volumes shall be taken and recorded before, during, and after the test.	**C**		
12.9.10.5.5. No deformation, damage, or leakage is allowed.	**C**		
12.9.11. Testing Modified and Repaired Flight Hardware Cryogenic Systems	**I**		
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.	**C**		
12.9.11.2. The component retest sequence shall be as follows:	**C**		
12.9.11.2.1. The component shall be hydrostatically proof tested at ambient temperature to 1.5 times the component MAWP or MEOP.	**C**		
12.9.11.2.2. The component shall be reinstalled into the cryogenic system and a leak check performed at system MOP or MEOP.	**C**		
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 or MEOP.	**C**		
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.	**C**		
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 Safety Data Packages (SDPs) or submitted as a separate package when appropriate.	**C**		
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.	**C**		
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.	**C**		
12.10.2. Flight Hardware Pressure Systems General Data Requirements. The following general flight hardware pressure systems data is required:	**C**		
12.10.2.1. Hazard analysis of hazardous pressure systems in accordance with the project's SSP. (See Volume 1, Attachment 2.)	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
12.10.2.3. General flight hardware pressure systems data shall be submitted in accordance with Attachment 1, A1.2.4.7.1 of this volume.	**C**		
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.	**C**		
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.	**C**		
12.10.4.2. MAWP for all pressure system components and the MOP the component will see when installed in the system.	**C**		
12.10.4.3. Safety factors or design burst pressure for all pressure system components and identification of actual burst pressures, if available.	**C**		
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.	**C**		
12.10.4.5. Materials used in the fabrication of each element within the component including soft goods and other internal elements.	**C**		
12.10.4.6. Cycle limits if fatigue is a factor of the component.	**C**		
12.10.4.7. Temperature limits of each system component.	**C**		
12.10.4.8. Component information shall be placed in tables.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
12.10.6.2. These files shall be accessible for PSWG review.	**C**		
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:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12.10.6.3.1. As applicable, stress, safe-life, fatigue, and fracture mechanics analysis in accordance with 12.1.4.3, 12.1.5.4, and 12.1.5.5.	**C**		
12.10.6.3.2. Specification drawings and documents for all components.	**C**		
12.10.6.3.3. If necessary, a cross-sectional assembly drawing of the component to assess the safety aspects of the internal elements.	**C**		
12.10.6.3.4. Certification that welding and weld NDE meet applicable standards and have been performed by certified personnel.	**C**		
12.10.6.3.5. Qualification and acceptance test plans and test reports.	**C**		
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.	**C**		
12.10.6.3.7. Certification that all components, including pipe and tube fittings, have successfully passed a hydrostatic proof test.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 13 ORDNANCE SYSTEMS	**I**		
13.1 ORDNANCE HAZARD CLASSIFICATION Safety requirements for non-explosive actuators, ordnance devices, and circuits specific for NASA ELV payloads are provided in this publication. *Note: For purposes of these requirements the term ordnance items is meant to include non-explosive actuator 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 Organization (UNO) hazard classification for transport of dangerous goods and storage compatibility group in accordance with ST/SG/AC.10/1, Recommendations on the Transport of Dangerous Goods Model Regulations, and in accordance with DoD 6055.9-STD.	**C**		
13.1.1.2. Items that have not previously been classified and cannot be classified based on similarity with previously classified items shall obtain a hazard classification in accordance with the procedures required by 49 CFR 173.56, New Explosives – Definitions and Procedures for Classification and Approval, and AFTO 11A-1-47/(NAVSEAINST 8020.3/TB700-2/DLAR 8220.1), Explosive Hazard Classification Procedures, and classified accordingly.	**C**		
13.1.1.3. Ordnance items shall also have a DOT classification. The payload project is responsible for obtaining DOT classification.	**C**		
13.1.1.4. The payload project shall provide the UNO, DoD, and DOT documentation demonstrating proper classification for review and approval before delivering ordnance.	**C**		
13.1.2. Ordnance Device and System Categorization	**I**		
13.1.2.1. Ordnance Device and System Categorization Process and Submittals	**I**		
13.1.2.1.1. A FMECA shall be performed to determine if each ordnance device and system, including non-explosive initiators (NEIs), shall be classified as category A (hazardous) or B (non-hazardous).	**C**		
13.1.2.1.2. A device shall be assigned Category A whenever test data to the contrary is not available. A device assigned Category A prior to installation may be downgraded to Category B after installation if the effects of the device and the subsequent chain of events are controlled to the satisfaction of the PSWG and Range Safety.	**C**		
13.1.2.1.3. The payload project shall submit ordnance devices', NEIs', and systems' proposed classifications to the PSWG for PSWG, Range Safety and appropriate local safety authority review and approval before delivering ordnance to the payload processing facility and launch site area.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Electroexplosive device (EED) Categories are based on the effects of inadvertent initiation. *Category A: Category A electroexplosive devices or ordnance that, by the expenditure of their own energy or because they initiate a chain of events, may cause serious injury or death to personnel or damage to property.* *Category B: Category B electroexplosive devices or ordnance that, by the expenditure of their own energy or because they initiate a chain of events, will not cause serious injury or death to personnel or damage to property.*	**I**		
13.1.2.2. The following criteria shall be used to determine ordnance device and system hazard category:	**C**		
13.1.2.2.1. Handheld Mode	**C**		
13.1.2.2.1.1. At least 1 percent of an ordnance item qualification lot or a minimum of 10 units shall be functioned to determine if the ordnance produces fragments, if the temperature rises above 260°C, if the ordnance produces flame, or if the ordnance produces pressure in excess of 150 psig at the output end. If testing or analogy is not accomplished, the initiating device shall be treated as category A.	**C**		
It is not the intention of this publication to impose excessive test requirements. Similarities with previously tested items are often sufficient for categorization.	**I**		
13.1.2.2.1.2. If one or more of the tested units violate the criteria, the ordnance shall be considered category A in the handheld mode.	**C**		
13.1.2.2.2. Assembled Mode	**C**		
13.1.2.2.2.1. An analysis of the ordnance system shall be performed to determine if its initiation is capable of causing injury or damage to property at the payload processing facility and launch site area.	**C**		
13.1.2.2.2.2. Tests will not be required for the assembled mode.	**C**		
13.2 ORDNANCE SYSTEM GENERAL REQUIREMENTS The remaining parts of this chapter establish the design requirements for Category A ordnance and ordnance systems during transportation, handling, storage, installation, testing, and connection at the payload processing facility and launch site area. Category B ordnance and ordnance systems do not have to meet the design requirements identified in this chapter; however, Category B ordnance and ordnance systems shall meet the operational requirements identified in Volume 6 of this publication.	**C**		
13.2.1. Ordnance Subsystem Identification. Ordnance systems include the following subsystems. All of these subsystems are subject to the design requirements described below.	**C**		
13.2.1.1. Power Source. The power source may be a battery, a dedicated power bus, or a capacitor.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.2.1.3. Control Circuit. The control circuit activates and deactivates the safety devices in the firing circuit.	**C**		
13.2.1.4. Monitor Circuit. The monitor circuit monitors status of the firing circuits.	**C**		
13.2.1.5. Initiating Device. The initiating device converts electrical, mechanical, or optical energy into explosive energy.	**C**		
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.	**C**		
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.	**C**		
13.2.3. Failure Mode Effects and Criticality Analysis. A comprehensive FMECA shall be performed on all ordnance systems in accordance with the requirements of a jointly tailored MIL-STD-882C.	**C**		
13.3 ORDNANCE ELECTRICAL CIRCUITS	**I**		
13.3.1. Ordnance Electrical Circuit General Design Requirements	**C**		
13.3.1.1. Ordnance system circuitry shall be protected to preclude energy sources such as electromagnetic energy or from causing undesired output of the system.	**C**		
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 from the range and/or launch vehicle from causing undesired output of the system.	**I**		
13.3.1.2. Category A ordnance systems shall be designed so that the initiating devices can be installed in the system just before final electrical hookup on the launch pad.	**C**		
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. Alternative proposed processing scenarios will be supported with the detailed system design and hazard assessments.	**I**		
13.3.1.2.1. Initiating device locations shall be accessible to facilitate installation and removal and electrical connections as late as possible in the launch countdown.	**C**		
13.3.1.2.2. Access required at the launch complexes shall be identified and demonstrated to accommodate this accessibility requirement.	**C**		
13.3.1.3. Separate power sources and/or busses shall be required for ordnance initiating systems.	**C**		
13.3.1.4. RF energy shall not be used to ignite initiating devices.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
13.3.1.5.2. This interconnection shall be at the power source only.	**C**		
13.3.1.5.3. Other ground connections with equivalent isolation shall be identified and assessed individually.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.3.2.3. RF shielding shall provide a minimum of 85 percent of optical coverage ratio.	**C**		
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.	**C**		
13.3.2.5. Electrical shields terminated at a connection shall be joined around the full 360 degree circumference of the shield.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.3.2.7. Firing, control, and monitor circuits shall all be shielded from each other.	**C**		
13.3.3. Ordnance Electrical Circuits Wiring	**I**		
13.3.3.1. Twisted shielded pairs shall be used unless other configurations such as coaxial leads can be shown to be more effective.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.3.3.5. Splicing of firing circuit wires or overbraid shields is prohibited.	**C**		
13.3.3.6. The use of wire wrap to connect wire shields is prohibited.	**C**		
13.3.4. Ordnance Electrical Connectors	**I**		
13.3.4.1. The outer shells of electrical connectors shall be made of metal.	**C**		
13.3.4.2. Electrical connectors shall be selected to eliminate the possibility of mismating. Mismating includes improper installation as well as connecting wrong connectors.	**C**		
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.	**C**		
13.3.4.4. The design shall ensure that the shielding connection for an electrical connector is complete before the pin connection.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.3.4.9. Source circuits shall terminate in an electrical connector with female contacts.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
13.3.4.13. Separate cables and connectors shall be used when redundant circuits are required.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.3.6.1.1. These inhibits shall be directly monitored.	**C**		
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.	**C**		
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.	**C**		
13.3.6.3. Monitoring, control, and checkout circuits shall not be routed through arm or safe plugs.	**C**		
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).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.3.6.9. Maximums and minimums for monitor circuit outputs shall be specified.	**C**		
13.3.6.10. No single point failure in monitoring, checkout, or control circuitry and equipment shall compromise the safety of the firing circuit.	**C**		
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.	**C**		
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.	**C**		
13.4 INITIATOR ELECTRICAL CIRCUITS	**I**		
13.4.1. Electrical Low Voltage Electromechanical Circuits Design Requirements	**C**		
13.4.1.1. All solid rocket motor ignition circuits and other high hazard ordnance systems using low voltage initiators shall provide an electromechanical safe and arm (S&A) device.	**C**		
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 circuit interrupts such as “enable” and “fire” switches in the power side of the initiator and one safe plug that interrupts both the power and return side.	**C**		
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.	**C**		
13.4.1.4. The final electrical connection of an EED to the firing circuit shall be as close to the EED as possible.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
Electromagnetic environment evaluation should either be by analysis or electromagnetic compatibility (EMC) testing. RF power density levels for facilities are available from the 30 SW and 45 SW for VAFB and CCAFS, respectively, and the KSC Electromagnetics Lab.	**I**		
13.4.2. High Voltage Exploding Bridgewire Circuits	**I**		
13.4.2.1. All solid rocket motor ignition circuits for payloads using exploding bridgewire (EBW) systems shall include a manual arming and safing plug in addition to an EBW-firing unit (EBW-FU).	**C**		
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 as determined by the PSWG and Range Safety.	**C**		
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.	**C**		
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.	**C**		
13.5.1.2. All safety devices shall be capable of being functionally tested by ground test equipment.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.5.1.6. Safety devices shall not require adjustment throughout their service life.	**C**		
13.5.1.7. Each safety device shall be designed for a service life of at least 10 years after passing the acceptance test.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
13.5.3.6. S&A design shall incorporate provisions to safe the ordnance train from any rotor and/or barrier position.	**C**		
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.	**C**		
13.5.3.8. Remote and manual safing shall be accomplished without passing through the arm position.	**C**		
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.	**C**		
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."	**C**		
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).	**C**		
13.5.3.12. A remote status indicator shall be provided to show the armed or safed condition.	**C**		
13.5.3.12.1. The device shall also indicate its arm or safe status by visual inspection.	**C**		
13.5.3.12.2. There shall be easy access to this visual indication throughout ground processing.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.5.3.14.2. When inserted and rotated, the pin shall manually safe the device.	**C**		
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.	**C**		
13.5.3.14.4. Safing pin insertion shall require a reasonable force of resistance.	**C**		
The force required for safing pin insertion should be between 20 and 40 pounds and/or 20 to 40 inch-pounds of torque.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.3.14.5. The safing pin shall provide a means of attaching warning streamers.	**C**		
13.5.3.14.6. When installed, each safing pin shall be marked by a red streamer.	**C**		
13.5.3.14.7. The following requirements apply whenever the arm command has been energized:	**C**		
13.5.3.14.7.1. Removal of the safing pin shall not be possible if the arming circuit is energized.	**C**		
13.5.3.14.7.2. The safing pin retention mechanism shall be capable of withstanding applied forces of tension or torque without failure.	**C**		
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:	**C**		
13.5.3.14.8.1. Removal of the safing pin shall not cause the S&A to automatically arm.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.4.2. Mechanical S&As shall incorporate the same features as electrically actuated devices except that arming and safing is performed mechanically.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.5.5.3. EBW-FU design shall provide a positive remotely controlled means of interrupting the capacitor charging circuit.	**C**		
13.5.5.4. A gap tube shall be provided that interrupts the EBW trigger circuit.	**C**		
13.5.5.5. EBW-FUs shall be designed to be discriminatory to spurious signals in accordance with MIL-STD-461E, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.	**C**		
13.5.5.6. 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.	**C**		
13.5.5.7. 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.	**C**		
13.5.5.8. The isolation resistance between EBW-FU output circuits and any other circuits shall not be less than 50 mega-ohms at 500 Vdc.	**C**		
13.5.5.9. Remote discharged indicators for EBW-FUs shall not appear unless the capacitor bank voltage is one-half 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."	**C**		
13.5.5.10. The EBW-FU shall be capable of being remotely safed and armed.	**C**		
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 AFSPCMAN 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	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.6.6.1.1. Ordnance S&As shall provide mechanical isolation of the explosive train.	**C**		
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.	**C**		
13.5.6.6.1.3. Safe to Arm Transition	**C**		
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.	**C**		
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.	**C**		
13.5.6.6.1.4. Detonation Propagation	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.5.6.6.2. Ordnance S&A Arm and Safe Mechanisms	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.5.6.6.2.5. S&As shall be capable of being remotely safed and armed.	**C**		
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.	**C**		
13.5.6.6.2.7. Remote and manual safing shall be accomplished without passing through the armed position.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.6.6.3. Ordnance S&A Status Indicators	**C**		
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).	**C**		
13.5.6.6.3.2. Ordnance S&A Remote and Visual Status Indicators	**C**		
13.5.6.6.3.2.1. A remote status indicator shall be provided to show the armed or safed condition.	**C**		
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.	**C**		
13.5.6.6.3.2.3. Easy access to the visual status indicator shall be provided throughout ground processing.	**C**		
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.	**C**		
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."	**C**		
13.5.6.6.4. Ordnance S&A Safing Pins	**C**		
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.	**C**		
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.	**C**		
13.5.6.6.4.3. When inserted and rotated, the pin shall manually safe the device.	**C**		
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.	**C**		
13.5.6.6.4.5. Safing pin insertion shall require a reasonable force of resistance.	**C**		
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.	**C**		
13.5.6.6.4.7. When installed, each safing pin shall be marked by a red streamer.	**C**		
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.	**C**		
13.5.6.6.4.9. The following requirements apply whenever the arm command has been energized:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.5.6.6.4.9.1. Removal of the safing pin shall not be possible if the arming circuit is energized.	**C**		
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.	**C**		
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:	**C**		
13.5.6.6.4.10.1. Removal of the safing pin shall not cause the S&A to automatically arm.	**C**		
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.	**C**		
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	**C**		
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.	**C**		
13.6.1.2. Periodic testing of ordnance to verify that no sensitivity changes have occurred shall be in accordance with DoD-E-83578, Explosive Ordnance for Space Vehicles, General Specification for, unless it can be shown that sensitivity with aging is not a credible concern with the specific explosive composition.	**C**		
13.6.1.3. Ordnance should be designed for a service life of at least 10 years with a design goal of 15 years.	**C**		
13.6.1.4. The decomposition, cook-off, and melting temperatures of all explosives shall be at least 30^{o}C higher than the maximum predicted environmental temperature to which the material will be exposed during storage, handling, transportation, and launch.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.6.2.4. The auto-ignition temperature shall not be less than 150ºC.	**C**		
13.6.2.5. Carbon bridgewires and conductive mixes without bridgewires are prohibited.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.6.2.9. Insulation resistance between pin-to-case shall not be less than 2 mega-ohms at 500 Vdc.	**C**		
13.6.2.10. The outer case of the EED main body shall be made of conductive material, preferably metal.	**C**		
13.6.2.11. RF survivability shall meet the testing criteria described in MIL-STD-1576, Electro-explosive Subsystem Safety Requirements and Test Methods for Space Systems.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.6.2.12.3. The shielding cap shall be designed to accommodate the torque tool during installation.	**C**		
13.6.2.12.4. Shorting plugs (caps) shall not be used as a substitute for shielding caps.	**C**		
13.6.3. High Voltage Exploding Bridgewires	**I**		
13.6.3.1. Explosive materials shall be secondary explosives.	**C**		
Examples of secondary explosives include pentaerythritoltetranitrate (PETN) or cyclotrymethylenetrinitramine (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.	**C**		
13.6.3.3. A voltage blocking gap shall be provided.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.6.3.3.2. The nominal gap breakdown voltage tolerance shall be specified and approved by the PSWG and Range Safety.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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 13.1. The frequency shall be applied across the input terminals of the EBW detonator for 5.0 to 6.0 seconds.	**C**		

<table>
<tr><th>ORIGINAL TEXT</th><th>STATUS</th><th>TAILORED TEXT</th><th>RATIONALE/ COMMENTS</th></tr>
<tr><td>

Table 13.1. RF Sensitivity.

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

</td><td></td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>13.6.3.9. The autoignition temperature of the EBW shall not be less than 150°C.</td><td>C</td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>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.</td><td>C</td><td></td><td></td></tr>
<tr><td>13.6.4. Laser Initiated Devices
Note: Laser initiated devices are not anticipated to be used. If they are used they must comply with AFSPCMAN 91-710, Volume 3 section 13.6.4.</td><td>I</td><td></td><td></td></tr>
</table>

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.6.5. Percussion Activated Devices	**I**		
13.6.5.1. Stab initiation of percussion activated devices (PADs) is prohibited.	**C**		
13.6.5.2. Each initiator shall have a positive safety interrupter feature that can be mechanically locked in place.	**C**		
13.6.5.3. The initiator and its interrupter shall be designed to withstand all transportation, handling, and installation environments.	**C**		
13.6.5.4. The interrupter safety lock shall be designed to remain in place during and after installation.	**C**		
13.6.5.5. The interrupter safety lock shall be designed to be removed after installation.	**C**		
13.6.5.6. The design shall ensure the PAD cannot be assembled without the interrupter.	**C**		
13.6.5.7. Percussion initiators shall be designed so that the operating energy is at least twice the all-fire energy.	**C**		
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.	**C**		
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 and shall be classified as either category A or B.	**C**		
13.7 EXPLOSIVE TRANSFER SYSTEMS AND RECEPTOR ORDNANCE 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 DoD-E-83578 and the requirements below.	**C**		
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.	**C**		
13.7.2. Periodic testing of ordnance to verify no sensitivity changes shall be in accordance with DoD-E-83578 unless it can be shown that the sensitivity with aging is not a credible concern with the specific explosive composition.	**C**		
13.7.3. Explosives used in ETS lines shall be secondary explosives.	**C**		
13.7.4. Flexible confined detonation cord (FCDC) shall not fragment or separate from end fittings upon initiation. Gaseous emission is permissible.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.7.7. All ETS interconnections shall provide for safety (lock) wiring or a PSWG and Range Safety approved equivalent.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.7.11. Exposed end fittings shall be equipped with protective caps.	**C**		
13.7.12. Receptor ordnance shall be designed to meet the applicable safety sections of DoD-E-83578 and this part and shall use secondary high explosives.	**C**		
Examples of secondary high explosives used for receptor ordnance include such items as PETN, RDX, cyclotetramethylenetetra-nitramine (HMX), or 2,2,4,4,6,6 hexanitrostilbene (HNS).	**I**		
13.7.12.1. Explosives shall be non-hygroscopic.	**C**		
13.7.12.2. Specific approval from the PSWG and Range Safety is required for all explosive compositions.	**C**		
13.7.13. The receptor ordnance shall not detonate after being subjected to a 6-foot drop test on to a steel plate.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.8.4. Laser Test Equipment *Note: Laser test equipment are not anticipated to be used. If they are used they must comply with AFSPCMAN 91-710, Volume 3, section 13.8.4.*	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.9 ORDNANCE AND NON-EXPLOSIVE INITIATOR DATA REQUIREMENTS Data items shall be submitted in accordance with the requirements of Attachment 1, A1.2.4.9 of this volume.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. Equipment shall be designed, fabricated, inspected, and tested in accordance with NFPA 70 and MIL-HDBK-454, Standard General Requirements for Electrical Equipment, requirements.	**C**		
14.1.2. All wiring shall be copper and contact with dissimilar metals shall be avoided. Aluminum wire shall not be used.	**C**		
14.1.3. At a minimum, Electrical and Electronic Ground Support Equipment (EGSE) shall be designed to operate within the voltage ratings of ANSI C84.1, Electric Power Systems and Equipment - Voltage Ratings (60 Hz).	**C**		
14.1.4. Electrical and Electronic Ground Support Equipment 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.	**C**		
14.1.5. EGSE and Flight Hardware Power Transient. Safety critical systems shall be protected against power transients and power outages.	**C**		
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. 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.	**C**		
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.	**C**		
Mismating includes improper installation as well as connecting wrong connectors. Prevention of connector mismating includes alignment pins and key-way arrangements or other possible means to make it impossible to incorrectly mismate. Color coding may be used in addition to, but not in lieu of, the more positive means of connector mismate prevention.	**I**		
14.1.6.2. If a hazardous event can occur, the following precautions shall be taken:	**C**		
14.1.6.2.1. Power and signal leads shall not be terminated on adjacent pins of a connector.	**C**		
14.1.6.2.2. Wiring shall be isolated so that a single short circuit occurring in a connector cannot affect other components.	**C**		
14.1.6.2.3. Pin locations shall be assigned to prevent inadvertent pin-to-pin and pin-to-case shorts.	**C**		
14.1.6.2.4. Spare pins shall not be used in connectors controlling hazardous operations or safety critical functions.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
14.1.6.3. Connectors used in safety critical or hazardous systems shall be of the locking type.	**C**		
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	**C**		
14.1.6.5. Plug and socket type connectors shall be used in safety critical or hazardous systems.	**C**		
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.	**C**		
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.	**C**		
14.1.7.2. Shields shall not be used as current carrying ground connections, except for coaxial cables.	**C**		
14.1.7.3. Circuits that operate safety critical or hazardous functions shall be protected from the electromagnetic environment to preclude inadvertent operation.	**C**		
14.1.8. EGSE and Flight Hardware Cables	**I**		
14.1.8.1. Cables shall be supported and protected against abrasion or crimping.	**C**		
14.1.8.2. Cables shall be located or protected so as not to present a tripping hazard.	**C**		
14.1.8.3. Cables in hazardous areas shall be designed so that they do not, in and of themselves, create a hazard.	**C**		
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.	**C**		
14.1.9. EGSE and Flight Hardware Batteries	**I**		
14.1.9.1. EGSE and Fight Hardware Battery General Design Requirements	**C**		
14.1.9.1.1. All batteries shall be capable of being readily accessible for electrical disconnection and/or removal.	**C**		
14.1.9.1.2. Battery connectors shall be designed to prevent reverse polarity.	**C**		
14.1.9.1.3. The capability for reverse current to cause a hazardous condition shall be prevented.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
Protection against shorting of connector terminals may be accomplished by taping or guarding with a suitable temporary connector.	**I**		
14.1.9.1.5. Identification. Each battery shall be permanently identified with the following appropriate information:	**C**		
14.1.9.1.5.1. Component name.	**C**		
14.1.9.1.5.2. Type of construction; for example lead-acid or nickel-cadmium.	**C**		
14.1.9.1.5.3. Manufacturer identification.	**C**		
14.1.9.1.5.4. Part number.	**C**		
14.1.9.1.5.5. Lot and serial number.	**C**		
14.1.9.1.5.6. Date of manufacture.	**C**		
14.1.9.2. EGSE and Flight Hardware Lithium Primary Batteries. The following requirements are applicable to lithium batteries used in flight hardware and EGSE.	**C**		
Batteries that have a UL listing and are intended for public use 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.	**C**		
14.1.9.2.2. Safety devices shall be incorporated into the lithium battery design.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.1.9.2.3. Each electrical safety device shall have a specific quality control program approved by the PSWG and Range Safety.	**C**		
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.	**C**		
14.1.9.2.5. Batteries shall be designed not to create a catastrophic hazard even when the safety tests described in 14.3.4 are performed.	**C**		
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. *Note: 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.* *Note: The following Li-Ion system safety requirements are applicable to any flight hardware or aerospace ground support equipment (GSE) without UL or MSA approval for the cells, batteries, and battery chargers approved specifically for the cell pack used.*	**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.	**C**		
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.*	**C**		
14.1.9.3.1.3. Individual cell monitoring and recording of voltage, current and temperature is required during charging and discharging to preclude the inadvertent venting of cells. (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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.1.9.3.1.4. Charging, monitoring, and recording EGSE shall be intrinsically safe if used within the Class I Division I or Division II areas and shall prevent high heat, sparking, and high charge/ discharge current rates.	**C**		
14.1.9.3. 1.5. Discharge shall not take place below -20C or above 60C.	**C**		
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 3:1 burst pressure based on vent device operating pressure with individual cells capable of surviving a short circuit current with a vent opening to release products. (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. *Note: Recommended test is NAVSEA 9310 High Temperature Test.* (3) Battery case design shall not impede cell vent operation. Battery design shall accommodate all cells within the battery venting at the same time. This shall be demonstrated by test.	**C**		
14.1.9.3.2.2. 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.	**C**		
14.1.9.3.2.3. 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.	**C**		
14.1.9.3.2.4. 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.	**C**		
14.1.9.3.2.5. Storage of the batteries (when not installed in GSE or Airborne hardware) shall be in approved battery storage locations.	**C**		
14.1.9.3.2.6. 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.	**C**		
14.1.9.3.2.7. Batteries that are transported incorporated into flight hardware shall be approved on a case-by-case basis.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
14.2.2.2. Power switches shall be located so that accidental contact by personnel cannot place equipment in operation.	**C**		
14.2.2.3. All switches and controls shall be clearly marked.	**C**		
14.2.2.4. Switches and controls shall be sufficiently separated and protected if they could be inadvertently actuated, creating a hazardous condition.	**C**		
14.2.2.5. Critical switches that can produce or induce hazardous conditions if inadvertently activated shall have a protective cover over them.	**C**		
14.2.3. EGSE Circuit Protection	**I**		
14.2.3.1. Protective devices shall be provided for EGSE primary circuits.	**C**		
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.	**C**		
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.	**C**		
14.2.3.4. All safety devices shall be located for easy access.	**C**		
Safety devices include fuses, circuit breakers, resets, and others.	**I**		
14.2.3.5. Circuit breaker trips shall be detectable by visual inspection.	**C**		
14.2.3.6. Replaceable components and test points shall be readily accessible.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
14.2.3.9. Each circuit shall not have the capability to inhibit, by loss of control, more than one safety critical control device.	**C**		
14.2.3.10. Megohm meters (megger high voltage resistance meters) shall be current limited depending on application.	**C**		
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.	**C**		
14.2.5. EGSE Batteries	**I**		
14.2.5.1. Sufficient ventilation shall be provided for unsealed EGSE batteries to ensure concentrations of vapor do not reach 25 percent of the LEL.	**C**		
14.2.5.2. Polarity of EGSE battery terminals shall be marked.	**C**		
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.	**C**		
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.	**C**		
14.2.6.2. Analysis or testing shall be conducted in accordance with 14.3.4.1.	**C**		
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 (NEC). The PSWG and Range Safety shall approve exceptions.	**C**		
14.2.7.2. Definition of Hazardous (Classified) Locations. Hazardous (Classified) locations are defined in NEC Article 500, Hazardous (Classified) Locations.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. The appropriate local safety authorities as identified by the PSWG and Range Safety and the local Fire Marshal shall approve all potential critical facility hazardous location designations. See Attachment 3 of this volume for a flow path for classifying hazardous areas.	**C**		
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.	**C**		
14.2.7.3.1.2. Below grade locations in a Class II, Division 1 area.	**C**		
14.2.7.3.1.3. Locations in which flammable liquids, vapors, or gases may be present in the air during normal operations.	**C**		
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.	**C**		
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, 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.	**C**		
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.	**C**		
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.	**C**		
14.2.7.3.2.4. Class I, Division 2 locations include the following equipment or areas:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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).	**C**		
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).	**C**		
14.2.7.3.2.4.3. 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.	**C**		
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.	**C**		
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.	**C**		
14.2.7.3.3. Hazardous Commodity Groups. Hazardous commodities are grouped by similar characteristics.	**C**		
14.2.7.3.3.1. These fuels shall be considered ignitable regardless of the ambient temperature.	**C**		
14.2.7.3.3.2. The following fuels shall be categorized as follows:	**C**		
14.2.7.3.3.2.1. Group B: Liquid or gaseous hydrogen.	**C**		
14.2.7.3.3.2.2. Group C: Hypergolic propellant fuels such as N2H4, MMH, UDMH, A50.	**C**		
14.2.7.3.3.2.3. Group D: Hydrocarbon fuels (RP and JP).	**C**		
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.	**C**		
14.2.7.3.3.2.5. 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:	**C**		
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.	**C**		
14.2.7.3.3.2.5.2. The motor nozzle is attached but does not have a nozzle plug.	**C**		
14.2.7.3.3.2.5.3. The unassembled motor segments do not have front and rear covers.	**C**		
14.2.7.3.3.2.5.4. The igniter is removed from the motor and cover is not provided.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
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.	**C**		
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.	**C**		
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 I Hazardous Areas, and be listed and labeled by a nationally recognized laboratory such as UL, FM, or those accredited by 29, CFR 1910.7.	**C**		
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 NEC, Article 500 is acceptable with the following additional requirements:	**C**		
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.	**C**		
14.2.7.4.4.2. Rooms into which unprotected personnel may enter shall be purged with air only.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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. *Note: 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.*	**C**		
14.3.2. Flight Hardware Electromechanical Initiating Devices and Systems	**I**		
Electromechanical initiating devices and systems, including non-explosive initiators (NEIs), are used for such purposes as structure deployment or actuation release mechanisms.	**I**		
14.3.2.1. Electromechanical initiating devices and systems shall be evaluated to determine the severity of the hazard (Category A or B).	**C**		
14.3.2.2. Design, test, and data requirements shall be determined by the PSWG and Range Safety on a case-by-case basis.	**C**		
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.	**C**		
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.	**C**		
14.3.3.1.1. This pressure buildup shall take into account hydraulic and temperature extremes.	**C**		
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 Range Safety approved analysis can be used on a case-by-case basis.	**I**		
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. Range Safety approved analyses include fracture mechanics that can be used on a case-by-case basis.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
14.3.4. Test Requirements for Lithium Batteries. 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. *Note: Li-Ion battery safety see section 14.1.9.3.*	**C**		
Batteries that have a UL listing and are intended for public use are exempt from these requirements.	**I**		
14.3.4.1. Lithium Battery Constant Current Discharge and Reversal Test	**I**		
14.3.4.1.1. 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.	**C**		
14.3.4.1.2. The test shall be performed according to the following criteria:	**C**		
14.3.4.1.2.1. The test shall consist of a constant current discharge using a DC power supply.	**C**		
14.3.4.1.2.2. The fusing of the battery shall be bypassed (shorted).	**C**		
14.3.4.1.2.3. The discharge shall be performed at a level equal to the battery fuse current rating and the voltage of the battery.	**C**		
14.3.4.1.2.4. 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.	**C**		
14.3.4.1.2.5. Voltage, pressure, and temperature shall be continuously monitored and recorded.	**C**		
14.3.4.2. Lithium Battery Short Circuit Test	**I**		
14.3.4.2.1. 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.	**C**		
14.3.4.2.2. The test shall be performed according to the following criteria:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.3.4.2.2.1. 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.	**C**		
14.3.4.2.2.2. Voltage, current, pressure, and temperature shall be continuously monitored and recorded.	**C**		
14.3.4.3. Lithium Battery Drop Test. A drop test shall be performed according to the following criteria:	**C**		
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**		
14.3.4.3.1. 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.	**C**		
14.3.4.3.2. The battery shall not vent or start a hazardous event when dropped.	**C**		
14.3.4.3.3. 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.	**C**		
14.3.5. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 encompasses 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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
15.2.1.2. Motor vehicles for the transport of explosives shall conform to AFMAN 91-201 and DoD 6055.9-STD when on Air Force property, and NASA-STD 8719.12 when on NASA property.	**C**		
15.2.1.3. Special-purpose trailers for range use only shall conform to AFMAN 91-201 and DoD 6055.9-STD.	**C**		
15.2.1.4. If the motor vehicle is not exempted from 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:	**C**		
15.2.1.4.1. Design, test, and NDE inspection requirements for vehicles.	**C**		
15.2.1.4.2. FMECA in accordance with MIL-STD-882C on selected applications.	**C**		
15.2.1.4.3. Engineering documentation such as analyses (performance, stress, SFPs), tests, and inspections that justifies acceptance of DOT non-compliances based on “equivalent safety” or “meets DOT intent” criteria.	**C**		
15.2.2. Special-Purpose Trailers Used to Transport Critical or Hazardous Loads Design Requirements:	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
15.2.2.2. Load test tags shall be attached to the trailer and marked with the following minimum information:	**C**		
15.2.2.2.1. Part number.	**C**		
15.2.2.2.2. Date and weight of most recent load test (or date of next load test).	**C**		
15.2.2.2.3. Rated load.	**C**		
15.2.2.2.4. Date of most recent NDE (or date of next NDE).	**C**		
15.2.3. Special-Purpose Trailers Used to Transport Critical or Hazardous Loads Tests:	**C**		
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:	**C**		
15.2.3.1.1. Road/load test at 125 percent rated load at typical terrain and design speeds for selected applications.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
15.3 LIFT TRUCKS	**I**		
15.3.1. Lift Truck Standards	**I**		
15.3.1.1. Lift trucks shall be in accordance with ANSI/ASME B56.2, Type Designated Area, Use Maintenance, Operator, and ANSI B56.3, Electric Battery-Powered Industrial Trucks, safety standards.	**C**		
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.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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, AFMAN 91-201, and DoD 6055.9-STD.	**C**		
15.3.2. Lift Truck General Design Requirements	**C**		
15.3.2.1. Lift trucks shall be equipped with shoulder-high wing safety seats with seatbelts.	**C**		
15.3.2.2. Personnel platforms attached to lift trucks shall be designed and tested in accordance with 6.3 of this volume.	**C**		
15.3.2.3. Critical loads shall not exceed 75 percent of the lift truck rated capacity.	**C**		
15.3.3. Lift Truck Tests. Lift trucks shall be tested in accordance with ASME/ANSI B56 Series Safety Standards.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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-8719.13, Software Safety Standard, and NASA-STD-8739.8, Software Assurance 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 by NASA-STD-8719.13 are described in NASA-STD-8719.13 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. *Note: 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.*	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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**		
16.2 DETERMINATION OF SAFETY CRITICAL COMPUTER SYSTEM FUNCTIONS The payload project shall identify all safety critical software in accordance with NASA-STD-8719.13, Software Safety Standard, and the provisions of this document. The payload project shall identify all safety critical computer system functions (SCCSFs). These functions 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. Safety critical computer system functions include, but are not necessarily limited to, the following:	**I**		
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. Software used to control and/or monitor safety critical systems.	**C**		
16.2.2. Software used for fault detection in safety critical computer hardware or software.	**C**		
16.2.3. Software used to transmit safety critical data, including time-critical data and data about hazardous conditions.	**C**		
16.2.4. Software that responds to the detection of a safety critical fault.	**C**		
16.2.5. FTS Software.	**C**		
16.2.6. Software that computes safety critical data.	**C**		
16.2.7. Software used to access safety critical data.	**C**		
16.2.8. Processor interrupt software associated with previously designated safety critical computer system functions.	**C**		
16.3 HARDWARE AND SOFTWARE SAFETY DESIGN REQUIREMENTS The following subparagraphs identify general hardware and software requirements that shall be met for all safety critical computer system functions.	**I**		
16.3.1. Computer Systems	**I**		
16.3.1.1. Computer systems shall be validated for operation in the intended environment.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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 failure tolerant.	**C**		
16.3.1.3.1. No single software failure/output shall initiate a hazardous operation.	**C**		
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.	**C**		
16.3.1.3.3. No single or double software failure/output shall cause a catastrophic accident.	**C**		
16.3.1.3.4. Fulfilling the following requirements in addition to the other requirements in 16.3.1 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:	**C**		
16.3.1.3.4.1. All hazardous operations that can be triggered by software, either intentionally or unintentionally.	**C**		
16.3.1.3.4.2. All critical accidents that can be triggered by software.	**C**		
16.3.1.3.4.3. Catastrophic accidents that can be triggered by software.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
16.3.2. Computer System Power	**I**		
16.3.2.1. Computer systems shall be powered up and/or restarted in a safe state.	**C**		
16.3.2.2. A computer system shall not enter a hazardous state as a result of an intermittent power transient or fluctuation.	**C**		
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.	**C**		
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.	**C**		
16.3.3. Computer System Anomaly and Failure Detection	**I**		
In addition, 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.	**C**		
16.3.3.2. The following hazardous conditions and failures, including those from multiple sources, shall be detected:	**C**		
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.	**C**		
16.3.3.2.2. Invalid output - data output from software modules that are outside a specified range for safe operation.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
16.3.3.2.3. Timing errors - the state when software-timed events do not happen according to specification.	**C**		
16.3.3.2.4. Data transmission errors.	**C**		
16.3.3.2.5. Loss of memory integrity.	**C**		
16.3.3.2.6. Greater than allowed safe input data rates.	**C**		
16.3.3.2.7. The existence of a pattern other than the arm or safe codes in the arm/safe data register.	**C**		
16.3.3.2.8. Software exceptions, such as "divide by zero" or "file not found."	**C**		
16.3.3.2.9. Data transfer messages corrupted or not in the proper format.	**C**		
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.	**C**		
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**		
16.3.4.1.1. The display shall distinguish between read and unread anomaly alerts.	**C**		
16.3.4.1.2. The display shall support reporting multiple anomalies.	**C**		
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.	**C**		
16.3.4.2. Upon detecting an event described in 16.3.3, the software shall remain in or revert to a stable state.	**C**		
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.	**C**		
16.3.4.3.1. The software shall maintain the FTS in the safe state before arming.	**C**		
16.3.4.3.2. After the FTS is armed, the software shall retain the FTS in the armed state.	**C**		
16.3.4.3.3. When the FTS receiver is on internal power, the software shall maintain the FTS receiver on internal power.	**C**		
16.3.4.3.4. During flight, all detected FTS-related system errors shall be transmitted to the range.	**C**		
16.3.5. Computer System Testing and Maintenance	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
16.3.5.1. Non-operational hardware and software required for testing or maintenance shall be clearly identified.	**C**		
16.3.5.2. Systems shall include interlocks, as necessary, to mitigate hazards when performing maintenance or testing.	**C**		
16.3.5.3. Interlocks shall be designed to prevent an inadvertent override.	**C**		
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.	**C**		
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.	**C**		
16.3.5.6. The status of overridden interlocks shall be displayed on the appropriate operator console(s).	**C**		
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.	**C**		
16.3.5.8. Compilers	**C**		
16.3.5.8.1. Existing code compiled with a new compiler or new release of a compiler shall be regression tested.	**C**		
16.3.5.8.2. Beta test versions of language compilers shall not be used for safety critical functions.	**C**		
16.4 SOFTWARE REQUIREMENTS	**I**		
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-8719.13, Software Safety Standard, NASA-STD-8739.8, NASA Software Assurance Standard, and commercial software development standard IEEE/EIA 12207, Standard for Information Technology. NASA-GB-8719.13, NASA Software Safety Guidebook, is recommended for guidance in ensuring software safety.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
16.4.3.1. General human-computer interfaces should use the "DoD Human-Computer Interface Style Guide" as specified in Section 2.5 of Version 3.1 of the Joint Technical Architecture (JTA).	**C**		
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.	**C**		
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.	**C**		
16.4.3.4. Only one operator at a time shall control safety critical computer system functions.	**C**		
16.4.3.5. Operator-initiated hazardous functions shall require two or more independent operator actions. *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.*	**C**		
16.4.3.6. Software shall provide confirmation of valid command and/or data entry to the operator.	**C**		
16.4.3.7. Software shall provide feedback to the operator that indicates command receipt and status of the operation commanded.	**C**		
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.	**C**		
16.4.3.9. Error messages that distinguish safety critical states/errors from non-safety critical states/errors shall be provided.	**C**		
16.4.3.10. The system shall ensure that a single failure or error cannot prevent the operator from taking safing actions.	**C**		
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.	**C**		
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.	**C**		
16.4.5. Configuration Control	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
16.4.5.3. A Software Configuration Control Board (SCCB) shall be established to approve changes to configuration-controlled software before implementation.	**C**		
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.	**C**		
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.	**C**		
16.4.5.6. Object code patches shall not be performed unless the SCCB and the PSWG and Range Safety give specific approval.	**C**		
16.5 COMPUTER SYSTEM AND SOFTWARE DATA REQUIREMENTS Computer system and software data shall be provided in accordance with Attachment 1, A1.2.5.18 of this volume.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 17 WESTERN RANGE SEISMIC DESIGN	**C**		
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.	**C**		
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 safety is preserved.	**C**		
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.	**C**		
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.	**C**		
17.1.5. Gravity friction shall not be used as the only means to anchor or restrain equipment.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
17.2.3. Appropriate seismic hazard mitigation shall be implemented for high cost computer or electronic equipment.	**C**		
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.	**C**		
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 ($0.2*S_{DS}*D$).	**C**		
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.	**C**		
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.	**C**		
17.2.5. Exemptions. GSE that meets any of the following criteria shall be exempt from seismic design and/or restraint requirements:	**C**		
17.2.5.1. Internal operational elements of GSE that are confined within the GSE structure.	**C**		
17.2.5.2. Man-handled GSE physically attached to flight hardware or GSE.	**C**		
17.2.5.3. GSE categorized as hand tools.	**C**		
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 tipping that may present a crushing or pinching hazard.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
17.3 WR SEISMIC DATA REQUIREMENTS 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.	**C**		
17.4 EARTHQUAKE EMERGENCY PLANNING AND POST RECOVERY RESPONSE 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 18 SOLID ROCKET MOTORS, ROCKET MOTOR SEGMENTS, AND ROCKET MOTOR COMPONENTS	**I**		
18.1 GENERAL 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:	**C**		
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.	**C**		
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.	**C**		
18.2 FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS (FMECA) AND OPERATIONAL HAZARDS ANALYSIS (OHA) FMECA and operational hazard analysis (OHA) for all aspects of solid rocket segment and/or motor handling and buildup. This analysis shall include the following:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
18.3.3 These analyses shall specify any operational restrictions needed to insure lightning safety during storage and processing.	**C**		
18.4 SOLID ROCKET MOTOR AND MOTOR SEGMENT DATA REQUIREMENTS 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 1 SAFETY DATA PACKAGE (MISSILE SYSTEM PRELAUNCH SAFETY 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).	**C**		
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 ELV payloads, and related ground support systems, including AGE, GSE, and facilities.	**C**		
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.	**C**		
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 90 calendar days prior to payload (spacecraft) shipment or as determined by the PSWG.	**C**		
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.	**C**		
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 A1.2.4.4). All schematics, functional diagrams, and operational manuals shall have well defined, standard IEEE or Mil-Spec terminology and symbols.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
A1.2.2.1. Table of Contents and Glossary. The SDP (MSPSP) shall contain a table of contents and a glossary.	**C**		
A1.2.2.2. Introduction. The "introduction" section shall address the scope and purpose of the SDP (MSPSP).	**C**		
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:	**C**		
A1.2.3.1. Physical dimensions and weight.	**C**		
A1.2.3.2. Nomenclature and description of major subsystems.	**C**		
A1.2.3.3. Types of motors and propellants to be used.	**C**		
A1.2.3.4. Sketches and/or photographs of the launch vehicle, payload, or ground support system.	**C**		
A1.2.3.5. Synopsis of each hazardous and safety critical subsystem.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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:	**C**		
A1.2.4.1.1. Subsystem overview.	**C**		
A1.2.4.1.2. Nomenclature of major subsystems.	**C**		
A1.2.4.1.3. Function of the subsystem.	**C**		
A1.2.4.1.4. Location of the subsystem.	**C**		
A1.2.4.1.5. Operation of the subsystem.	**C**		
A1.2.4.1.6. Subsystem design parameters.	**C**		
A1.2.4.1.7. Subsystem test requirements.	**C**		
A1.2.4.1.8. Subsystem operating parameters.	**C**		
A1.2.4.1.9. Summaries of any PSWG and Range Safety required hazard analyses conducted.	**C**		
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.	**C**		
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.)	**C**		
A1.2.4.4. 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).	**C**		
A1.2.4.5. A list of all the PSWG and Range Safety approved non-compliances.	**C**		
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 A1.2.4.1, the material properties of the main structures, mechanisms, and deployables used on launch vehicles and payloads shall be included in the SDP (MSPSP).	**C**		
A1.2.4.6.2. Flight Hardware Used in Lifting Critical Loads. At a minimum, the following documentation is required:	**C**		
A1.2.4.6.2.1. SFP analysis.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.6.2.2. NDE plan and test results for SFP components and SFP welds. A1.2.4.6.2.3. Initial proof load test plan and test results.	**C**		
A1.2.4.6.2.4. Stress analysis.	**C**		
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:	**C**		
A1.2.4.7.1.1. Material compatibility analysis.	**C**		
A1.2.4.7.1.2. Physical and chemical properties and general characteristics of the propellant, test fluid, and gases.	**C**		
A1.2.4.7.1.3. For hazardous propellants, fluids, and gases, the following shall be submitted:	**C**		
A1.2.4.7.1.3.1. Specific health hazards such as toxicity and physiological effects.	**C**		
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.	**C**		
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).	**C**		
A1.2.4.7.1.3.4. Maximum credible spill size including volume and surface area and supporting analyses.	**C**		
A1.2.4.7.1.3.5. Description of hazards other than toxicity such as flammability and reactivity.	**C**		
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.	**C**		
A1.2.4.7.1.3.7. Manufacturer, model number, specifications, operating limits, type of certification, and general description of vapor detecting equipment.	**C**		
A1.2.4.7.1.3.8. Identification of material incompatibility problems in the event of a spill.	**C**		
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.	**C**		
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:	**C**		
Nomenclature of each element should be made adjacent to or in the vicinity of each element.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.7.2.1. Identification of all pressure system components such as valves, regulator, tubes, hoses, vessels, and gauges using standard symbols.	**C**		
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.	**C**		
A1.2.4.7.2.3. Identification of expected source pressures and expected delivery pressures.	**C**		
A1.2.4.7.2.4. All relief valve pressure settings and flow rates.	**C**		
A1.2.4.7.2.5. System fluid and maximum expected temperature.	**C**		
A1.2.4.7.2.6. Pressure ranges of all pressure transducers.	**C**		
A1.2.4.7.2.7. Pressure settings of pressure regulators.	**C**		
A1.2.4.7.2.8. Charging pressure of reservoirs and vessels, their nominal capacities, and wall thickness.	**C**		
A1.2.4.7.2.9. Pressure setting of all pressure switches.	**C**		
A1.2.4.7.2.10. The nominal outside diameter and wall thickness of all tubing and piping.	**C**		
A1.2.4.7.2.11. Flow path through all components.	**C**		
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.	**C**		
A1.2.4.7.2.13. End-to-end electrical schematics of electrical and electronic components giving full functional data and current loads.	**C**		
A1.2.4.7.2.14. Connections for testing or servicing.	**C**		
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.	**C**		
A1.2.4.7.2.16. A sketch or drawing of the system that shows physical layout and dimensions.	**C**		
A1.2.4.7.2.17. System information shall be placed in tabular form; suggested format is shown below.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Example Systems Data Format *System ID Number* *System Title* *Location* *MOP* *Commodity* *Responsible Organization* *Number of Vessels* *Recertification Date* *Recertification* *Material(s)* *Inspection Results* *ISI Requirements*	**I**		
A1.2.4.7.3. Flight Hardware Pressure, Propellant, and Propulsion Component Design Data. The following information shall be submitted for each component:	**C**		
A1.2.4.7.3.1. Identification of each component by a reference designation permitting cross reference with the system schematic.	**C**		
A1.2.4.7.3.2. The MAWP for all pressure system components.	**C**		
A1.2.4.7.3.3. The MOP at which the component shall operate when installed in the system.	**C**		
A1.2.4.7.3.4. Safety factors or design burst pressure for all pressure system components.	**C**		
A1.2.4.7.3.5. Actual burst pressures, if available.	**C**		
A1.2.4.7.3.6. Pre-assembly hydrostatic test proof pressure for each system component.	**C**		
A1.2.4.7.3.7. If applicable, the proof pressure the component will be tested to after installation in the system.	**C**		
A1.2.4.7.3.8. Materials used in the fabrication of each element in the component, including soft goods and other internal elements.	**C**		
A1.2.4.7.3.9. Cycle limits if fatigue is a factor of the component.	**C**		
A1.2.4.7.3.10. Temperature limits of each system component.	**C**		
A1.2.4.7.3.11. Component information shall be placed in tabular form; suggested format is shown below.	**C**		
Example Vessels Data Format:	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Vessel ID Number *System ID Number* *Manufacturer Name* *Manufacturer Serial No.* *Manufacturer Drawing No.* *Commodity* *Original MAWP* *Burst Pressure* *Volume* *Location* *DOT Specification* *Year of Manufacture* *National Board No.* *Code Stamps* *Recertification MAWP* *Recertification Date* *Recertification Period* *Cyclic Limit* *Test Pressure* *Vessel Design Material* *Temperature Limits* *Maximum Stress* *Inside Radius* *Thickness* *Dimensions* *ISI Information* *ISI Results*			

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Example Relief Devices Data Format: *ID Number* *System Number* *Type* *Manufacturer* *Manufacturer Part No.* *Code Stamps* *Manufacturer Date* *Inlet Size* *Outlet Size* *Set or Burst Pressure* *System MOP* *System Commodity* *Flow Capacity* *Material* *Temperature Limits* *Test Pressure* *ISI Requirements* *ISI Results*	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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* *ISI Results*	**I**		
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	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ISI Results			
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.	**C**		
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 A1.2.4.1.	**C**		
A1.2.4.8.2. Flight Hardware Battery Design Data. The following information shall be submitted for flight hardware batteries:	**C**		
A1.2.4.8.2.1. Design versus actual operating parameters of cells and battery.	**C**		
A1.2.4.8.2.2. Cell chemistry and physical construction.	**C**		
A1.2.4.8.2.3. Cell vent parameters.	**C**		
A1.2.4.8.2.4. Toxic chemical emission of cells and evaluation of hazards.	**C**		
A1.2.4.8.2.5. EPA classification of the battery.	**C**		
A1.2.4.8.2.6. DOT classification of the battery.	**C**		
A1.2.4.8.2.7. Physical and electrical integration of cells to form the battery.	**C**		
A1.2.4.8.2.8. Description of safety devices.	**C**		
A1.2.4.8.2.9. Case design including vent operation and cell and battery case housing yield point.	**C**		
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.	**C**		
A1.2.4.8.2.11. Identification of the hazards associated with each activity in A1.2.4.8.2.10 above and the safety controls that shall be in effect.	**C**		
A1.2.4.8.2.12. Manufacturing qualification and acceptance testing results that are considered safety critical.	**C**		
A1.2.4.8.2.13. Battery size and weight.	**C**		
A1.2.4.8.2.14. Specification of the system that uses the battery.	**C**		
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.	**C**		
A1.2.4.8.2.16. A list and summary of test plans, test procedures, and test results in accordance with 14.3.4.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
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.	**C**		
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.	**C**		
A1.2.4.8.3.3. A description of how inadvertent commands that can cause a hazardous condition are prevented.	**C**		
A1.2.4.8.3.4. Identification of potential shock hazards.	**C**		
A1.2.4.8.3.5. A description of how the intent of hazard proofing is met for electrical and electronic systems.	**C**		
A1.2.4.8.3.6. Complete grounding and bonding methodology.	**C**		
A1.2.4.8.3.7. A bent pin analysis for all connectors for safety critical or hazardous systems that have spare pins.	**C**		
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.	**C**		
A1.2.4.9.2. Flight Hardware Ordnance Hazard Classifications and Categories. The following ordnance hazard classification data shall be submitted:	**C**		
A1.2.4.9.2.1. UNO classifications and DOD hazard classifications, including class, division, and compatibility group, in accordance with DOD-STD-6055.9 and NASA-STD 8719.12 respectively.	**C**		
A1.2.4.9.2.2. DOT classification.	**C**		
A1.2.4.9.2.3. The ordnance device and system hazard category for each ordnance item and system in accordance with 13.1.2; test results and/or analysis used to classify the ordnance devices and systems as Category A or B.	**C**		
A1.2.4.9.3. Flight Hardware Ordnance System Data. The following ordnance system data shall be submitted:	**C**		
A1.2.4.9.3.1. A block diagram of the entire ordnance system.	**C**		
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.	**C**		
A1.2.4.9.3.3. Diagrams showing the location of all ordnance components on the vehicle.	**C**		
A1.2.4.9.3.4. A description of wiring, ETS, and FOC routing.			

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.9.3.5. A description of electrical, ETS, and optical connections and connectors.	**C**		
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.	**C**		
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.	**C**		
A1.2.4.9.3.6.2. All pin assignments shall be accounted for.	**C**		
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.	**C**		
A1.2.4.9.3.8. The FMECA for each ordnance system.	**C**		
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.	**C**		
A1.2.4.9.3.10. A sketch showing the accessibility of manual arming and safing devices.	**C**		
A1.2.4.9.3.11. Specification drawings and documents for all airborne and ground ordnance systems.	**C**		
A1.2.4.9.4. Flight Hardware Ordnance Component Design Data. The following ordnance component design data shall be submitted:	**C**		
A1.2.4.9.4.1. A complete and detailed description of each ordnance system component and how it functions.	**C**		
A1.2.4.9.4.2. Specification drawings and documents for all airborne and ground ordnance components.	**C**		
A1.2.4.9.4.3. Illustrated breakdown of all mechanically operated ordnance components.	**C**		
A1.2.4.9.4.4. Part number, manufacturer, and net explosive weight for each ordnance item.	**C**		
A1.2.4.9.4.5. Temperature and humidity requirements for each ordnance item.	**C**		
A1.2.4.9.4.6. Bridgewire resistance, maximum safe no-fire current, and minimum all-fire current for each low voltage EED.	**C**		
A1.2.4.9.4.7. Maximum no-fire voltage and minimum all-fire voltage for each EBW.	**C**		
A1.2.4.9.4.8. Maximum no-fire energy and minimum all-fire energy for each LID and PAD.	**C**		
A1.2.4.9.4.9. A list and summary of test plans procedures, and results, as required.	**C**		
A1.2.4.9.4.10. 8 x 10 inch color photographs or electronic copies of all ordnance items.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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:	**C**		
A1.2.4.9.6.1. Propellant Properties.	**C**		
A1.2.4.9.6.1.1. Propellant explosive hazard classification (DoD, UNO, DOT, including test results), if not previously addressed by A1.2.4.9.2.1.	**C**		
A1.2.4.9.6.1.2. Propellant formulation (composition).	**C**		
A1.2.4.9.6.1.3. Propellant autoignition température.	**C**		
A1.2.4.9.6.1.4. Propellant static sensitivity (energy in Joules required to ignite the propellant).	**C**		
A1.2.4.9.6.1.5. Propellant conductivity.	**C**		
A1.2.4.9.6.2. Propellant Reactions to Impact on Hard Surface.	**C**		
A1.2.4.9.6.2.1. Ignition threshold drop height.	**C**		
A1.2.4.9.6.2.2. Low order detonation threshold drop height.	**C**		
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).	**C**		
A1.2.4.9.6.3. Igniter data	**C**		
A1.2.4.9.6.3.1. Type of propellant and propellant properties data as specified in A1.2.4.9.6.1 and A1.2.4.9.6.2 above.	**C**		
A1.2.4.9.6.3.2. Data on each igniter initiator, such as a through bulkhead initiator (TBI).	**C**		
A1.2.4.9.6.3.3. Igniter weight.	**C**		
A1.2.4.9.6.3.4. Igniter grounding provisions.	**C**		
A1.2.4.9.6.3.5. Igniter storage requirements.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.9.6.3.6. Igniter handling requirements.	**C**		
A1.2.4.9.6.3.7. Igniter testing and inspection requirements.	**C**		
A1.2.4.9.6.3.8. Igniter packaging requirements (if shipped separately).	**C**		
A1.2.4.9.6.3.9. Igniter case description, including design safety factors.	**C**		
A1.2.4.9.6.4. Rocket Motor/Segment Data.	**C**		
A1.2.4.9.6.4.1. Motor/segment case description, including design safety factors.	**C**		
A1.2.4.9.6.4.2. Method of proof testing the rocket motor/segment case before propellant loading.	**C**		
A1.2.4.9.6.4.3. Weight of propellant.	**C**		
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.	**C**		
A1.2.4.9.6.4.5. Motor/segment nondestructive testing requirements.	**C**		
A1.2.4.9.6.4.6. Motor/segment storage requirements.	**C**		
A1.2.4.9.6.4.7. Motor/segment handling requirements.	**C**		
A1.2.4.9.6.4.8. Motor/segment grounding requirements.	**C**		
A1.2.4.9.6.4.9. Description of structural, mechanical, and electrical subsystems.	**C**		
A1.2.4.9.6.4.10. Description of materials and properties of seals and O-rings.	**C**		
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.	**C**		
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 A1.2.4.1.	**C**		
A1.2.4.10.2. Flight Hardware RF Emitter Data. The following information shall be submitted for RF emitters:	**C**		
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:	**C**		
A1.2.4.10.2.1.1. Location of generating equipment.	**C**		
A1.2.4.10.2.1.2. RF hazard areas.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.10.2.1.3. Description and use of nearby facilities and operating areas.	**C**		
A1.2.4.10.2.2. Design and Test Data. At a minimum, the following RF emitter design and test data shall be submitted:	**C**		
A1.2.4.10.2.2.1. Emitter peak and average power.	**C**		
A1.2.4.10.2.2.2. Pulse widths.	**C**		
A1.2.4.10.2.2.3. Pulse repetition frequencies.	**C**		
A1.2.4.10.2.2.4. Pulse codes.	**C**		
A1.2.4.10.2.2.5. Maximum rated duty cycle.	**C**		
A1.2.4.10.2.2.6. Type and size of antenna.	**C**		
A1.2.4.10.2.2.7. Antenna gain and illumination.	**C**		
A1.2.4.10.2.2.8. Beam width and beam skew.	**C**		
A1.2.4.10.2.2.9. Operating frequency in MHz.	**C**		
A1.2.4.10.2.2.10. Insertion loss between transmitter and antenna.	**C**		
A1.2.4.10.2.2.11. Polarization of transmitted wave hardware.	**C**		
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.	**C**		
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).	**C**		
A1.2.4.10.2.2.14. A description of interlocks, inhibits, and other safety features that prevent inadvertent exposures.	**C**		
A1.2.4.10.2.2.15. A copy of the RPO/RSO approved Radiation Protection Program RF Use Request Authorization.	**C**		
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.	**C**		
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.	**C**		
A1.2.4.10.3. Flight Hardware Laser System Data. At a minimum, the following laser system data shall be submitted:	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
A1.2.4.10.3.6. Laser System Performance Data.	**C**		
A1.2.4.10.3.6.1. Type, class, nomenclature, manufacturer model number, general identification, and other pertinent information.	**C**		
A1.2.4.10.3.6.2. General description of the test, pertinent drawing of the operation site, and associated equipment.	**C**		
A1.2.4.10.3.6.3. Lasing material.	**C**		
A1.2.4.10.3.6.4. Continuous wave (CW) or pulse identification.	**C**		
A1.2.4.10.3.6.5. Wavelength.	**C**		
A1.2.4.10.3.6.6. Bandwidth.	**C**		
A1.2.4.10.3.6.7. Average power and/or energy per pulse and/or maximum output energy.	**C**		
A1.2.4.10.3.6.8. Pulse duration and pulse rate.	**C**		
A1.2.4.10.3.6.9. Beam width at 1/e point for both axes.	**C**		
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.	**C**		
A1.2.4.10.3.6.11. Beam divergence at 1/e point for both axes.	**C**		
A1.2.4.10.3.6.12. Emergent beam diameter.	**C**		
A1.2.4.10.3.6.13. Coolant.	**C**		
A1.2.4.10.3.6.14. Amount of energy reflected back through the eyepiece or pointing device.	**C**		
A1.2.4.10.3.6.15. Electrical voltage applied to the system.	**C**		
A1.2.4.10.3.6.16. Any other pertinent laser parameter such as distribution of energy onbeam and scan rate as determined by the payload project or the PSWG and Range Safety.	**C**		
A1.2.4.10.3.6.17. Composition, color, and specularly or diffusely reflected surface characteristics of intended targets.	**C**		
A1.2.4.10.3.6.18. Maximum incident energy on targets.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
A1.2.4.10.3.6.20. Intended method (such as binoculars or spotter scope) of viewing the beam and/or its reflections.	**C**		
A1.2.4.10.3.6.21. Safety devices such as interlocks, filters, shutters, and aiming devices.	**C**		
A1.2.4.10.3.6.22. Azimuth and elevation and/or electrical and mechanical elevation stops.	**C**		
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:	**C**		
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.	**C**		
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.	**C**		
A1.2.4.10.3.8. Biophysiological Data	**C**		
A1.2.4.10.3.8.1. Safe eye and skin distances based on occupational exposure limits.	**C**		
A1.2.4.10.3.8.2. Safety clearance and hazard zones.	**C**		
A1.2.4.10.3.8.3. Personal protective equipment required for personnel remaining inside clearance zones.	**C**		
A1.2.4.10.3.9. A copy of the RPO/RSO approved Radiation Protection Plan Laser Use Request Authorization.	**C**		
A1.2.4.10.3.10. A list and summary of test plans, test procedures, and test results in accordance with 8.2.3.	**C**		
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.	**C**		
A1.2.4.11.2. Flight Hardware Ionizing Radiation Subsystem Data. The following data shall be submitted:	**C**		
A1.2.4.11.2.1. The final SAS (Safety Analysis Summary) as required by NPR 8715.3, Chapter 6, and AFI 91-110, Attachment 3. The SAS shall be referenced in the SDP (MSPSP) and submitted as an accompanying document.	**C**		
A1.2.4.11.2.1.1. Status reports on the SAS approval.	**C**		
A1.2.4.11.2.1.2. Verification of approval for launch by separate correspondence in accordance with the requirements of NPR 8715.3, Chapter 6, AFI 91-110 or the equivalent.	**C**		
A1.2.4.11.2.2. Manufacturer of the source.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.11.2.3. Date of source preparation.	**C**		
A1.2.4.11.2.4. Source identification number.	**C**		
A1.2.4.11.2.5. Cross-sectional sketch showing dimensions of the source.	**C**		
A1.2.4.11.2.6. Source container or holder construction material.	**C**		
A1.2.4.11.2.7. Physical source form such as powder or plate.	**C**		
A1.2.4.11.2.8. Chemical source form such as metal or oxide.	**C**		
A1.2.4.11.2.9. Strength in curies.	**C**		
A1.2.4.11.2.10. Type of protective cover material over the source.	**C**		
A1.2.4.11.2.11. Date and result of last wipe test.	**C**		
A1.2.4.11.2.12. Method of sealing against leakage.	**C**		
A1.2.4.11.2.13. Radionuclide solubility in sea water.	**C**		
A1.2.4.11.2.14. Description, including diagrams, showing exact placement of the source in the vehicle or payload.	**C**		
A1.2.4.11.2.15. A brief description of intended use.	**C**		
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.	**C**		
A1.2.4.11.2.17. Description of potential accidents that would cause release of radioactive material including potential personnel exposure and ground contamination.	**C**		
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.	**C**		
A1.2.4.11.2.19. Description of recovery plans for land and sea launch abort scenarios.	**C**		
A1.2.4.11.2.20. Location and name of responsible organization and licensed individual assigned to supervise handling of this material.	**C**		
A1.2.4.11.2.21. Detailed nuclear system design.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.11.2.23. The predicted responses of the nuclear system to processing, launch, and flight environments and failures.	**C**		
A1.2.4.11.2.24. The predicted resulting nuclear risk.	**C**		
A1.2.4.11.2.25. Ground support systems design data as required by the appropriate sections of this publication.	**C**		
A1.2.4.11.2.26. Detailed ground processing flow.	**C**		
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; 45 SWI 40-201, Radiation Protection Program (ER only)].	**C**		
A1.2.4.11.2.28. A copy of the Radiation Protection Plan as required by the 30th SW RADSAFCOM (WR only).	**C**		
A1.2.4.11.2.29. A list and summary of test plans, test procedures, and test results in accordance with 9.2.2.	**C**		
A1.2.4.11.3. Flight Hardware Ionizing Radiation Producing Equipment and Devices. The following data shall be submitted:	**C**		
A1.2.4.11.3.1. Manufacturer and model number.	**C**		
A1.2.4.11.3.2. A description of the system and its operation.	**C**		
A1.2.4.11.3.3. A description of the interlocks, inhibits, and other safety features.	**C**		
A1.2.4.11.3.4. If installed on a flight system, a diagram showing the location of the equipment or devices.	**C**		
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.	**C**		
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; 45 SWI 40-201, Radiation Protection Program, (ER only), etc.], allowing the use of these radiation sources during ground processing activities.	**C**		
A1.2.4.11.3.7. A copy of the Radiation Protection Plan as required by the 30th SW RADSAFCOM (WR only).	**C**		
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.	**C**		
A1.2.4.12.2. Flight Hardware Acoustics Hazards Data. The following data requirements shall be submitted for acoustic hazards:	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.4.12.2.2. The anticipated operating schedules of these noise sources.	**C**		
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).	**C**		
A1.2.4.12.2.4. A copy of the Bioenvironmental Engineering approval stating the equipment and controls used are satisfactory.	**C**		
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.	**C**		
A1.2.4.13.2. Flight Hardware Hazardous Materials Data. At a minimum, the following hazardous materials data shall be submitted:	**C**		
A1.2.4.13.2.1. A list of all hazardous materials on the flight system and used in ground processing.	**C**		
A1.2.4.13.2.2. A description of how each of these materials and liquids is used and in what quantity.	**C**		
A1.2.4.13.2.3. A description of flammability and, if applicable, explosive characteristics.	**C**		
A1.2.4.13.2.4. A description of toxicity including TLV and other exposure limits, if available.	**C**		
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.	**C**		
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.	**C**		
A1.2.4.13.2.7. A description of personal protective equipment to be used with the hazardous material and liquid.	**C**		
A1.2.4.13.2.8. A summary of decontamination, neutralization, and disposal procedures.	**C**		
A1.2.4.13.2.9. An MSDS for each hazardous material and liquid on flight hardware or used in ground processing; the MSDS shall be available for review at each location in which the material is stored or used.	**C**		
A1.2.4.13.2.10. Description of any detection equipment, location, and proposed use.	**C**		
A1.2.4.13.2.11. Additional Data for Plastic Materials	**C**		
A1.2.4.13.2.11.1. Identification of the cleaning methods to be used to maintain surface cleanliness and conductivity, if applicable.	**C**		
A1.2.4.13.2.11.2. Identification of the minimum acceptable voltage accumulation levels for the plastic materials or operations.	**C**		
A1.2.4.13.2.11.3. Identification of the method for ensuring conductivity between adjoining pieces of the plastic materials.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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):	**C**		
A1.2.4.14.1. System description including hardware, software, and layout of operator console and displays.	**C**		
A1.2.4.14.2. Flow charts or diagrams showing hardware data busses, hardware interfaces, software interfaces, data flow, and power systems.	**C**		
A1.2.4.14.3. Logic diagrams, Software Design Descriptions (SDDs).	**C**		
A1.2.4.14.4. Operator user manuals and documentation.	**C**		
A1.2.4.14.5. List and description of all safety critical computer system functions, including interfaces.	**C**		
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-8719.13 and NASA-GB-8719.13.*	**C**		
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 Standard.	**C**		
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.	**C**		
A1.2.4.14.9. Documentation describing Independent Validation & Verification (IV&V) process used to ensure safety requirements have been correctly and completely implemented.	**C**		
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.	**C**		
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:	**C**		
A1.2.5.1.1. Subsystem overview.	**C**		
A1.2.5.1.2. Nomenclature of major subsystems.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.1.3. Function of the subsystem.	**C**		
A1.2.5.1.4. Location of the subsystem.	**C**		
A1.2.5.1.5. Operation of the subsystem.	**C**		
A1.2.5.1.6. Subsystem design parameters.	**C**		
A1.2.5.1.7. Subsystem test requirements.	**C**		
A1.2.5.1.8. Subsystem operating parameters.	**C**		
A1.2.5.1.9. Summaries of any PSWG and Range Safety required hazard analyses conducted.	**C**		
A1.2.5.2. Supporting data shall be included or summarized and referenced as appropriate with availability to Range Safety upon request.	**C**		
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.)	**C**		
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).	**C**		
A1.2.5.5. A list of all PSWG and Range Safety approved noncompliances.	**C**		Added PSWG
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.	**C**		
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.	**C**		
A1.2.5.6.2. Ground Support Slings Used to Handle Critical Hardware. At a minimum, the following data is required:	**C**		
A1.2.5.6.2.1. SFP analysis.	**C**		
A1.2.5.6.2.2. NDE plan and test results for SFP components.	**C**		
A1.2.5.6.2.3. Initial proof load test plan and test results.	**C**		
A1.2.5.6.2.4. Stress analysis.	**C**		
A1.2.5.6.3. Ground Support Below-the-Hook Lifting Devices. At a minimum, the following documentation is required:	**C**		
A1.2.5.6.3.1. SFP analysis.	**C**		
A1.2.5.6.3.2. NDE plan and test results for SFP components.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.6.3.3. Initial proof load test plan and test results.	**C**		
A1.2.5.6.3.4. Stress analysis.	**C**		
A1.2.5.6.4. Ground Support Handling Structures Used to Handle Critical Hardware. At a minimum, the following documentation is required:	**C**		
A1.2.5.6.4.1. SFP analysis.	**C**		
A1.2.5.6.4.2. NDE plan and test results for SFP and non-SFP components and SFP and non-SFP welds.	**C**		
A1.2.5.6.4.3. Initial proof load test plan and test results.	**C**		
A1.2.5.6.4.4. Stress analysis for structures.	**C**		
A1.2.5.6.4.5. Safe-life analysis if Option 2 of Attachment 2 of this volume is chosen.	**C**		
A1.2.5.6.4.6. O&SHA and FMECA analyses for structural mechanisms like spin tables, rotating structures, and portable launch support frames.	**C**		
A1.2.5.6.5. Support Structures Used to Handle Critical Hardware. At a minimum, the following documentation is required:	**C**		
A1.2.5.6.5.1. SFP analysis.	**C**		
A1.2.5.6.5.2. NDE plan and test results for SFP and non-SFP components and SFP and non-SFP welds.	**C**		
A1.2.5.6.5.3. Initial proof load test plan and test results.	**C**		
A1.2.5.6.5.4. Stress analysis for structures.	**C**		
A1.2.5.6.5.5. Safe-life analysis if Option 2 of Attachment 2 of this volume is chosen.	**C**		
A1.2.5.6.6. Ground Support Hydrasets and Load Cells Used to Handle Critical Hardware. At a minimum, the following documentation is required:	**C**		
A1.2.5.6.6.1. SFP analysis.	**C**		
A1.2.5.6.6.2. NDE plan and test results for SFP components and SFP welds.	**C**		
A1.2.5.6.6.3. Initial proof load test plan and test results.	**C**		
A1.2.5.6.6.4. Stress analysis.	**C**		
A1.2.5.6.7. Ground Support Rigging Hardware Used to Handle Critical Hardware. At a minimum, the following documentation is required:	**C**		
A1.2.5.6.7.1. SFP analysis.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.6.7.2. NDE plan and test results for SFP components.	**C**		
A1.2.5.6.7.3. Initial proof load test plan and test results.	**C**		
A1.2.5.6.8. 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.	**C**		
A1.2.5.8. Removable, Extendible, and Hinged Personnel Work Platforms. At a minimum, the following documentation is required:	**C**		
A1.2.5.8.1. SFP analysis.	**C**		
A1.2.5.8.2. NDE plan and test results for SFP and non-SFP components and SFP and non-SFP welds.	**C**		
A1.2.5.8.3. Initial proof load test plan and test results.	**C**		
A1.2.5.8.4. Stress analysis.	**C**		
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 A1.2.5.1, A1.2.4.7.1.1, A1.2.4.7.1.2, A1.2.4.7.1.3 as well as the inservice operating, maintenance, and ISI plan.	**C**		
A1.2.5.9.2. Ground Support Pressure and Propellant System Data. The system data as identified in A1.2.4.7.2 shall be submitted in addition to a copy of any DOT approved exemptions for mobile and portable hazardous pressure systems.	**C**		
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.	**C**		
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 A1.2.5.1.	**C**		
A1.2.5.10.2. EGSE Battery Design Data. At a minimum, the battery design data identified in A1.2.4.8.2 shall be provided for EGSE batteries.	**C**		
A1.2.5.10.3. EGSE Design Data. The following EGSE design data is required:	**C**		
A1.2.5.10.3.1. Identification of EGSE and its use.	**C**		
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.	**C**		
A1.2.5.10.3.3. A description of how inadvertent commands that can cause a hazardous condition are prevented.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.10.3.4. Identification of potential shock hazards.	**C**		
A1.2.5.10.3.5. A description of how the intent of the NFPA is met with respect to hazardous atmospheres.	**C**		
A1.2.5.10.3.6. Identification of all non-explosion proof equipment powered up during and after propellant loading.	**C**		
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:	**C**		
A1.2.5.10.3.7.1. Manufacturer.	**C**		
A1.2.5.10.3.7.2. Model number.	**C**		
A1.2.5.10.3.7.3. Hazardous location class and group.	**C**		
A1.2.5.10.3.7.4. Operating temperature.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
A1.2.5.10.3.11. A bent pin analysis for all connectors for safety critical or hazardous systems that have spare pins.	**C**		
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.	**C**		
A1.2.5.11.2. Ordnance Ground Systems Design Data. The following ordnance ground systems design data is required:	**C**		
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.	**C**		
A1.2.5.11.2.2. Specifications, schematics, and a complete functional description of the low voltage stray current monitor.	**C**		
A1.2.5.11.2.3. Schematics of all ordnance system monitor circuits from the ordnance component pick-off points to the OSC termination.	**C**		
A1.2.5.11.2.4. Calibration data for all monitor circuit terminations that will be provided to the OSC.	**C**		

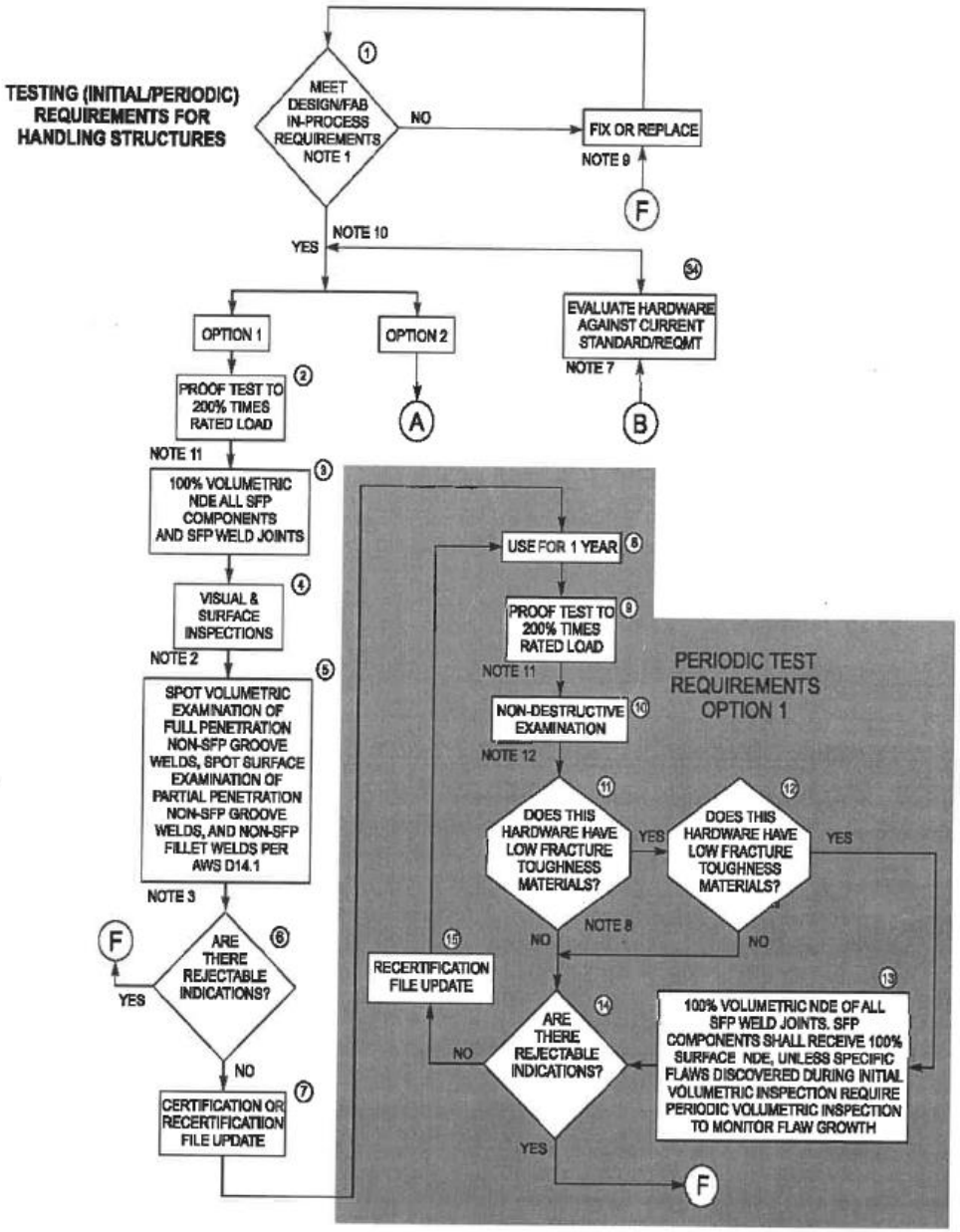
ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.11.2.5. A complete and detailed description of the airborne and ground ordnance telemetry system and how it functions, including general specifications and schematics.	**C**		
A1.2.5.11.2.6. The following information is required for ordnance continuity and bridgewire resistance measurement devices:	**C**		
A1.2.5.11.2.6.1. Maximum safe no-fire energy of the ordnance being tested.	**C**		
A1.2.5.11.2.6.2. A declaration of any certification currently in effect for the instrument along with the manufacturer specifications including:	**C**		
A1.2.5.11.2.6.2.1. Range.	**C**		
A1.2.5.11.2.6.2.2. Accuracy.	**C**		
A1.2.5.11.2.6.2.3. Power supply and recharge capability.	**C**		
A1.2.5.11.2.6.2.4. Self-test features.	**C**		
A1.2.5.11.2.6.2.5. Schematics.	**C**		
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).	**C**		
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.	**C**		
A1.2.5.11.2.6.5. Description of intended operations.	**C**		
A1.2.5.11.2.7. The following information is required for monitor circuit outputs:	**C**		
A1.2.5.11.2.7.1. Tolerances.	**C**		
A1.2.5.11.2.7.2. Maximum and minimum values.	**C**		
A1.2.5.11.2.8. For high voltage exploding bridgewires, the nominal gap breakdown voltage tolerance.	**C**		
A1.2.5.11.2.9. For laser initiated devices, the following information is required:	**C**		
A1.2.5.11.2.9.1. If modified secondary (composition) explosives are used, test requirements and reports.	**C**		
A1.2.5.11.2.9.2. Heat dissipation analysis.	**C**		
A1.2.5.11.2.10. Ordnance Hazard Classifications and Categories.	**C**		
A1.2.5.11.2.10.1. DoD/UN hazard classifications (class, division, and compatibility group) in accordance with DoD 6055.9-STD.	**C**		
A1.2.5.11.2.10.2. DOT classification.	**C**		

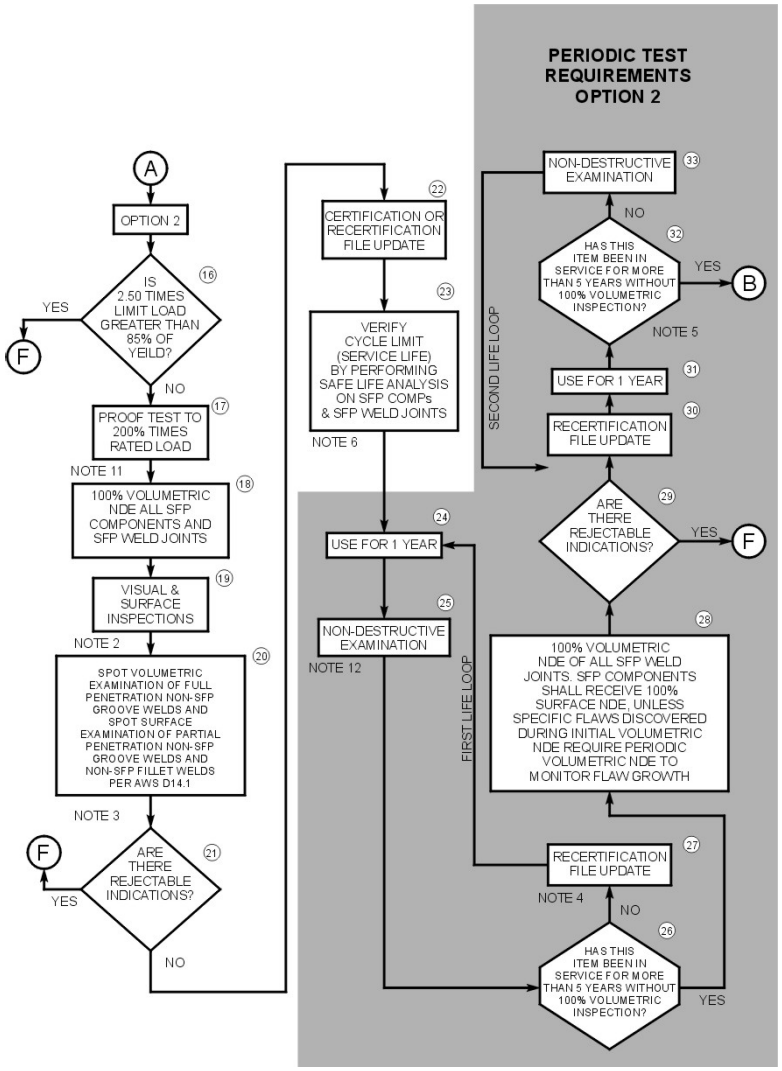
ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.5.11.2.10.3. The ordnance device and system hazard category for each ordnance item and system.	**C**		
A1.2.5.11.2.10.4. Test results and/or analysis used to classify the ordnance devices and systems as Category A or B.	**C**		
A1.2.5.11.2.11. A list and summary of test plans, test procedures, and test results, as required.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
A1.2.5.14.2. Acoustic Hazards Data. The data identified in A1.2.4.12.2 shall be submitted for acoustic hazards.	**C**		
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.	**C**		
A1.2.5.15.2. Ground Support Hazardous Materials Data. The hazardous materials data identified in A1.2.4.13.2 shall be submitted.	**C**		
A1.2.5.17. Motor Vehicle Data. At a minimum, the following data shall be provided for motor vehicles:	**C**		
A1.2.5.17.1. General Vehicle Data	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
A1.2.5.17.1.2. If DOT certification or exemption documentation is not available, the following information is required:	**C**		
A1.2.5.17.1.2.1. Design, test, and inspection requirements.	**C**		
A1.2.5.17.1.2.2. Stress analysis.	**C**		
A1.2.5.17.1.2.3. SFP analysis.	**C**		
A1.2.5.17.1.2.4. FMECA.	**C**		
A1.2.5.17.1.2.5. Comparison analysis with similar DOT approved vehicle.	**C**		
A1.2.5.17.1.2.6. "Equivalent safety" (meets DOT intent) analysis.	**C**		
A1.2.5.17.2. Special-Purpose Trailer Data	**I**		
A1.2.5.17.2.1. Stress analysis.	**C**		
A1.2.5.17.2.2. SFP analysis.	**C**		
A1.2.5.17.2.3. Initial proof load test plan and test results.	**C**		
A1.2.5.17.2.4. Initial road test plan and test results.	**C**		
A1.2.5.17.2.5. NDE plan and test results for SFPs.	**C**		
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 ANSI/ASME B56 Series Safety Standards.	**C**		
A1.2.5.17.3.2. For personnel platforms on lift trucks.	**C**		
A1.2.5.17.3.2.1. Stress analysis.	**C**		
A1.2.5.17.3.2.2. SFP analysis.	**C**		
A1.2.5.17.3.2.3. NDE plan and test results for SFP components and SFP welds.	**C**		
A1.2.5.17.3.2.4. Proof load test plan and test results.	**C**		
A1.2.5.17.3.3. For lift trucks used to lift or move critical loads; maintenance plans shall be submitted for review and approval.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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).	**C**		
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:	**C**		
A1.2.5.19.1. GSE designation and applicable drawing numbers.	**C**		
A1.2.5.19.2. Whether the equipment is new or existing.	**C**		
A1.2.5.19.3. GSE description; for example, weight, materials, structural system.	**C**		
A1.2.5.19.4. How the GSE is used and where and how it is stored.	**C**		
A1.2.5.19.5. The length of time the GSE is used and stored.	**C**		
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.	**C**		
A1.2.5.19.7. Whether the equipment is required to be designed to meet seismic design requirements.	**C**		
A1.2.5.19.8. Whether the equipment is required to be anchored.	**C**		
A1.2.5.19.9. Design margin of safety under seismic loading (if applicable).	**C**		
A1.4 MODIFICATIONS TO THE SAFETY DATA PACKAGE (SDP) 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 2 HANDLING STRUCTURES INITIAL AND PERIODIC TEST REQUIREMENT FLOW PATH	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
 **Figure A2.1 Flow Path**	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
 **Figure A2.1 Flow Path (page 2)**	**C**		
NOTES:	**C**		

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

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
1. Design, Fabrication, and In-Process Requirements:	**C**		
a. Meet NASA-STD-8719.9 and AFSPCMAN 91-710 design requirements for handling structures.	**C**		
b. Identify SFP components and SFP welds.	**C**		
2. Perform 100 percent visual inspection of all components (including SFP) and weld joints (including SFP and non-SFP) and perform 100 percent surface NDE testing of all SFP components and SFP welds.	**C**		
3. Perform volumetric NDE on 4 inches or 10 percent (whichever is less) of every continuous, non-SFP, full penetration weld in accordance with AWS D14.1 paragraph 10.9.5 or paragraph 10.13.6.	**C**		
4. Cycle count is required.	**C**		
5. MHE and MHSE that has been in service for 10 years or 2,500 cycles, whichever is less, shall be evaluated against current standards and requirements.	**C**		
6. Perform safe-live analysis assuming flaws to be in the worst location (transition areas, heat affected areas, weld joints, membrane sections, and highest stressed areas). Safe-life analysis shall be performed using fatigue crack growth computer programs such as NASA/FLAGRO (JSC-22267) or other PSWG and Range Safety Approved computer programs or analysis methods. *Note: Fracture mechanics analysis used to establish cyclic limits may assume "crack-like defects." This assumption does not imply that cracks or other rejectable indications are acceptable. The logic identified in this flow chart requires that cracks and rejectable indications be fixed.*	**C**		
7. Provide noncompliance issues, if any, to PSWG for PSWG and Range Safety disposition.	**C**		
8. All parts shall be considered to have low-fracture toughness with a material property ratio Kic/Fty<0.33 in 1/2. If the part is a steel bolt and the Kic value is unknown, low fracture toughness shall be assumed when Ftu > 180 ksi. Where: Kic = Plane strain fracture toughness Fty = Allowable tensile yield strength Ftu = Allowable tensile ultimate strength Reference: NASA NBH 8071.1			
9. Fix hardware. This means either repair or an analytical solution is required as approved by the PSWG and Range Safety.	**C**		
10. Periodic test and inspection requirements are identified in the gray areas of the flow chart. All the processes identified in the figure are considered initial test requirements.	**C**		
11. Proof test shall be performed on fully assembled handling structures, unless otherwise approved by the PSWG and Range Safety. Do not proof test greater than 85 percent of yield.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
12. Perform NDE in accordance with the PSWG and Range Safety approved NDE plan.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 3 HAZARD AREA CLASSIFICATION	**C**		

Block #1:

- Is the presence of flammable liquids or gases likely? (See Note 1) **OR**
- Are combustible liquids having flash points at or above 100ºF likely to be handled, processed, or stored at temperatures above their flash points? (See Note 2)

Block #3:

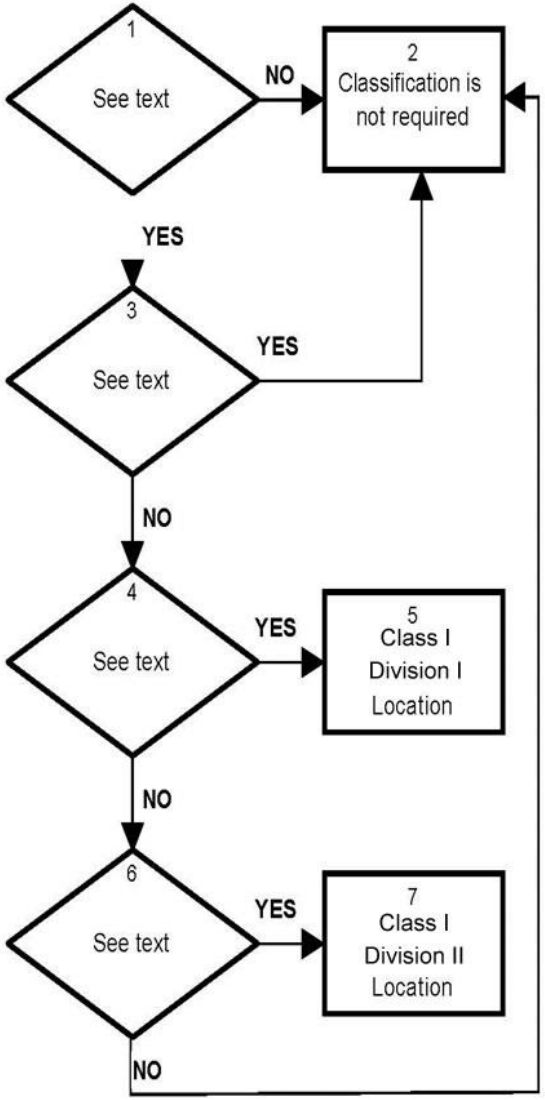
- In an adequately ventilated location, are flammable substances contained in a suitable, well-maintained, closed piping system that includes only the pipe, valves, fittings, flanges, and meters? (See Note 3) **OR**
- In an adequately ventilated facility, are flammable substances contained in piping systems without valves, fittings, flanges, and similar accessories? (See Note 4) **OR**
- Are flammable liquids or gases in suitable containers? (See Note 5) **OR**

Block #4:

- Is the flammable gas concentration likely to exist in the air under operating conditions? **OR**
- Is a flammable atmospheric concentration likely to occur frequently because of maintenance, repairs, or leakage? **OR**
- Would a failure of process, storage, or other equipment be likely to cause an electrical system failure creating an ignition source simultaneously with the release of a flammable liquid or gas? **OR**
- Is the flammable liquid or gas piping system in an adequately ventilated location, and is the piping system (containing valves, meters, or screwed or flanged fittings) poorly maintained? **OR**
- Is the location lower than the surrounding elevation or grade so that flammable liquids or gases may accumulate there?

Block #6:

- Is the flammable liquid or gas piping system in an adequately ventilated location, and is the piping system (containing valves, meters, or screwed or flanged fittings) well-maintained? **OR**
- In a process equipment system containing flammable liquids or gases in an adequately-ventilated location (exclusive of well-maintained piping system), can the liquid or gas escape from such potential sources as pumps seals, atmospheric vents, or relief valves, sample stations, drains, and so forth, as a result of an abnormal condition? (see Note 6) **OR**
- Is the location adjacent to a Division 1 location, or can the gas be conducted to the location, as through trenches, pipe, or duct? **OR**
- If positive mechanical ventilation is used, could failure or abnormal operation of ventilating equipment permit atmospheric vapor mixtures to build up to flammable concentrations? (See Note 7)

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
 **Figure A3.1. Flow Path.**	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
NOTES: 1. The following are considered flammable liquids/gasses:	**C**		
a. Unsymmetrical dimethylhydrazine (UDMH) - Flashpoint *(Closed Cup) 5×F. *Note: There is conflicting information in available literature that presents the closed cup flashpoint of UDMH to be either 5 degrees F or 35 degrees F.*	**C**		
b. Monomethyl hydrazine (MMH) - Flashpoint* (Closed Cup) 17 degrees F.	**C**		
2. Hydrazine (N2H4) - is considered a combustible liquid.	**C**		
a. The surface temperature of potential spill areas must also be considered.	**C**		
b. Temperature in the area must be single failure tolerant to remain below the flashpoint (Closed Cup) of 100 degrees F.	**C**		
c. Below grade locations may still accumulate enough N2H4 to become flammable at lower temperatures.	**C**		
3. Adequate ventilation is defined by NFPA 30, Flammable and Combustible Liquids Code, as that which is sufficient to prevent the accumulation of significant quantities of vapor-air mixtures in concentrations over 25 percent of the lower flammability limit.	**C**		
a. An adequately ventilated location is one of the following:	**C**		
(1) An outside location.	**C**		
(2) A building, room, or space that is substantially open and free of obstruction to the natural passage of air, either vertically or horizontally. Such locations may be roofed over with no walls, may be roofed over and closed on one side or may be provided with suitably designed wind breaks.	**C**		
(3) An enclosed or partly enclosed space provided with mechanical ventilation equivalent to natural ventilation. The mechanical ventilation system must have adequate safeguards against failure.	**C**		
b. Lower flammability limits of specific commodities are as follows:	**C**		
(1) N2H4 - 4.7 percent.	**C**		
(2) MMH - 2.5 percent.	**C**		
(3) UDMH - 2.0 percent.	**C**		
(4) Aerozine 50 - 2.0 percent.	**C**		
c. Payload propellant systems cannot normally be considered closed piping systems that include only the pipe, valves, fittings, flanges, and meters; they normally also include a pressure vessel.	**C**		
4. Payload propellant systems cannot normally be considered piping without valves, fitting, flanges, and similar accessories.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5. Payload propellant systems cannot be considered suitable containers unless they meet DOT or ASME requirements or meet Volume 3, Chapter 12 of this publication and are also protected from outside damage.	**C**		
6. If this system is poorly maintained, this location shall be classified Class I, Division 1 per Diamond 4, item 4 above. Thus there is not a "no" answer to this question leading to non-classification.	**C**		
7. A payload propellant system would normally be considered a process equipment system. In a dynamic mode, the answer to this question will almost always be “yes;” in a static mode, the answer may be “yes” or “no” depending on past history and adequacy of protection from outside damage.	**C**		
8. An analysis shall be provided. Consideration shall be given to the size of the containment area, credible potential size of the spill, adequacy of the ventilation equipment and its potential failure modes, and the specific gravity of the commodity in question.	**C**		

VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS, AND MATERIAL OPERATIONS SAFETY REQUIREMENTS

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
VOLUME 6: GROUND AND LAUNCH PERSONNEL, EQUIPMENT, SYSTEMS, AND MATERIAL OPERATIONS SAFETY REQUIREMENTS	**I**		
This manual implements NASA Procedural Requirements related to NASA ELV payloads including NPR 8715.7 Expendable Launch Vehicle Payload Safety Program and AFSPCMAN 91-710 Range Safety User Requirements Manual as it applies to NASA payloads. It also implements NPR 8715.3, NASA General Safety Program Requirements; Department of Defense Directive (DoDD) 3100.10, Space Policy; DoDD 3200.11, Major Range and Test Facility Base; Air Force Policy Directive (AFPD) 91-1, Nuclear Weapons and Systems Surety; AFPD 91-2, Safety Programs; and AFPD 63-12, Assurance of Occupational Safety, Suitability, and Effectiveness.	**I**		
This volume contains NASA and Air Force Range Safety requirements for NASA ELV payload projects and related personnel and equipment, systems, and material operations on NASA or NASA contracted facilities and on the Air Force Space Command (AFSPC) ranges, including the Eastern Range (ER) and Western Range (WR). This volume, as does this publication, applies to all NASA ELV 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 ELV payload projects processing and launching from Air Force 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. *The following major topics are addressed: payload project responsibilities; ground operations policies; documentation requirements; ground operations general requirements; material handling equipment, crane and hoist, personnel platform, powered industrial truck, and elevator operations; acoustic hazard operations; non-ionizing radiation operations; radioactive (ionizing radiation) sources operations; hazardous materials operations; ground support and flight hardware pressure systems operations; ordnance operations; electrical systems operations; motor vehicle operations; convoy operations; launch operations; and solid rocket motor and motor segment operations.*	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 1 INTRODUCTION	**I**		
1.1 APPLICABILITY All NASA ELV 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**		

ORIGINAL TEXT	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 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 Occupational Safety and Health Administration (OSHA) (29 CFR), Environmental Protection Agency (EPA) (40 CFR), Department of Transportation (DOT) (49 CFR), NASA procedural requirements (NPRs) documents including NPR 8715.7, NASA Standards, Air Force instructions (AFIs), and 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.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 2 RESPONSIBILITIES AND AUTHORITIES	**I**		
2.1 PAYLOAD SAFETY WORKING GROUP 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) in accordance with NPR 8715.7. 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.	**C**		
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.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
2.1.3.1.1. Observe, evaluate, and enforce compliance of Range Safety requirements by all personnel 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.*	**I**		
2.1.3.1.2. Review and provide comments on hazardous procedures to Range Safety.	**I**		
2.1.3.1.3. Review and provide comments on system design data and operating procedures.	**I**		
2.1.3.1.4. Implement specified safety precautions and impose safety holds, when necessary, during ground operations, as required by procedures or OSP.	**I**		
2.1.3.1.5. Assist in the resolution of safety problems in areas where Pad Safety has jurisdiction.	**I**		
2.1.3.1.6. Attend meetings and conferences that involve safety working groups and facility working groups, technical interchange meetings, etc., as necessary.	**I**		
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.	**I**		
2.1.3.1.8. Coordinate with Bioenvironmental Engineering and Environmental Health (both Health Physics and Industrial Hygiene) on environmental health hazards.	**I**		
2.1.3.1.9. Notify Environmental Health, Range Safety, Range Scheduling (30 SW), and Cape Support (45 SW) immediately anytime an incident involves an environmental health hazard.	**I**		
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.	**I**		
2.1.3.1.11. Respond to mishaps and/or incidents in accordance with 30/45 SW OPLANs 32-1	**I**		
2.1.3.1.12. Assist payload projects on safety related issues.	**I**		
2.1.3.2. Hazardous and Safety Critical Pad Support. Pad Safety shall provide oversight of the payload project for the following:	**I**		
2.1.3.2.1. Ensure compliance with established directives and procedures during hazardous and safety critical operations.	**I**		
2.1.3.2.2. Assess procedure deviations and resolve with Range Safety, as necessary.	**I**		
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.*	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
2.1.3.2.4. Ensure a comprehensive safety briefing is conducted and understood by participants prior to the start of a hazardous operation.	**I**		
2.1.3.2.5. Control personnel access into safety clearance zones during hazardous operations.	**I**		
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.	**I**		
2.1.3.2.7. Allow operations to resume only after the imminent danger no longer exists and safety requirements are met.	**I**		
2.1.3.3. Notifications	**I**		
2.1.3.3.1. Immediately notify the appropriate agency (Command Post at the 30 SW and Range Safety at the 45 SW) 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.	**I**		
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.	**I**		
2.1.3.4. Flight Termination System (FTS) Installation, Checkout, and Status (45 SW Only). Monitor and verify the installation, checkout, and status of the FTS in accordance with Range Safety instructions at locations designated by Range Safety.	**I**		
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 AFI 91-201, Explosives Safety Standards. These duties are performed by SEW at the 30 SW.	**I**		
2.1.3.5.2. Inspect critical facilities prior to the start of a hazardous operation or as directed by Range Safety.	**I**		
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 (45 SW only).	**I**		
2.1.3.5.4. Audit the execution of procedures for handling ordnance, propellant material, and high pressure gases performed on CCAFS and VAFB at least quarterly.	**I**		
2.1.3.5.5. Audit the execution of procedures for handling ordnance, propellant material, and high pressure gases performed on down range facilities at least annually.	**I**		
2.2 PAYLOAD PROJECT RESPONSIBILITIES Payload projects are responsible for the following:	**I**		
2.2.2. Conduct of Operations	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
2.2.2.1. Planning and conducting hazardous and safety critical operations in accordance with procedures approved by the appropriate local safety authority.	**C**		
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.	**C**		
2.2.2.3. Planning and conducting other operations in accordance with the current edition of other safety plans, as applicable.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
2.2.4.14. Obtaining appropriate approval for procedures in accordance with KNPR 8715.3, Kennedy NASA Procedural Requirements; 45 SWI 40-201, Radiation Protection Program; or 30 SW1/Sup1 Radiation Protection Plan, supplement to AFI 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.	**C**		
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.	**C**		
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.	**C**		
2.2.4.19. At the WR, developing, obtaining 30 SW Range Safety approval and PSWG concurrence, and implementing a 30 SW First Use Tag Program for lifting hardware at the WR.	**C**		
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.	**C**		
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.	**C**		
Interruptions include such events as a safety hold, shift change, evacuation, or breaks.	**I**		
2.2.5.3. Before initiating hazardous or safety critical operations, the following shall be accomplished:	**C**		
2.2.5.3.1. Pre-operation and shift change briefings.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
2.2.5.6. Reviewing and providing comments on hazardous and safety critical procedures to Range Safety or the appropriate local safety authority.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 3 GROUND OPERATIONS POLICIES	**I**		
3.1 PERSONNEL SAFETY All personnel shall be protected during the performance of operations.	**C**		
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.	**C**		
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.	**C**		
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 Air 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.	**C**		
3.2.4. Notification of Work Stoppage. The Contracting Officer or Administrator for an Air Force Construction Contract shall be immediately notified of any work stoppage of their respective construction contract.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 4 DOCUMENTATION REQUIREMENTS	**I**		
4.1 GROUND OPERATIONS PLANS 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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
4.1.4. The GOP shall be approved before the start of any hazardous operations.	**C**		
4.2 TEST AND INSPECTION PLANS 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.	**C**		
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:	**C**		
4.2.1.1.1. Logs and test records shall contain chronological entries including:	**C**		
4.2.1.1.1.1. Records of use or running time.	**C**		
4.2.1.1.1.2. Maintenance.	**C**		
4.2.1.1.1.3. Modifications.	**C**		
4.2.1.1.1.4. Tests, inspections, acceptable parameters, and results.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
4.2.1.1.2. Discrepancies and out of specification results shall be clearly identified.	C		
4.2.1.1.3. Resolution of discrepancies and out of specification results shall be noted.	C		
4.2.1.2. Logs and test records shall be maintained for the life of the system/equipment.	C		
4.2.1.3. Logs and test records shall be available to the PSWG and Range Safety upon request.	C		
4.3 SAFETY AND EMERGENCY PLANS	I		
4.3.1. Operations Safety Plans and Danger Area Information Plans	C		
4.3.1.1. Payload project shall comply with and implement in their operations, applicable OSPs, and emergency plans.	C		
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.	C		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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."	**C**		
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.	**C**		
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.	**C**		
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 is encouraged to provide a draft of a typical procedure for early review by all appropriate local safety authorities.	**C**		
4.5 RANGE USER TRAINING PLAN 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.	**C**		
4.6 MISHAP REPORTING Mishap reporting shall be in accordance with NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, NPR 8715.7 and in accordance with local safety authorities procedures.	**C**		
4.6.1. Mishaps Involving Air Force Personnel and Property. Reporting criteria for mishaps involving Air Force personnel and property are established in AFI 91-204, Safety Investigations and Reports. Mishaps involving radioactive materials shall be reported in accordance with AFI 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
4.7.1.2. The Payload or Sample Return Recovery Safety Plan shall:	**C**		
4.7.1.2.1. Identify each organizational unit involved in the payload or sample recovery operations.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
4.7.1.5. Changes to the Recovery Safety Plan subsequent to the "final" edition will be expediently coordinated with the local safety authorities.	**C**		
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.	**C**		
4.7.2.2. Hazards identified shall be documented on the NF 1825 NASA ELV Payload Safety Hazard Report found on the NASA ELV Payload Safety Program website at http://kscsma.ksc.nasa.gov/ELVPayloadSafety or an equivalent form that contains all information required on NF 1825.	**C**		
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.	**C**		
4.7.3 Hazardous Operations.	**I**		
4.7.3.1. Hazardous 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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
4.7.4.2. Safety training courses shall include information on hazards and preventing injury during payload or sample recovery operations.	C		
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.	C		
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 to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) for review prior to the project's Preliminary Design Review (PDR).	C		
4.7.6.1.2. A baselined Payload or Sample Recovery Safety Plan shall be submitted to appropriate local safety authorities and to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) for review and approval prior to the project's Critical Design Review (CDR).	C		
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.	C		
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 to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) at least 180 days prior to payload or sample recovery.	C		
4.7.6.2. 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 to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) prior to the project's PDR.	C		
4.7.6.2.2. Updated Hazard Reports shall be submitted for review and approval to the local safety authorities and to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) prior to the project's CDR.	C		
4.7.6.2.3. Updated Hazard Reports shall be submitted to the appropriate local safety authorities and to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) for review and approval prior to the project's Operational Readiness Review (ORR).	C		
4.7.6.2.4. Final Hazard Reports shall be submitted for review and approval to the local safety authorities and to the NASA ELV Payload Safety Program Agency Team (via the NASA ELV Payload Safety Manager or designee) at least 180 days prior to payload or sample recovery.	C		
4.7.6.3. Hazardous Operations.	I		
4.7.6.3.1. Written 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.	C		
4.7.6.3.2. Finalized written 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.	C		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
5.1.3. Personnel Conduct	**C**		
5.1.3.1. Food, Beverage, and Cigarette Consumption. The payload project shall ensure that eating, drinking, or smoking is authorized only in designated areas.	**C**		
5.1.3.2. Alcoholic Beverages and Narcotics	**C**		
5.1.3.2.1. The payload project shall ensure that the use of alcoholic beverages and narcotics while on duty is prohibited.	**C**		
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.	**C**		
5.1.3.3. Mischief. The payload project shall ensure that their personnel are prevented from indulgence in practical jokes, horseplay, scuffling, and wrestling.	**C**		
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 2.15, 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 Air Force property the following shall apply:	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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:	**C**		
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.	**C**		
5.1.4.4.2. A maximum of 60 hours per week.	**C**		
5.1.4.4.3. A maximum of 14 consecutive days.	**C**		
5.1.4.5. Consecutive Launch Attempts	**C**		
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.	**C**		
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.	**C**		
5.1.4.6. 30 SW Additional Work Restrictions	**C**		
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 30 SW Commander or Vice Commander, commanders of tenant organizations, or the 30 SW Chief of Safety for personnel under their respective control.	**C**		
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.	**C**		
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:	**C**		
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 30 SW Commander or Vice Commander, WR Commander, Operations Groups Commander, or the Chief of Safety.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
5.2.1.2.2. Pressure and propellant system operations shall be performed with equipment that simulates flight equipment valve connections and operations.	**C**		
5.2.1.2.3. Pathfinder operations shall use GSE that will be used for flight operations.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
5.2.2.3.4. The buddy system shall be used in all hazardous operations.	**C**		
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:	**C**		
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).	**C**		
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.	**C**		
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. 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)].	**C**		
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. AFOSHSTD 91-5, Welding, Cutting, and Brazing applies for hot work operations on USAF properties.	**C**		
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).	**C**		
5.2.3.3. Hot Work General Operating Requirements	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5.2.3.3.1. A written permit shall be obtained from the Fire Marshall before performing hot work.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
5.2.3.3.5. Proper housekeeping and protective shields and barriers shall be used to prevent inadvertent combustion.	**C**		
5.2.3.3.6. Combustibles shall be kept at least 35 feet away from the operation.	**C**		
5.2.3.3.7. A suitable fire extinguisher shall be available.	**C**		
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.	**C**		
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.	**C**		
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), and ANSI Z244.1, Safety Requirements for the Lockout/Tagout of Energy Sources, as well as local safety requirements.	**C**		
5.2.4.2. Lockout/tagout procedures shall be developed by the payload project and approved by the appropriate local safety authority.	**C**		
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 Confined Spaces, and local safety requirements.	**C**		
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.	**C**		
5.2.6. Tethering of Equipment	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	C		
5.2.6.2. 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.	C		
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.	C		
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.	C		
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.	C		
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.	C		
5.3.3.2. Open-toed and high-heeled shoes are prohibited.	C		
5.3.3.3. Canvas shoes are not permitted where liquid propellants or cryogenics are handled.	C		
5.3.3.4. Dresses and shorts shall not be worn on towers.	C		
5.3.3.5. The appropriate attire for hazardous and safety critical operations shall be identified in the operating procedure.	C		
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.	C		
5.3.3.7. Expended work clothes shall be clearly segregated from work clothes ready for use.	C		
5.3.3.8. Work clothes exposed to an oxygen-rich atmosphere shall be thoroughly aired before smoking is allowed.	C		
5.3.4. The operating procedure shall include a check for PPE training.	C		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5.4 FALL PROTECTION The payload project shall observe and use applicable industry standards for fall protection (such as guard rails, lanyard anchorages, lanyards, snap hooks, ladders, inspections). Specific criteria for the equipment listed above can be found in ANSI Z359.1, Personnel Fall Arrest Systems, Subsystems, and Components; ANSI A10.14, Construction and Demolition Operations - Requirements for Safety Belts, Harnesses, Lanyards and Lifelines for Construction and Demolition Use; NPR 8715.1, NASA Occupational Safety and Health Programs, 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes; 29 CFR 1910.27, Fixed Ladders; and 29 CFR 1926.105, Safety Nets.	**C**		
Fall Hazards: *All open-sided floors or fall hazards over 4 feet 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.*	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.* *(2) Ladder safety devices with body belts should be the preferred method of fall protection.*			
5.5 SMOKING AREAS	**I**		
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.	**C**		
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 is prohibited at all times and flame-producing devices shall be prohibited within the following areas:	**C**		
5.5.2.1. Within 100 feet of any propellant storage tank.	**C**		
5.5.2.2. On gantries or service towers.	**C**		
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.	**C**		
5.5.2.4. In the vicinity of the launch vehicle and/or payload during and after ordnance installation.	**C**		
5.5.2.5. In missile impact areas where radioactive contamination, ordnance, or fuels are present.	**C**		
5.5.2.6. In any area displaying NO SMOKING signs.	**C**		
5.5.2.7. In all propellant operating and storage areas except in specifically designated smoking areas.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5.6 OPERATING RESTRICTIONS DUE TO ADVERSE WEATHER	**I**		
5.6.1. General. Local adverse weather requirements for NASA, NASA contractors, Air 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.	**C**		
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 45 SW/SEA and documented in the specific OSP.	**C**		
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 detanking, 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.	**C**		
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.	**C**		
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:	**C**		
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.	**C**		
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.	**C**		
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 SW OPLAN 15-1, Weather Operations Plan.	**I**		
5.6.3. WR Lightning/Thunderstorm Watches and Warnings. The 30th Weather Squadron issues two messages related to lightning/thunderstorms: A watch and a warning.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 VAFB. 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 VAFB.	**I**		
5.6.3.3. Meteorological and weather warning notification procedures are provided in 30 SWI 15-101, Weather Support.	**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.	**C**		
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.*	**C**		
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 AFI 32-1605 or National Fire Protection Association Standard 780. These are the minimum lightning protection requirements imposed by 30 SW 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.	**C**		
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.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5.6.3.9. Range Users working an approved operation involving propellant or ordnance activities during a Lightning/ Thunderstorm Watch can call 30 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.	**C**		
5.7.2. For Winds of 30 Knots or More as Measured on or Closest to Specific Facilities	**I**		
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.	**C**		
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.	**C**		
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.	**C**		
5.8.1.2. Only those operations that are consistent with facility design, materials, equipment, and personnel shall be performed in the facility.	**C**		
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.	**C**		
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.	**C**		
5.8.2.3. Facilities used for hazardous activities shall have an FEOP and an Evacuation Plan developed by facility operators.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5.8.2.4. Simultaneous hazardous operations within the same control area are prohibited.	**C**		
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.	**C**		
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.	**C**		
5.8.3.1.2. Inspection reports shall be maintained in accordance with local safety requirements (NPR 8715.1 NASA Occupational Safety and Health Programs for NASA facilities or for Air Force facilities in accordance with AFMAN 91-201, AFI 91-202, and DoD 6055.9-STD).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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:	**C**		
5.8.3.2.2.1. At least two weeks before a launch vehicle or payload being brought to the pad or facility.	**C**		
5.8.3.2.2.2. Within 48 hours of the pad erection day.	**C**		
5.8.3.2.2.3. Immediately before the start of any hazardous or safety critical operation.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
5.8.3.2.2.4. After any major or safety-related modification has been made to facilities or equipment.	**C**		
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.	**C**		
5.8.3.3. Facility Operator Inspections. The facility operator shall inspect explosive storage and operating areas and facilities at least once a month.	**C**		
5.8.3.4. Facility Spot-Checks. Spot-checks of processing facilities shall be performed to ensure compliance with this publication.	**C**		
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.	**C**		
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.	**C**		
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 AFMAN 91-201, Volume 3, Chapter 8 and Volume 6, Chapter 8 of this manual.	**C**		
5.9.2.2. Safety Net shall be used during transit and when SCAPE personnel are off Operational Intercommunications System (OIS).	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 6 MATERIAL HANDLING EQUIPMENT, CRANE AND 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 ANSI 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 The operations requirements for material handling equipment (MHE) used for handling (lifting, supporting, or manipulating) critical and non-critical hard- ware 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.	**C**		
MHE is comprised of below-the-hook lifting devices (BTHLD), handling structures, support structures, slings, load cells, Hydrasets, and rigging hardware.	**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.	**C**		
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; 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).	**C**		
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. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
6.1.2.1.2. Operators shall be physically tested for vision and hearing before being assigned to operator duty and annually thereafter.	**C**		
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.	**C**		
6.1.2.2.2. Operator training shall include, but not be limited to, the following topics:	**C**		
6.1.2.2.2.1. The requirements of the operator manual.	**C**		
6.1.2.2.2.2. The requirements of NASA-STD-8719.9, Lifting Standard; and ASME B30 series, Material Handling Equipment.	**C**		
6.1.2.2.2.3. The parts of 29 CFR 1910, Subpart N, Material Handling and Storage.	**C**		
6.1.2.2.2.4. The parts of ANSI B30 and other industry standards.	**C**		
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, 6.1.1.3.	**C**		
6.1.3.1.2. All damaged MHE shall be removed from service until all discrepancies are corrected.	**C**		
6.1.3.1.3. All MHE shall be marked with the due date of next inspection.	**C**		
6.1.3.2. MHE General Data Requirements. All MHE data requirements shall be provided in accordance with Volume 3, Chapter 4, and Volume 3, Attachment 1 of this publication, NPR 8715.7, and the other standards referenced herein.	**C**		
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.	**C**		
6.1.4.2. All MHE shall be verified as safe for its intended use by the payload project.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.5. Sling Operations	**I**		
6.1.5.1. Sling Operating Standards. All slings shall be operated, maintained, and tested in accordance with NASA-STD-8719.9 and ASME B30.9, Slings.	**C**		
6.1.5.1.1. For identification and onsite assurance purposes, equipment shall have a periodic recertification tag containing equipment identification, next required test date, and quality control stamp.	**C**		
6.1.5.1.2. Slings which have components that are normally disassembled shall be either marked, coded, or tethered to assure proper assembly of verified hardware.	**C**		
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 proofload/certification of the whole assembly.*	**C**		
6.1.5.2. Sling Inspection and Periodic Test Requirements. Slings shall be inspected and tested in accordance with Volume 3, 6.1.2.2. The following used to support critical operations shall be inspected and load tested within one year of intended use.	**C**		
6.1.5.2.1 Verify, overall, that there is no evidence of visual damage, gouges in metal, flaking paint, loose bolts, rivets, or connections, or deformation such as galling or gouges in pins, eyes, and end connections.	**C**		
6.1.5.2.2. Ensure there are no bent, deformed, cracked, or excessively corroded support or main members.	**C**		
6.1.5.2.3. Inspect load-bearing bolts and verify that there is no visual evidence of bending cracking, gross wear, or improper configuration.	**C**		
6.1.5.2.4. Inspect attached and lifting lugs for visual deformation and evidence of local yielding.	**C**		
6.1.5.2.5. Ensure there are no elongated attach or lifting holes.	**C**		
6.1.5.2.6. Inspect around fasteners for local yielding and deformation.	**C**		
6.1.5.2.7. Remove and inspect load-bearing slip pins for visual deformation, evidence of bending, abnormal defects such as galling, scoring, and diameters not within drawing tolerances. Nondestructive Inspection (NDI) shall be used when required by design requirements or when cracks are suspected.	**C**		
6.1.5.2.8. Inspect pin bores visually for cracks, deformation, local yielding, scoring, and galling. NDI shall be performed as required.	**C**		
6.1.5.2.9. Inspect welds for cracks and evidence of deformation, deterioration, damage, or other defects by visually inspecting all welds.	**C**		
6.1.5.2.10. Inspect welds for cracks and evidence of deformation, deterioration, damage, or other defects by magnetic particle, x-ray, or other suitable crack-detecting methods as appropriate for critical welds as identified on the drawings.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.1.5.2.11. Inspect all parts, particularly bare metal, for corrosion. Corrosion-protect all surfaces that are to be painted, lubricated, or coated with strippable vinyl as necessary. Do not paint over un-inspected areas; do not paint over cracks, deformations, deterioration, or other damage until engineering assessment has been made.	**C**		
6.1.5.2.12. Wire rope slings shall be immediately removed from service if any of the following conditions are present:	**C**		
6.1.5.2.12.1. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.	**C**		
6.1.5.2.12.2. Wear or scraping of one-third the original diameter of outside individual wires.	**C**		
6.1.5.2.12.3. Kinking, crushing, bird caging, or any other damage resulting in distortion of the wire rope structure.	**C**		
6.1.5.2.12.4. Evidence of significant heat damage.	**C**		
6.1.5.2.12.5. End attachments that are cracked, deformed, or worn.	**C**		
6.1.5.2.12.6. Hooks that have been opened more that 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.	**C**		
6.1.5.2.12.7. Significant corrosion of the rope or end attachment.	**C**		
6.1.5.3. Sling Recurring Data Requirements. Recurring data is required in accordance with Volume 3, Chapter 4.	**C**		
6.1.6. Hydraset and Load Cell Operations	**I**		
6.1.6.1. Operator Training. Hydraset operators shall be trained and certified in accordance with manufacturer recommendations and NASA-STD-8719.9, Lifting Standard.	**C**		
6.1.6.2. Hydraset and Load Cell Operating Standards. Hydrasets and load cells shall be operated, maintained, and tested in accordance with the manufacturer instructions; NASA-STD-8719.9, Lifting Standard; and the additional requirements described below.	**C**		
6.1.6.3. Hydraset and Load Cell Inspection and Periodic Test Requirements. Hydrasets and load cells shall be inspected and tested in accordance with Volume 3, Section 6.1.6.3 of this publication and NASA-STD-8719.9, Lifting Standard.	**C**		
6.1.6.4. Hydraset and Load Cell Recurring Data Requirements. Recurring data is required in accordance with Volume 3, Chapter 4.	**C**		
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.	**C**		
6.1.7.2. Handling Structure Inspection and Periodic Test Requirements. Handling structures shall be inspected and tested in accordance with Volume 3, 6.1.4.2.	**C**		
6.1.7.3. Handling Structure Recurring Data Requirements. Recurring data is required in accordance with Volume 3, Chapter 4.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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, National Electric Code.	**C**		
At VAFB, cranes not on VAFB exclusive federal jurisdiction property also require inspection, testing, and certification in accordance with CAL-OSHA requirements.	**C**		
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; and the qualifications stated in the ASME B30 series, 29 CFR 1910.179, and 29 CFR 1910.180, as applicable.	**C**		
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.	**C**		
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.	**C**		
6.2.2.4. Annual Crane Operator Certification. Annual crane operator certification is required and shall be conducted in three parts:	**C**		
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.	**C**		
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, ASME B30 series, and the local requirements of the crane owner.	**C**		
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:	**C**		
6.2.2.4.3.1. Name of operator.	**C**		
6.2.2.4.3.2. Certification expiration date.	**C**		
6.2.2.4.3.3. Other pertinent information such as the types of equipment the operator is certified to operate.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
6.2.3.1.2. Daily inspections shall cover the following items:	**C**		
6.2.3.1.2.1. The function of all controls, brakes, and operating mechanisms for maladjustment interfering with proper operations.	**C**		
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 deteriation 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, distrorted links interfering with proper function, or stretch beyond manufacturer's recommendations; control mechanisms; all chords and lacing; tension in guys; and plumb of mast.	**C**		
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.	**C**		
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.	**C**		
6.2.6. Dual Crane Lift Operating Requirements. Dual crane lifts are considered hazardous operations without regard to the load. The following is required:	**C**		
6.2.6.1. The load shall be restricted to no more than 75 percent of rated capacity for each crane.	**C**		
6.2.6.2. All mobile crane dual lifts shall require load cells and cab-installed load indicators.	**C**		
6.2.6.3. A dry run with a geometric/mass simulator shall be required for all critical hardware lifts.	**C**		
6.2.6.4. A Dual Crane Lift Plan addressing the following information shall be submitted to Range Safety for review and approval:	**C**		
6.2.6.4.1. The exact weight (+/- 1 percent) of the total load including spreader bar/beam, hoist attachments, fixtures, and slings.	**C**		
6.2.6.4.2. Any dynamic forces that affect the load.	**C**		
6.2.6.4.3. All crane movements, including trolley, bridge, boom up, down, extension, and swing, and crane travel.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.2.6.4.4. Center of gravity throughout the complete lift.	**C**		
6.2.6.4.5. Certification of cranes and crane operators.	**C**		
6.2.6.4.6. Operating surface capacity compatibility with mobile cranes (paved areas).	**C**		
6.2.6.4.7. Soil compaction compatibility with mobile cranes (unpaved areas).	**C**		
6.2.6.4.8. Provisions for a lift director, two-ways communication, and spotter(s).	**C**		
6.2.6.5. Operations involving offset lifts shall not exceed the crane's capability.	**C**		
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:	**C**		
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.	**C**		
6.2.7.1.2. An approved quality assurance program identifying controls, inspection points, and complete First Use Tag information.	**C**		
6.2.7.1.3. Identification of shelf-life criteria.	**C**		
The shelf-life shall not exceed 5 years in an environmentally controlled location without retest.	**C**		
6.2.7.2. Range Safety shall withdraw approval upon any infraction of the program.	**C**		
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 ANSI/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.	**C**		
6.2.8.1. Mobile cranes shall be certified for operational use by the appropriate authorizing agency.	**C**		
6.2.8.2. Dual crane lift operations require Range Safety approved lift plans (See 6.2.6.4).	**C**		
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:	**C**		
6.2.9.1.1. The crane has met all of its maintenance, test, and inspection requirements and is operated within its rated capacity.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.2.9.1.2. The operator is properly certified.	**C**		
6.2.9.1.3. The operator remains at the controls the entire time a load is suspended. *Exceptions shall be allowed in the interest of operational efficiency to allow lifting hardware such as slings, spreader bars, BTHLDs, load cells, and Hydrasets to remain suspended while unattended provided all of the following conditions are met:*	**C**		
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.	**C**		
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).	**C**		
6.2.9.1.3.3. The load is scheduled to be lifted within 24 hours.	**C**		
6.2.9.1.3.4. The load and immediate vicinity are roped off or otherwise identified to prohibit unauthorized personnel entry.	**C**		
6.2.9.1.3.5. The crane controls are locked in the off position.	**C**		
6.2.9.1.3.6. The restrictions against people being under the suspended lifting hardware are enforced.	**C**		
6.2.9.1.4. The vicinity of the lift is controlled so that:	**C**		
6.2.9.1.4.1. Unauthorized personnel entry is precluded.	**C**		
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.	**C**		
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.	**C**		
6.2.9.1.4.4. A large enough area is cleared so as to protect against flying debris from a dropped object.	**C**		
6.2.9.1.5. All personnel within the controlled hoisting area wear suitable head and foot protection.	**C**		
6.2.9.1.6. Previously announced lightning advisories and lightning warnings will not cause the load to be in jeopardy.	**C**		
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.	**C**		
6.2.9.1.8. If using a mobile crane, the crane shall be level and the following criteria shall be met:	**C**		
6.2.9.1.8.1. The area shall be set up so that the lift is made within the shortest possible radius.	**C**		
6.2.9.1.8.2. The lift shall be made over the rear of the crane, if possible.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
6.2.9.1.8.6. Outriggers and outrigger floats shall be used on flat hard/compacted surfaces.	**C**		
6.2.9.1.8.7. Outrigger floats or cribbing is required in areas that do not have a hard surface such as concrete.	**C**		
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.	**C**		
6.2.9.1.10. All operators or spotters shall have aural communications for coordination between themselves when power is on the system.	**C**		
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.	**C**		
6.2.9.1.12. Tag line personnel shall not impart undesirable motion to the load.	**C**		
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.	**C**		
6.2.9.1.14. Unattended suspended loads require local safety authority approval.	**C**		
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.	**C**		
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.	**C**		
6.2.9.3.2. The load shall be lifted to a height sufficient to clear all obstacles in its intended path.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
6.2.9.3.3.3. When lifting a load, load lines shall not contact load girts, structural members, or any other obstructions.	**C**		
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:	**C**		
6.2.9.3.4.1. There is no safer way to accomplish the rotation.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
6.2.9.3.4.6. The load is prevented from swinging or otherwise inducing dynamic loads on the hoisting system.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
6.2.10.1.4. Each lift shall be planned so that the load is suspended for a minimum amount of time.	**C**		
6.2.10.1.5. The load shall not be lifted until immediately before intended travel.	**C**		
6.2.10.1.6. The most direct route of travel shall be used.	**C**		
6.2.10.1.7. Loads shall not be carried over critical hardware except when that load is being mated to the critical hardware.	**C**		
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.	**C**		
6.2.10.1.9. If the load remains suspended for any length of time, the safety clearance zone shall remain in force.	**C**		
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.	**C**		
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.	**C**		
6.2.10.1.12. An alarm device or personnel accompanying the load shall be used to clear other persons out of the load path.	**C**		
6.2.10.1.13. Tag lines shall be used to control movement of the load and not impart undesirable motion to the load.	**C**		
6.2.10.1.14. Tag lines shall be long enough to protect personnel from being struck by the load.	**C**		
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.	**C**		
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.	**C**		
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 and 29 CFR 1926.1431, Crane or Derrick Suspended Personnel Platforms, and specifically authorized by the appropriate local safety authority.	**C**		
6.2.10.3. Man-Rated Crane Criteria. All cranes used to suspend personnel platforms and work baskets shall meet the following requirements:	**C**		
6.2.10.3.1. Crane free-fall features shall be deactivated.	**C**		
6.2.10.3.2. Load testing of the current configuration shall have been performed within past 12 months.	**C**		
6.2.10.3.3. Two-way communication shall be maintained between the crane operator and the person in the basket.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
6.2.10.3.4. The crane operator shall be appropriately qualified.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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).	**C**		
6.3.2.3. Aerial Work Platform Operations	**I**		
6.3.2.3.1. Only qualified and trained personnel shall operate aerial work platforms.	**C**		
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; ANSI B56.2 Type Designated Area, Use Maintenance, Operator, and ANSI B56.3, Electric Battery-Powered Industrial Trucks, safety standards.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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**		
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 ANSI B56 series safety standards and bear identifying mark(s) evidencing the same.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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).	**C**		
6.4.3. Powered Industrial Truck Operations	**I**		
6.4.3.1. Only qualified and trained personnel shall operate powered industrial trucks.	**C**		
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 ANSI B56 series safety standards.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
6.4.3.6. Lift trucks shall be derated to 75 percent of rated capacity for critical loads.	**C**		
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.	**C**		
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.	**C**		
6.5.3. Personnel shall not ride in elevators during movement of the materials listed in 6.5.2.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 7 ACOUSTIC HAZARD OPERATIONS	**I**		
7.1 ACOUSTIC HAZARD OPERATING STANDARDS 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.)	**C**		
7.2 ACOUSTIC HAZARD OPERATIONS PERSONNEL PROTECTION REQUIREMENTS	**I**		
7.2.1. Unprotected personnel shall not be exposed to hazardous noise levels.	**C**		
7.2.2. Approved hearing protection devices shall be worn as required.	**C**		
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.	**C**		
7.3.2. Identified noise sources shall be surveyed by the Bioenvironmental Engineer or a designated representative.	**C**		
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.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
8.1.2. All non-ionizing radiation operation shall be conducted in accordance with the requirements of the following standards:	**C**		
8.1.2.1. NPR 1800.1, NASA Occupational Health Program Procedures for requirements on non-ionizing radiation; KNPR 1860.1, Kennedy NASA Procedural Requirements, for any processing performed on KSC property; and 45 SWI 40-201 for personnel exposure limits on Air Force property. NPR 8715.3, NASA General Safety Program Requirements, provides requirements for protecting personnel and property during laser use in NASA operations. Exposure requirements for laser radiation are provided in 21 CFR Part 1040, Performance Standards For Light-Emitting Products.	**C**		
8.1.2.2. NASA-STD 8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics; AFMAN 91-201; DoD 6055.9-STD; and MIL-STD-1576, Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems, for radiation limits for ordnance exposure.	**C**		
8.1.2.3. NASA-STD 8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics; AFMAN 91-201; DoD 6055.9-STD; and T.O. 31Z-10-4, Electromagnetic Radiation Hazards, for guidance with respect to siting ordnance.	**C**		
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.	**C**		
8.2 RADIO FREQUENCY PROCEDURES All radio frequency (RF) 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 RF transmitters are exempt from controls.	**C**		
8.3 RF OPERATIONS	**I**		
8.3.1. RF Operations General Requirements	**I**		
Non-ionizing radiation operations involve RF transmitters in the range of 3 kHz to 300 GHz and optical devices such as lasers.	**I**		
8.3.1.1. Before transmitting, areas in which power density levels exceed permissible exposure limits shall be controlled to restrict access.	**C**		
Area control may be accomplished using appropriate warning signs, lights, and access barriers.	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
8.3.1.2. The RPO/RSO shall survey RF transmitting devices as required.	**C**		
8.3.1.2.1. The payload project shall comply with the survey recommendations.	**C**		
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. *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:* *Barriers - a physical means to keep personnel away from hazardous energy or to contain/deflect hazardous energy if it were released.* *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.* *Inhibit - a device that prevents system operation if a predetermined condition is not satisfied.* *Interlock - a device that may be inserted into the system to prevent system operation (often used in maintenance).* *Interrupt - a device that disrupts system operation if a predetermined condition is violated.* *Redundancy/failure tolerance - the built-in ability of a system to provide continued correct operation in the presence of a specific number of failures.* *Special system features - systems or devices, such as fire suppression and hazardous gas detection, that control and/or warn of system hazards.*	**C**		
8.3.1.3. All new, modified, or relocated RF transmitters shall be reported to the appropriate safety authority and the RPO/RSO so that potential hazards can be evaluated.	**C**		
8.3.2. RF Transmission Operations for EEDs and Open Grain Solid Propellant	**I**		
8.3.2.1. As determined by analyses and tests, local or range-wide RF silence is required during periods of EED installation, removal, and electrical connection or disconnection. At a minimum, RF silence within the complex or area shall be required.	**C**		
8.3.2.2. Radio transmitters shall be kept away from systems with installed EEDs in accordance with the guidance found in AFMAN 91-201 and NASA-STD 8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
The 25-foot radio transmission distance requirement is the minimum requirement; however, this requirement does not take into account situations where EEDs are RF sensitive and leads are unshielded. Based on the specific radio, ordnance, and area involved, an RF analysis performed in accordance with MIL-STD-1576 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.	**C**		
8.4 OPTICAL/LASER OPERATIONS	**I**		
8.4.1. Optical/Laser Operating Standards. Optics and lasers shall be operated in accordance with 21 CFR Part 1040, Performance Standards For Light-Emitting Products; NPR 8715.3, NASA General Safety Program Requirements; and ANSI Z136.1, LIA (Laser Institute of America) Z136.1 Safe Use of Lasers and ANSI Z136.2, Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources. And for Air Force property, optics and lasers shall be operated in accordance with 45 SWI 40-201 as applicable.	**C**		
8.4.2. Optical/Laser Operation Personnel Protection Requirements	**I**		
8.4.2.1. Optical/laser operations personnel shall be trained and certified in accordance with NPR 8715.3, NASA General Safety Program Requirements, Chapter 7. And for Air Force property, optical/laser operations shall be trained and certified in accordance with 45 SWI 40-201 as applicable.	**C**		
8.4.2.2. Approved protective eye wear and other PPE shall be worn as required.	**C**		
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 RPO/RSO approved procedures with the appropriate controls established.	**C**		
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.	**C**		
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.	**C**		
8.4.4.3. Inspection records shall be available at the request of the appropriate local safety authority.	**C**		
8.4.5. Optical/Laser Operations	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
8.4.5.2. Active beam or target viewing shall be accomplished with closed circuit television or an optical comparator with an appropriate filter.	**C**		
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.	**C**		
8.4.5.4. Activated lasers shall not be left unattended.	**C**		
8.4.5.5. Unattended lasers shall be locked out and otherwise safed.	**C**		
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.	**C**		
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.	**C**		
8.4.5.8. Operations involving lasers with high voltage or capacitance shall follow the requirements in Chapter 14 of this volume.	**C**		
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.)	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
8.4.5.13. All nominal hazardous procedural items shall be accomplished including, but not limited to, the following:	**C**		
8.4.5.13.1. 24-hour notification of Pad Safety.	**C**		
8.4.5.13.2. Pre-operational PA announcements.	**C**		
8.4.5.13.3. Clearance of safety clearance zones.	**C**		
8.4.5.13.4. Posting of applicable warning signs and operation of area warning lights.	**C**		
8.4.5.13.5. Pad Safety permission prior to start of the hazardous lasing activity.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. The appropriate safety authority or RPO/RSO shall approve all procedures for handling radioactive sources.	**C**		
9.2. All ionizing operations shall be planned and conducted so that personnel exposure is as low as reasonably achievable (ALARA), but in no case shall the maximum dose and exposure limits in 10 CFR 20, Standards for Protection Against Radiation, be exceeded.	**C**		
9.3. Payload projects shall comply with KNPR 1860.1, KSC Ionizing Radiation Protection Program, and 45 SWI 40-201 or 30SW RADSAFCOM process as applicable.	**C**		
9.4. 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. CCAFS Cape Support (ER 321-853-5211) or VAFB 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 property. KNPR 1860.1 shall be followed for releases and spill on KSC property.	**C**		
9.5. Flight radioactive sources shall be installed as late in the countdown as practical.	**C**		
9.6. 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. AFI 91-110 and AFI 91-204 shall also apply for mishaps on Air Force property.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
10.1.2. Hazardous operations shall be conducted in accordance with 29 CFR 1910.1200, Hazard Communication; 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals; 40 CFR 68, Chemical Accident Prevention Provisions, subpart G Risk Management Plan; NPR 8715.3, NASA General Safety Program Requirements; and local requirements as directed by the PSWG and Range Safety for process safety management (PSM) and risk management plan (RMP). KNPR 8715.3 shall be followed for hazardous materials processes performed on KSC property. AFI 90-821, Hazard Communication; AFOSHSTD 91-119, Process Safety Management of Highly Hazardous Materials;	**C**		
10.1.3. When threshold quantities of toxic chemicals as defined by OSHA, NASA, or Air 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 45 SW point of contact for process safety management is System Safety (45 SW/SEA).	**C**		
10.2 HAZARDOUS MATERIALS OPERATIONS PERSONAL PROTECTIVE EQUIPMENT (PPE) 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.	**C**		
10.3 HAZARDOUS MATERIALS PROCEDURES Hazardous materials procedures shall be established per local requirements. For operations taking place on Air 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:	**C**		
10.3.1. Emergency actions for unplanned events such as spills, fires, and personnel contamination.	**C**		
10.3.2. Actions for decontamination, neutralization, cleanup, and disposal.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
10.4.3. Control measures for hazardous liquids include, but are not limited to, the following criteria:	**C**		
10.4.3.1. Approved containers shall be used.	**C**		
10.4.3.2. Containers shall remain capped (covered) when not in use.	**C**		
10.4.3.3. Quantities shall be limited as approved by the Fire Authority Having Jurisdiction (AHJ).	**C**		
10.4.3.4. Work areas shall contain no more than the quantity required for a single shift.	**C**		
10.4.3.5. Work areas shall not be used for storage unless approved storage cabinets and lockers are available.	**C**		
10.4.3.6. Local or general exhaust ventilation shall be used to control solvent vapors from reaching toxic levels or explosive levels.	**C**		
10.4.3.7. Materials that are themselves not hazardous, but that can be hazardous in conjunction with other materials, shall be controlled.	**C**		
10.4.3.8. The location and/or facility shall be compatible with the type and quantity of hazardous material.	**C**		
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.	**C**		
10.4.3.10. Materials prone to electrostatic charge buildup shall not be used in the vicinity of ordnance or propellants.	**C**		
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.	**C**		
10.4.4. In the event of an unplanned toxic release local emergency response plans shall be followed. *Note: The following documents apply: at Air Force Ranges: AFI 32-4002, Hazardous Material Emergency Planning and Response Compliance, 30 SWI 91-106, Toxic Hazard Assessments, and 45 SW Launch Toxic Hazard Control Plan. At KSC: KNPR 8715.2, Comprehensive Emergency Management Plan.*	**C**		
10.5 RESTRICTIONS ON THE USE OF PLASTIC FILMS, FOAMS, AND ADHESIVE TAPES (PFAS) AND OTHER STATIC-PRODUCING AND FLAMMABLE MATERIALS	**I**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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:	**C**		
10.5.1.1.1. Materials shall not come into contact with a system having an installed EED or other ordnance.	**C**		
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.	**C**		
10.5.1.1.3. Materials shall not come within 50 feet of exposed flammable liquids.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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:	**C**		
10.5.2.3.1. Ability to build up a charge (triboelectric test).	**C**		
10.5.2.3.2. Ability of that charge to decay (triboelectric test).	**C**		
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	**C**		
10.5.2.3.4. Compatibility with other materials and liquids the material may come into contact with.	**C**		
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).	**C**		
10.5.2.5. The appropriate local safety authority shall approve the use of materials based on the test results.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
10.6.2. Hazardous Commodity Locker Inspection. The payload project shall inspect hazardous commodity lockers at least weekly.	**C**		
10.7 DISPOSAL OF CONTAMINATED LIQUID PROPELLANT, GAS, OR OTHER REGULATED WASTES	**I**		
10.7.1. On Air Force Ranges, the payload project shall notify CCAFS 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.	**C**		
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. *Note: On AF Ranges, the approval authority is Range Safety and Civil Engineering (Environmental Coordinator). Follow 45 and 30 Space Wing Operations Plan 19-14, Petroleum Products and Hazardous Waste Management Program.*	**C**		
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 Air Force Ranges, Civil Engineering shall be notified.	**C**		
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.	**C**		
10.7.5. Records of management and identification of wastes shall be maintained by the organization generating the waste.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 CCAFS 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).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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 DoD 6055.9-STD and sub tier documents such as AFMAN 91-201 and NAVSEA OP 5, Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation and Shipping.	**C**		
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.	**C**		
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.	**C**		
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) CFR 49 regulations.	**C**		
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.	**C**		
11.2.2. Pressure Systems PPE	**C**		
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).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.1.1. Approval shall be limited to a particular model number of protective equipment and a particular operation.	**C**		
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.	**C**		
11.2.2.1.3. Approvals are not transferable; approvals for similar operations require a reevaluation of the parameters stated above.	**C**		
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).	**C**		
11.2.2.1.5. If the protective gear has limitations, these limitations and subsequent protective actions shall be identified in the operating procedure.	**C**		
For example, splash suits are not to be used when hydrazine concentrations can exceed 100 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:	**C**		
11.2.2.2.1.1. Connection and disconnection of wet lines or contaminated (not purged and flushed) dry lines.	**C**		
11.2.2.2.1.2. Sampling operations.	**C**		
11.2.2.2.1.3. During propellant flow.	**C**		
11.2.2.2.1.4. During initial pressurization with propellants until system integrity has been verified (no leaks).	**C**		
11.2.2.2.1.5. Connections and disconnections of tanker load/off-load lines.	**C**		
11.2.2.2.1.6. Removal and replacement of components in a liquid line.	**C**		
11.2.2.2.1.7. Opening any liquid system that has not been drained, purged, and flushed with referee fluid.	**C**		
11.2.2.2.1.8. When the condition of the system is uncertain or unknown.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. *Note: SCAPE categories are defined as:* *Category I - Propellant Handlers Ensemble (PHE) with breathing backpack unit.* *Category IV - Propellant Handlers Ensemble (PHE) with hardline breathing hose.* *Category VI - 'Chemturion' Chemical Protection Suit (CPS) "blue suit" with hardline breathing hose.* *Please refer to KNPR 8715.5 KSC Personal Protective Equipment (PPE) Procedural Requirements for SCAPE operations requirements and further explanation of categories.*	**C**		
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.	**C**		
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.	**C**		
11.2.2.3.1. Removal of full protective gear after system integrity verification shall require approval by the appropriate local safety authorities.	**C**		
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.	**C**		
11.2.2.3.3. The following non-liquid operations shall require splash suits:	**C**		
11.2.2.3.3.1. Removal and replacement of components on purged and isolated liquid lines.	**C**		
11.2.2.3.3.2. Removal and replacement of components on vent lines.	**C**		
11.2.2.3.3.3. Connections and disconnections of drained, purged, and isolated lines.	**C**		
11.2.2.3.3.4. Pressure leak checks when required by procedure.	**C**		
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.	**C**		
11.2.2.4. PPE for Cryogenic Systems	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.2.2.4.1. All personnel performing liquid oxygen and liquid hydrogen transfer operations, repairs, or adjustments to the system shall wear PPE 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.	**C**		
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.	**C**		
11.2.2.5. PPE for Hydrogen Peroxide Transfers. Hydrogen peroxide transfers shall require PPE 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.	**C**		
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.	**C**		
11.3.2. Procedures shall be developed for all operations involving propellants and the checkout of propulsion systems.	**C**		
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:	**C**		
11.3.3.1. Hardware:	**C**		
11.3.3.1.1. Launch vehicle.	**C**		
11.3.3.1.2. Launch vehicle fairing.	**C**		
11.3.3.1.3. Spacecraft.	**C**		
11.3.3.1.4. Launch complex.	**C**		
11.3.3.1.5. Process facility.	**C**		
11.3.3.1.6. Transport vehicle.	**C**		
11.3.3.1.7. Fixed GSE.	**C**		
11.3.3.1.8. Portable GSE.	**C**		
11.3.3.2. Software Command Capability:	**C**		
11.3.3.2.1. Flight Hardware.	**C**		
11.3.3.2.2. GSE:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.3.3.3. Personnel Capability:	C		
11.3.3.3.1. Remote.	C		
11.3.3.3.2. SCAPE.	C		
11.3.3.3.3. Combination of both.	C		
11.4 PRESSURE SYSTEMS TEST, INSPECTION, AND MAINTENANCE REQUIREMENTS	I		
11.4.1. General Test Requirements	C		
11.4.1.1. Pressure systems shall be initially tested in accordance with Volume 3, Chapter 11 or Chapter 12.	C		
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.	C		
11.4.1.3. Pressure relief valves and flex hoses shall be retested within one year of intended use.	C		
11.4.1.4. Pressure gauges and transducers shall be calibrated annually.	C		
11.4.1.5. After any disconnection, modification, or repair of a system, the affected part of the system shall be leak tested.	C		
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.	C		
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.	C		
11.4.1.8. New, modified, or repaired propellant systems shall be tested in accordance with Volume 3, Chapter 11 or Chapter 12.	C		
11.4.1.9. A log shall be kept on propellant systems to keep track of use, maintenance, modification, testing, and inspection.	C		
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.	C		
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.	C		
11.4.2.3. Periodic inspections shall be performed on all ground pressure systems in accordance with applicable procedures.	C		
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:	C		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.4.2.4.2. First Certification Period. Period from the first recertification effort until second recertification.	**C**		
11.4.2.4.3. All subsequent Recertification Periods.	**C**		
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.	**C**		
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.	**C**		
11.4.3.2. A record shall be kept on the certification of system and component cleanliness.	**C**		
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.	**C**		
11.4.4. Pressure Systems Tests. Tests performed shall meet the requirements as outlined in Volume 3, Chapter 11 and Chapter 12.	**C**		
11.4.4.1. Periodic Test Requirements for Pressure System Components:	**C**		
11.4.4.1.1. Flexible hoses shall be hydrostatically proof tested to 1.5 times their MAWP once a year unless otherwise approved by the PSWG and Range Safety.	**C**		
11.4.4.1.2. All permanently installed flexible hoses shall be visually inspected over their entire length at least annually for damaged fittings, broken braid, kinks, flattened areas, or other evidence of degradation.	**C**		
11.4.4.1.3. Pressure gauges and transducers shall be calibrated once a year.	**C**		
11.4.4.1.4. Pressure relief valves shall be tested for proper setting and operation once a year.	**C**		
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.	**C**		
11.4.4.3. Pressure Systems Tagging	**I**		
11.4.4.3.1. After test and inspection, pressure system components shall be tagged.	**C**		
11.4.4.3.2. Tags shall provide the date of the last inspection and proof-load test and the component MAWP.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.4.6. Pressure Vessel and Liquid Holding Tank Recertification Documentation. Documentation shall be recorded and maintained in accordance with Volume 3. Chapter 11.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.5.1.1.3. Pressure relief valves that present a noise hazard on activation shall be marked with danger signs.	**C**		
11.5.1.2. Pressure Systems Remote Pressurization. Exception. For the 30 SW, remote pressurization can be waived provided the following is provided: (1) The assembled system has been proof tested at a pressure equal to 1.5 times the system MEOP 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.	**C**		
11.5.1.2.1. Remote pressurization is required for the following conditions:	**C**		
11.5.1.2.1.1. Initial pressurization of any vessel or system with an inert medium.	**C**		
11.5.1.2.1.2. Any pressurization that will exceed MOP.	**C**		
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.	**C**		
11.5.1.2.2. All personnel shall be evacuated whenever pressure exceeds the MAWP.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.5.1.3.2. A system and/or facility check shall be made before the start of the pressurization operation.	**C**		
11.5.1.3.3. Personnel present during any pressurization shall be limited to those in direct support of the operation.	**C**		
11.5.1.3.4. If a leak occurs during pressurization, the system and/or subsystem shall be depressurized before adjusting any fittings.	**C**		
11.5.1.3.5. Flexible hose shall be secured along its length at 6-foot intervals or less.	**C**		
11.5.1.3.6. Bolts and fittings shall not be loosened or torqued while the system is under pressure.	**C**		
11.5.1.3.7. 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.	**C**		
11.5.1.3.8. Flight hardware pressure vessels that exhibit a brittle fracture or hazardous leak-before-burst (LBB) failure mode shall maintain a minimum safety factor of 2:1 during transport or ground handling operations unless otherwise specified and approved by the PSWG and Range Safety.	**C**		
11.5.1.3.9. 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.	**C**		
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.	**C**		
11.5.1.4.1.2. The steps listed below shall be followed:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.5.1.4.1.2.6. The isolated area shall be verified as being depressurized before opening.	**C**		
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:	**C**		
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.	**C**		
11.5.1.4.2.1.2. Personnel limits shall be established in a local safety authority approved procedure.	**C**		
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.	**C**		
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.	**C**		
11.5.1.4.2.4. Work requiring lockout and tagging includes the following:	**C**		
11.5.1.4.2.4.1. The system is depressurized for maintenance.	**C**		
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.	**C**		
11.5.1.4.2.4.3. The work site is left unattended.	**C**		
11.5.1.4.2.4.4. The valve is not visible at all times.	**C**		
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.	**C**		
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.*	**C**		
11.5.1.4.2.5. The following criteria shall be observed when removing locks and tags and returning the system to service:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.5.1.4.2.5.2. Tags shall be removed only by the crew placing the tag.	**C**		
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.	**C**		
11.5.1.4.2.5.4. Both tag and tear off portion shall be filed or disposed of in accordance with current practice.	**C**		
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.	**C**		
11.5.2.1. General Operating Requirements for Pressure Systems Containing Liquid Propellants	**C**		
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.	**C**		
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 45SW 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.	**C**		
11.5.2.1.3. Simultaneous tanking of fuels and oxidizers aboard a launch vehicle/payload is prohibited.	**C**		
11.5.2.1.4. Vessels, lines, and propellant loading systems shall be properly bonded and commonly grounded.	**C**		
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.	**C**		
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.	**C**		
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 Material Safety Data Sheet (MSDS) for the product being used. Appropriate medical attention shall be sought as early as possible (during flushing if possible).	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.5.2.1.9. Transport of more than five gallons of hypergolic propellants shall require a Security or HOS escort as described in Chapter 16 of this volume.	**C**		
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.	**C**		
11.5.2.2.2. As required by procedure, the appropriate local safety authority (Pad Safety on Air Force property) and other required support shall be on hand before the conduct of operations.	**C**		
11.5.2.2.3. Appropriate local safety authority concurrence to proceed shall be obtained by the payload project before the conduct of operations.	**C**		
11.5.2.2.4. Personnel qualification and training shall be verified by the respective supervisors.	**C**		
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:	**C**		
11.5.2.2.5.1. Wet check of safety showers and water lines before propellant transfer.	**C**		
11.5.2.2.5.2. Accessibility and operability of emergency exit doors.	**C**		
11.5.2.2.5.3. Operability of drain and sump systems and their capability for handling a worst case spill and wash down.	**C**		
11.5.2.2.5.4. Operability of vent systems.	**C**		
11.5.2.2.5.5. Availability of fire protection.	**C**		
11.5.2.2.5.6. Proper configuration and grounding of propellant systems.	**C**		
11.5.2.2.5.7. Weather conditions.	**C**		
11.5.2.2.5.8. PA announcements, warning lights, and barriers.	**C**		
11.5.2.2.5.9. Implementation of access control.	**C**		
11.5.2.2.5.10. All required support on hand.	**C**		
11.5.2.2.5.11. Availability of approved operating procedures and emergency procedures.	**C**		
11.5.2.2.5.12. Removal of ignition sources from the area.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.5.2.2.8. Emergency protective equipment shall be provided as required by the appropriate local safety authority.	**C**		
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.	**C**		
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.	**C**		
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.	**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.	**C**		
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.	**C**		
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.	**C**		
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 Air Force property) shall be obtained before starting propellant transfer operations and before pressurization.	**C**		
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.	**C**		
11.5.2.4.3. Fire Protection and Environmental Health shall be available as required by procedure.	**C**		
11.5.2.4.4. All persons and vehicles not absolutely essential to the operation shall be evacuated.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
11.5.2.4.7. Vapor monitoring shall be continuous whenever personnel are in enclosed areas having toxic propellants present.	**C**		
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 stops and systems shall be secured when lightning is within 10 nautical miles. Buildings are evacuated when lightning approaches 5 miles.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.5.2.4.12. The appropriate actions and evacuations shall take place in the event of an emergency such as a propellant spill.	**C**		
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.	**C**		
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; 30 SWI 91-106, Toxic Hazard Assessments; VAFB CEMP 10-2; 30 OPLAN 32-4002-A, Hazardous Materials (HAZMAT) Emergency Response Plan; 45 SW Launch Toxic Hazard Control Plan; 45 SW Range Safety Operations Requirements, Number 19, Toxic Hazard Control Daily and Launch Operations; 45SW IEMP 10-2; 45 SWI 91-204, Launch Vehicle Toxic Plume Instruction for On-Base Personnel.	**C**		
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 30 SWI 91-106 and the applicable facility or operations plan.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.5.3.3. The actual venting operation shall not start without approval from the appropriate local safety authority.	**C**		
11.5.3.4. Venting restrictions and controls shall be identified in the appropriate OSP or operating procedure.	**C**		
11.5.3.5. Venting operations require that the appropriate downwind sector be evacuated.	**C**		
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.	**C**		
11.5.3.7. The operations control authority shall verify that Security Police or HOS maintain the appropriate roadblocks.	**C**		
11.5.3.8. Planned releases shall be in accordance with permits maintained by the appropriate local safety authority (e.g., Civil Engineering for Air Force Range Safety locations).	**C**		
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 Air Force property) with Environmental Health and the Fire Department performing the decontamination, if required.	**C**		
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.	**C**		
11.5.5.2. Leak and Spill Procedures	**I**		
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 and NPR 8715.7. Additionally, CCAFS Cape Support (ER 321-853-5211) or VAFB 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..	**C**		
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).	**C**		
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.	**C**		
11.5.5.2.2.2. The downwind sector shall be based on the following factors:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
11.5.5.2.2.2.2. Maximum vapor concentration acceptable for personnel exposure.	**C**		
11.5.5.2.2.2.3. Average weather criteria, such as wind direction, wind speed, temperature, temperature lapse rate.	**C**		
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.	**C**		
11.5.5.2.4. Procedures shall address the topics covered in 10.7.	**C**		
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.	**C**		
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.	**C**		
See CPIA 394 and Range Safety for guidance on disposal of toxic or corrosive propellants.	**C**		
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; 45SW IEMP 10-2; VAFB CEMP 10-2; 30 SW OPLAN 32-4002-C, Hazardous Materials (HAZMAT) Emergency Response; 30 SWI 91-106 and KDP-KSC-P3008, Hazardous Materials Emergency Response for leaks or spills on KSC property). If the requirements described below are in conflict with these OPLANS, the OPLANS shall take precedence.	**C**		
11.5.5.4.2. The following actions shall be taken:	**C**		
11.5.5.4.2.1. Time and the situation permitting, the source of the propellant flow and pressure source shall be shut down.	**C**		
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.	**C**		
11.5.5.4.2.3. Injured or trapped personnel shall be rescued. Appropriate PPE shall be used.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
11.5.5.4.2.4. Adjacent areas shall be alerted.	**C**		
11.5.5.4.2.5. Personnel shall be available to direct emergency crews and to provide information to assist them.	**C**		
11.5.5.4.2.6. All personnel shall report to the supervisor at the designated assembly point for head count.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
11.5.5.6.1. If COPVs that contain inert pressurants 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:	**C**		
11.5.5.6.1.1. Verification that the COPV is not in a credible "drip zone" for liquid propellants during ground processing operations.	**C**		
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.	**C**		
11.5.5.6.1.3. Hazardous vapor detectors shall be used to monitor the propellant tanks.	**C**		
11.5.5.6.2. If COPVs on AFSPC 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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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).	**C**		
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 MEOP pressure limit without the manufacturer's approval and the PSWG and Range Safety's agreement.	**C**		
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.	**C**		
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.	**C**		
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 (above 1/3 design burst pressure) shall be performed remotely or behind a blast shield. Personnel will not approach the COPV for a minimum of 10 minutes following the pressurization.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
13.1.3. Procedures shall include transportation activity on-Center, all on-base or facility transportation.	**C**		
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 DoD 6055.9-STD, AFJMAN 24-204, Preparing Hazardous Materials for Military Air Shipments; NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics; 49 CFR, Transportation; AFMAN 91-201, VAFB Sup 1 to AFMAN 91-201; and 30 SWI 91-107, Contractor/ Commercial/ Associate Unit Explosive Storage, Transportation, Handling and Inspection.	**C**		
13.2.1.1.1. The transportation of explosives by rail, air, vessel, and public highway shall also comply with DOT regulations 49 CFR.	**C**		
13.2.1.1.2. The transportation of explosives by air shall also comply with International Civil Aviation Organization (ICAO), Technical Instructions for the Safe Transport of Dangerous Goods by Air; and International Air Transport Association (IATA), Dangerous Goods Regulations, as applicable.	**C**		
13.2.1.2. Over-the-road and rail shipments to and from NASA Centers, Air Force ranges or the payload processing facility shall comply with DOT requirements.	**C**		
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 and verified by the payload project before shipment:	**C**		
13.2.1.3.1. Proper DOT classification for transport. For air transport, refer to AFJMAN 24-204.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.2.1.3.3. The availability of adequate and suitable storage at the payload processing facility and on the launch site area. Availability of adequate and suitable storage space depends on the hazard classification, the size of the storage containers, and temperature and humidity requirements.	**C**		
13.2.1.3.4. The availability of proper connectors and cabling for ordnance checkout if local facilities and equipment are to be used.	**C**		
13.2.1.4. All ordnance air shipments shall comply with AFJMAN 24-204 for military air shipments.	**C**		
For all hazardous ordnance, the presence of a convoy may be required.	**I**		
13.2.1.5. All hazardous ordnance on VAFB that requires a convoy shall use Hazardous Operations Support (HOS).	**C**		
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.	**C**		
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. *Note: Plans for shipment of ordnance to CCAFS shall be coordinated with CCAFS Ordnance Services. Plans for shipment of ordnance to VAFB shall be coordinated with 30 SW/SEGW.*	**C**		
13.2.2.3. Ordnance Transportation Address For Air Force Range Deliveries. All ordnance shipments including Category B EEDs shall be addressed as follows: **To:** Transportation Officer Patrick Air Force Base, FL 32925 **Marked for:** Manager, Ordnance Services Bldg. 72905, 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 **or** **To:** Transportation Officer Vandenberg Air Force Base, CA 93437 **Marked for:** 30 TRANS/LGTT 2010 New Mexico Street Vandenberg Air Force Base, CA 93437 Name of Project Monitor and Office Complete Address **From:** Sender's Name and Address	**C**		
13.2.3. ER Ordnance Delivery and Receipt	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.2.3.1. Ordnance deliveries shall be scheduled through CCAFS Cape Support (853-5211) on the ER and delivered only to Range Safety approved facilities.	**C**		
13.2.3.2. Pad Safety shall be notified of ordnance deliveries on CCAFS.	**C**		
13.2.3.3. Ordnance shipments arriving at the range shall be escorted from the gate to the proper storage area.	**C**		
13.2.3.4. After receipt at the Munitions Storage Area (MSA) 2 at CCAFS, all ordnance transportation shall be performed by CCAFS Ordnance Services unless specifically approved by Range Safety.	**C**		
13.2.3.5. All ordnance transportation shall be approved by Range Safety.	**C**		
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 SW Transportation Squadron, Traffic Management Office (TMO) the appropriate local safety authority and the payload project to ensure that no damage has occurred during shipment.	**C**		
13.2.4.2. Any shipment discrepancy or DOT violation shall be reported to the TMO and appropriate local safety authority.	**C**		
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.	**C**		
13.2.5.2. The payload project shall make arrangements to remove ordnance from the ranges when it is no longer needed or becomes defective.	**C**		
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.	**C**		
13.2.4.4. Shielding caps are required during storage, handling, and after mechanical installation.	**C**		
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) with leg stats, or conductive shoes, and/or wrist stats. If required, the payload project shall submit a sample of the garment for testing.	**C**		
The following is guidance for Ordnance Systems Grounding PPE Criteria:	**I**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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. *2. With the transition of the Air 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 Air 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:* *3. General Criteria for Coveralls:* *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." Per NHB 8060.1B, Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments that Support Combustion, Test 1: "less than 6 inches sample consumed and no sparking, sputtering, or dripping of flaming particles."* *NOMEX garments are not covered by MIL-C-43122F.* *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 Air 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.*			

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.* *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). (Continued)* *(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.*			

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.* *Note: In NASA and Air Force contractor-operated cleanroom facilities, facility users are expected to use cleanroom coveralls provided by the NASA facility operator, Air 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 Air Force contractor-managed cleanroom facilities use cleanroom garments that meet the NASA/KSC specifications.*			
13.3.1.2. Other persons who may come in contact with ordnance, test equipment when ordnance is connected, or flight hardware when ordnance connections are not complete shall wear the same coveralls and equipment as described in 13.3.1.1 or as required in procedures specific to the subject equipment and operations.	**C**		
13.3.1.3. Sweaters and jackets shall not be worn as outer garments over protective coveralls.	**C**		
13.3.1.4. When solid and/or liquid propellants are present, smocks shall not be used as a substitute for full body protection (coveralls).	**C**		
13.3.1.5. More stringent controls shall be used when deemed necessary the appropriate local safety authority.	**C**		
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.	**C**		
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:	**C**		
13.3.2.2.1. Static-producing materials shall not come into contact with a system having an installed EED or other ordnance.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.3.2.3. Further restrictions and testing requirements are provided in 10.5.	**C**		
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.	**C**		
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.	**C**		
13.3.4.1.2. Platforms and ladders shall be grounded when used in conjunction with vehicles and/or payloads containing ordnance.	**C**		
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. Wrists stats shall be required if proper grounding cannot be attained.	**C**		
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.	**C**		
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 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.	**C**		
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 10 kilohms and 1 megohm.	**C**		
13.3.4.2.3. To ensure grounding of personnel, conductive floors shall be verified in all ordnance and propellant operating facilities before operations.	**C**		
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.	**C**		
13.3.4.2.5. Static ground points shall be verified to have a resistance to ground of 10 ohms or less using the methods of measuring resistance to earth described in ANSI/IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.3.4.3.3. Metal shipping containers shall be grounded before opening the containers.	**C**		
13.3.4.3.4. Before removing an ordnance item from a shipping container, the specific ordnance item shall be grounded.	**C**		
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.	**C**		
13.4 ORDNANCE OPERATIONS	**I**		
13.4.1. Ordnance Operating Standards and Procedures Guidance	**I**		
13.4.1.1. Electroexplosive Device (EED) Categories – EEDs are categorized as follows: • Category A: EED/ordnance Electroexplosive devices or ordnance that, by the expenditure of their own energy, or because they initiate a chain of events, may cause injury or death to people or damage to property. • Category B EED/ordnance: Electroexplosive devices or ordnance that, by the expenditure of their own energy, or because they initiate a chain of events, will not cause serious injury or death to people or damage to property. *All category A ordnance operations on the ranges shall be monitored and approved by Range Safety. Category B ordnance and ordnance systems are not required to meet the design requirements of Volume 3, Chapter 13; however, all ordnance and ordnance systems shall meet the operations requirements of this volume.*	**C**		
13.4.1.2. Ordnance operations performed on Air Force property shall be conducted in accordance with AFMAN 91-201 and DoD 6055.9-STD. 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:	**C**		
13.4.1.2.1. Before Operation. Before initiation of any operation involving explosives, operating procedures shall be written and approved.	**C**		
13.4.1.2.2. Supervisory Responsibility. Supervisory personnel shall be responsible for enforcing provisions of all procedures used in their jurisdictions.	**C**		
13.4.1.2.3. Preparation	**I**		
13.4.1.2.3.1. Procedures shall be prepared by responsible personnel with knowledge of the operations involved.	**C**		
13.4.1.2.3.2. All items presented in the procedure and operational steps specified shall be checked for compliance with the standards of this document.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.4.1.2.3.3. The specific types of equipment and building or area in which the operation is to be conducted should be designated in the procedure, when applicable.	**C**		
13.4.1.2.3.4. Supplemental procedures or sections shall be written when similar operations in the same area involve differences in equipment or process.	**C**		
13.4.1.2.4. Audits	**C**		
13.4.1.2.4.1. An audit system shall be established that will evaluate routinely the adequacy, availability, and currency of procedures. Audits also should include an evaluation of operator knowledge and compliance with procedures.	**C**		
13.4.1.2.4.2. Groups conducting audits in conjunction with the Explosives Safety Officer (ESO) should include personnel from areas other than the operating department or division using the procedure.	**C**		
13.4.1.2.5. Content of Operating Procedures. The following is intended to specify procedures content, not format or organization. Each NASA facility/operating contractor can develop its own system for preparing safety procedures. Distribution of procedures shall be controlled to ensure that each operating area has the most current revision. Superseded or inactive procedures shall be removed from operating areas. No operation shall be performed with a superseded, inactive, or unapproved procedure.	**C**		
13.4.1.2.5.1. Approval. All new, revised, and inactive operating procedures shall be reviewed and approved prior to use. Levels of approval required should be based on the inherent risk in the operation and be established by appropriate local safety authority Explosives Safety Officer. Review and approval requirements shall include, as a minimum, line and safety organizations. Inactive (dormant for a year), new, or revised procedures shall have a dry run prior to submission for approval. A dry run is used to ensure procedures are valid.	**C**		
13.4.1.2.5.2. Operating Procedures	**I**		
13.4.1.2.5.2.1. Introduction. The introduction to procedures should include the following:	**C**		
13.4.1.2.5.2.1.1. A statement of the scope of the procedure, defining what facilities and equipment are covered.	**C**		
13.4.1.2.5.2.1.2. The name of the department and/or individual responsible for the operation.	**C**		
13.4.1.2.5.2.1.3. If the procedure serves as the basis for a deviation or waiver from any applicable standard, a statement to this effect and a specific reference to the standard involved.	**C**		
13.4.1.2.5.2.2. Safety. The safety section of the procedure should present the following information or reference a safety manual that specifies the requirements:	**C**		
13.4.1.2.5.2.2.1. General safety rules to be observed and techniques to be applied that will ensure safety of operations, prevent injury or illness to personnel, and prevent damage to equipment. In particular, this section of the Standard Operating Procedures (SOPs) should describe the personnel control features of the facility that protect personnel from exposure to hazardous operations, toxic materials, or tests.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.4.1.2.5.2.2.2. Personnel number and explosive weight limits.	**C**		
13.4.1.2.5.2.2.3. Additional or specific emergency controls not addressed by the facility emergency plan.	**C**		
13.4.1.2.5.2.2.4. A description of the work authorized by the procedure.	**C**		
13.4.1.2.5.2.2.5. Safety rules that are specific to the operation, e.g., color coding of components (if applicable).	**C**		
13.4.1.2.5.2.2.6. Protective equipment that must be used during the operation.	**C**		
13.4.1.2.5.2.2.7. Emergency controls applicable to the operation that are not considered in the General Operating Procedures.	**C**		
13.4.1.2.5.2.3. Operations	**I**		
13.4.1.2.5.2.3.1. The operations section should consist of sequential directions written or pictured in clear, concise steps that describe how to perform a particular operation.	**C**		
13.4.1.2.5.2.3.2. If a particular operation requires that no other operation be performed simultaneously in the same work area, this requirement shall be clearly stated in the procedure.	**C**		
13.4.1.2.5.2.3.3. Particular emphasis should be placed on safety interlocks and controls, and the proper use of these systems.	**C**		
13.4.1.3. All initiators are considered Category A until the PSWG, Range Safety and appropriate local safety authority concurs with the Category B designation.	**C**		
13.4.3. Ordnance Operations General Requirements	**I**		
13.4.3.1. All category A ordnance operations shall be monitored and approved by the appropriate local safety authority. Category B ordnance and ordnance systems are not required to meet the design requirements of Volume 3, Chapter 13; however all ordnance and ordnance systems shall comply with the operations requirements of this volume.	**C**		
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 property) shall be present during on-site ordnance activities.	**C**		
13.4.3.3. An appropriate local safety representative (Pad Safety on Air 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. *Note: Such ordnance operations include: The receipt of ordnance at the assembly and/or processing area; resistance and continuity checks; "No voltage" (stray voltage) checks; Category A ordnance installation and electrical connection; solid propellant work involving open grain; handling of liquid and solid propellant motors, segments, stages, or payloads; cycling and checkout of S&As or other safety devices; destruct system checks; any render-safe operations; ordnance removal; and launch operations.*	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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 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 Air Force property, a list of currently approved instruments shall be maintained by the Range Safety offices.	**C**		
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:	**C**		
13.4.3.6.1. The operation is covered by an approved procedure.	**C**		
13.4.3.6.2. Approved equipment is used.	**C**		
13.4.3.6.3. The system or subsystem is approved.	**C**		
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.	**C**		
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.	**C**		
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 Air Force property) in the event of a malfunction that requires render-safe actions or a mishap recovery effort:	**C**		
13.4.3.9.1. One complete set of shielding caps (current design).	**C**		
13.4.3.9.2. One set of safety pins.	**C**		
13.4.3.9.3. Special tools used in installing, removing, and safing the ordnance.	**C**		
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:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
13.4.4.1.1. All necessary controls are established.	**C**		
13.4.4.1.2. Test equipment and the system conform to a configuration approved by the appropriate local safety authority.	**C**		
13.4.4.1.3. For RF susceptible ordnance distance separation requirements, refer to AFMAN 91-201 and NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.	**C**		
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.	**C**		
13.4.4.1.5. Personnel and explosives limits are enforced.	**C**		
13.4.4.1.6. Proper safety clearance zone has been established and cleared before starting the hazardous operation.	**C**		
13.4.4.1.7. Proper signs are posted, warning lights are operating, barricades are established, and Security/HOS is posted.	**C**		
13.4.4.1.8. Proper aural warnings and announcements have been made.	**C**		
13.4.4.1.9. All serial numbers, calibration dates, proof test dates, and other equipment requirements have been verified before operations.	**C**		
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.	**C**		
13.4.4.2.2. Requests to use alternate facilities shall be submitted in writing to the appropriate local safety authority.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
13.4.4.3.4. The power on check shall be performed anytime in the launch.	**C**		
13.4.4.3.5. The power off configuration requires the launch vehicle and payload to be powered down.	**C**		
13.4.4.3.6. Power off checks shall be made immediately before ordnance electrical connection.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.4.4.3.8. Shielding caps shall not be removed from EEDs until electrical connection to the ordnance is to be made.	**C**		
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.	**C**		
13.4.4.3.10. Meters that are used for no voltage checks shall have a valid calibration seal.	**C**		
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.	**C**		
13.4.4.3.12. The use of computerized no-voltage meters is acceptable if proper current-limiting can be demonstrated.	**C**		
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).	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.4.5.4. Ordnance items, particularly Category A initiators, shall be installed and electrically connected as late in processing flow as practical.	**C**		
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.	**C**		
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:	**C**		
13.4.5.6.1. Single complete rotation test (safe to arm to safe).	**C**		
13.4.5.6.2. Final rotation to arm on the last day of the count.	**C**		
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.	**C**		
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.	**C**		
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:	**C**		
13.4.6.1.1. For unlimited personnel exposure during LIO tests - the system shall contain three independent verifiable circuit inhibits (dual-failure tolerance).	**C**		
13.4.6.1.2. For essential personnel exposure during LIO tests - the system shall contain two independent circuit inhibits (single-failure tolerance).	**C**		
13.4.6.1.3. For no personnel exposure during LIO tests - the system shall contain one circuit inhibit.	**C**		
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).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
13.5.2. Obtaining AF EOD Services. AF EOD services may be obtained by calling Cape Support (853-5211) or PAFB Command Post (494-7001) on the ER or Range Scheduling (606-8825) on the WR.	**C**		
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.	**C**		
13.5.3.2. This approval and/or certification shall accompany the shipment.	**C**		
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.	**C**		
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.	**C**		
13.6.2. Ordnance deliveries from storage to the payload project shall be coordinated with the appropriate local safety authority.	**C**		
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 Air Force facilities, AFMAN 91-201, DoD 6055.9-STD, sub tier documents, and this publication.	**C**		
13.6.4. All operations and activities within an explosives sited facility shall be related and require the appropriate local safety authority approval.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
14.1.1.3. Maintenance of electric power systems shall be in accordance with AFI 32-1063, Electrical Power Systems.	**C**		
14.1.1.4. Maintenance of grounding systems shall be in accordance with AFI 32-1065, Grounding Systems.	**C**		
14.1.2. Electrical Equipment Operations in Hazardous (Classified) Locations	**I**		
See Volume 3, Attachment 3 for a Hazardous Area Classification decision flow path.	**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.	**C**		
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 (see Attachment 3 of Volume 3 for a flow path for classifying hazardous areas).	**C**		
14.1.2.2.1. Class I, Division 1. Complete definitions of classified locations are found in NFPA 70. These include the following locations:	**C**		
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.	**C**		
14.1.2.2.1.2. Below grade locations in a Class I, Division 2 area.	**C**		
14.1.2.2.1.3. Locations in which flammable liquids, vapors, or gases may be present in the air during normal operations.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.1.2.2.2. Class I, Division 2. Complete definitions of classified locations are found in NFPA 70. These include the following locations:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
14.1.2.2.2.4. Class I, Division 2 locations include the following equipment or areas:	**C**		
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).	**C**		
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).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
14.1.2.2.3. Hazardous Commodity Groups. Hazardous commodities are grouped by similar characteristics.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.1.2.2.3.1. These fuels shall be considered ignitable regardless of the ambient temperature.	**C**		
14.1.2.2.3.2. The following fuels shall be categorized as follows:	**C**		
14.1.2.2.3.2.1. Group B: Liquid or gaseous hydrogen.	**C**		
14.1.2.2.3.2.2. Group C: Hypergolic fuels such as N2H4, MMH, UDMH, A50.	**C**		
14.1.2.2.3.2.3. Group D: Hydrocarbon fuels (RP and JP).	**C**		
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.	**C**		
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:	**C**		
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.	**C**		
14.1.2.2.3.2.5.2. The motor nozzle is attached but does not have a nozzle plug.	**C**		
14.1.2.2.3.2.5.3. The unassembled motor segments do not have front and rear covers.	**C**		
14.1.2.2.3.2.5.4. The igniter is removed from the motor and cover is not provided.	**C**		
14.1.2.3. Personnel wearing conductive grounding devices shall not operate electrically powered devices which could result in a shock hazard.	**C**		
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.	**C**		
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.	**C**		
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:	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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).	**C**		
14.1.3.2.6. The camera shall be tethered to the photographer.	**C**		
14.1.3.2.7. Photography using heat-producing, expendable flash bulbs such as flash cubes and sun guns are not permitted within 100 feet of hazardous liquid propellant systems or solid propellant grain.	**C**		
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.	**C**		
14.1.3.2.9. The maximum operating temperature of the camera and/or flash attachment shall not exceed 80 percent of the ignition temperature for any vapor that may occur in the operating environment of the photography equipment.	**C**		
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.	**C**		
14.1.3.2.11. Photo equipment shall not be stored in the Class I, Division 2 area.	**C**		
14.1.3.2.12. Photo equipment shall be removed from the Class I, Division 2 area before any operation that could cause an increase in the hazardous environment.	**C**		
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.	**C**		
14.2.2. Special insulated equipment includes, but is not limited to, the following:	**C**		
14.2.2.1. Insulated hook sticks for opening and closing disconnect switches.	**C**		
14.2.2.2. Insulated fuse sticks for removing and installing cartridge-type fuses.	**C**		
14.2.2.3. Rubber insulating sleeves and gloves.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.2.2.4. Rubber insulation floor mats.	C		
14.2.2.5. Rubber insulating line conductor hose.	C		
14.2.2.6. Dielectric hard hats.	C		
14.3 ELECTRICAL SYSTEMS PROCEDURES	I		
14.3.1. Procedures shall be written for all electrical maintenance and repair work.	C		
14.3.2. Procedures shall include, but not be limited to, the following topics:	C		
14.3.2.1. Tagging and locking out control switches.	C		
14.3.2.2. Use of approved non-conductive fuse pullers.	C		
14.3.2.3. Provision and use of PPE.	C		
14.3.2.4. Grounding of equipment and personnel.	C		
14.3.2.5. Use of the buddy system (mandatory when working on energized equipment and circuits).	C		
14.3.2.6. Safety precautions to be followed when working on energized equipment and circuits.	C		
14.3.2.7. Fire protection and equipment.	C		
14.3.2.8. Knowledge of resuscitation procedures.	C		
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		
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.	C		
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.	C		
14.4.1.2. Ground Systems Test Plan and Test Frequency Criteria	I		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
14.4.1.2.3. Based on the floor plan, the following tests shall be conducted:	**C**		
14.4.1.2.3.1. Lightning protection system resistance to ground shall be tested annually to the following criteria:	**C**		
14.4.1.2.3.1.1. Ten ohms or less for the counterpoise system.	**C**		
14.4.1.2.3.1.2. Ten milliohms from the terminal to the counterpoise system.	**C**		
14.4.1.2.3.2. The lightning protection system shall be inspected visually and mechanically twice a year.	**C**		
14.4.1.2.3.3. The facility static/electrical ground system resistance shall be tested annually to a criteria of 10 ohms or less using the methods of measuring resistance to earth described in ANSI/IEEE-142.	**C**		
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 criteria of one ohm or less.	**C**		
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.	**C**		
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.	**C**		
14.4.1.2.3.7. Measuring devices such as megohm meters (meggers) shall be current-limited by the use of fuses or equivalent devices when the facility contains electrically connected EEDs.	**C**		
14.4.1.2.3.8. Test and inspection results shall be provided to the facility custodian and be available at the facility.	**C**		
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.	**C**		
14.4.3. Electrical Equipment Maintenance and Testing	**I**		
14.4.3.1. Electrical equipment shall be maintained in accordance with AFJMAN 32-1083, Facilities Engineering - Electrical Interior Facilities, and NFPA 70E.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.4.3.2. Conductors with worn, abraded, or defective insulating material shall be repaired or replaced before the circuit being energized.	**C**		
14.4.3.3. In addition to maintenance requirements in AFJMAN 32-1083, Chapter 15, electric motors shall be properly maintained and excess dust and oil shall be removed from motors by vacuum cleaning or wiping.	**C**		
14.4.3.4. Electrical system interior inspection and testing of wiring, power circuit breakers, and protective relaying shall be accomplished in accordance with AFJMAN 32-1083, Chapter 14 and 15 with testing intervals not to exceed two years.	**C**		
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 8715.3, NASA General Safety Program Requirements; and AFI 32-1064. Particular attention shall be given to the following:	**C**		
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 not wear conductive grounding devices.	**C**		
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.	**C**		
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).	**C**		
14.5.1.4. Rescue and first aid equipment shall be readily available in areas where electrical maintenance and repair work is being performed.	**C**		
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.	**C**		
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.	**C**		
14.5.1.7. Only listed explosion and/or hazard-proofed test and maintenance equipment shall be used in potentially hazardous atmospheres.	**C**		
14.5.1.8. Before working on capacitor circuitry, external power and short terminals shall be disconnected and discharged to ground.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.5.1.9. If temporary power lines are required to extend across outside work areas, they shall be protected by a wooden cover or elevated so as not to interfere with personnel, vehicles, or equipment traffic.	**C**		
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.	**C**		
14.5.1.11. Dead-end wires shall be completely insulated.	**C**		
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.	**C**		
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.	**C**		
14.5.1.14. Electrical equipment that must remain energized for hazardous operations (i.e., maintaining spacecraft thrusters solenoid valves in an opened or closed state) shall be equipped with an uninterrupted power source such as a battery backup.	**C**		
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.	**C**		
14.5.2.2. Power outages in facilities shall be coordinated with the affected parties.	**C**		
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.	**C**		
14.5.2.4. Electrical conductors shall be routed to eliminate tripping hazards or contact with energized lines.	**C**		
14.5.3. Electrical Systems Operating Requirements	**I**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
14.6.1.2. The means of disposal shall be in accordance with DOT and EPA requirements and carry DOT and EPA approvals.	**C**		
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.	**C**		
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 ANSI Z358.1, Emergency Eyewash and Shower Equipment.	**C**		
14.6.2.2.1.2. An emergency first aid kit, containing a burn neutralizer shall be provided.	**C**		
14.6.2.2.2. PPE	**I**		
14.6.2.2.2.1. The following PPE shall be provided in accordance with OSHA and used when servicing or handling batteries:	**C**		
14.6.2.2.2.1.1. Front and side face and eye protection.	**C**		
14.6.2.2.2.1.2. Rubber gloves.	**C**		
14.6.2.2.2.1.3. Rubber apron.	**C**		
14.6.2.2.2.1.4. Foot protection.	**C**		
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.	**C**		
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.	**C**		
14.6.3.2. Specific safing operations of batteries shall be in battery handling and checkout procedures.	**C**		
14.6.3.3. Battery handling and checkout procedures shall include the following topics:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
14.6.3.3.1. A list of proper handling equipment.	**C**		
14.6.3.3.2. Identification of specific personnel qualified to safe batteries if in an unsafe condition.	**C**		
14.6.3.3.3. Identification of the exact location of the storage site of depleted or unsafe batteries.	**C**		
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**		
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.	**C**		
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.	**C**		
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.	**C**		
14.6.5. Battery Maintenance, Storage, and Operations	**I**		
14.6.5.1. Rechargeable storage batteries and batteries requiring activation shall be handled only in designated battery shops and areas equipped for servicing and recharging.	**C**		
14.6.5.2. Separate areas shall be provided for servicing of batteries that have incompatible electrolytic solutions; for example, acid and alkaline.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 15 MOTOR VEHICLE OPERATIONS	**I**		
15.1 MOTOR VEHICLE OPERATING STANDARDS All vehicle operations shall comply with federal and state laws and Air Force and range regulations, including but not limited to the following criteria:	**C**		
15.1.1. Proper licensing of operators.	**C**		
15.1.2. The use of vehicle restraint devices such as seat belts.	**C**		
15.1.3. Restrictions on wearing headphones or ear speaker type radios while operating a vehicle.	**C**		
15.1.4. The use of spotters when backing with restricted rear vision vehicles.	**C**		
15.2 MOTOR VEHICLE OPERATING REQUIREMENTS	**I**		
15.2.1. Operator Instructions	**C**		
15.2.1.1. Maneuvering in the vicinity of hazardous commodities requires the use of a spotter.	**C**		
15.2.1.2. When backing, chocks shall be used to prevent contact.	**C**		
15.2.2. Indoor Operations. Gasoline or diesel vehicle operations in buildings shall require the approval of the Industrial Hygiene and/or Bioenvironmental Engineer.	**C**		
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.)	**C**		
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 8715.3, NASA General Safety Program Requirements; AFMAN 91-201, and DoD 6055.9-STD.	**C**		
15.2.3.2. General Parking Restrictions	**C**		
15.2.3.2.1. Designated parking areas shall be used.	**C**		
15.2.3.2.2. Privately owned vehicles shall not be parked within the fenced-in area of hazardous processing facilities.	**C**		
15.2.3.2.3. No vehicle shall be parked within 25 feet of lines containing liquid propellants.	**C**		
15.2.3.2.4. No vehicle shall be parked within 50 feet of storage tanks containing liquid propellants.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
15.2.3.2.6. While parked, the parking brake shall be engaged and wheels shall be chocked.	**C**		
15.2.3.3. Restricted Parking Areas. All non-essential vehicles are prohibited from parking in the following areas under the following conditions:	**C**		
15.2.3.3.1. Within the flight hazard area (FHA) once the FHA has been established.	**C**		
15.2.3.3.2. In the blast danger area (BDA) during wet dress rehearsal (cryogen tanking).	**C**		
15.2.3.3.3. Within the FHA during core vehicle tanking (other than cryogens that are tanked) after the BDA/FHA is established.	**C**		
15.2.3.3.4. Within the launch complex fence line during fueled spacecraft/upperstage mating operations.	**C**		
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:	**C**		
15.2.4.1. When transporting explosives that have exposed grain, scrap, waste or items visibly contaminated with explosives.	**C**		
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.	**C**		
15.2.5. Hazardous Commodities Vehicle Transportation Standards. Vehicles transporting hazardous commodities shall meet DOT and DoD (for example, AFMAN 91-201 and DoD 6055.9-STD) regulations unless exempted or approved for use by Range Safety or for non-AF Ranges, the appropriate local safety authority.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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) is considered a hazardous operation.	**C**		
16.1.3. All convoys shall be conducted in accordance with AFJMAN 24-306, Manual for the Wheeled Vehicle Driver.	**C**		
16.1.4. All convoy and convoy operations shall be in accordance with DOT requirements.	**C**		
16.1.5. At the WR, all convoys shall be conducted in accordance with 30 SW 31-101, Convoy Operations.	**C**		
16.2 CONVOY OPERATIONS PROCEDURES A procedure for convoy operations shall be submitted to the appropriate local safety authority for review and approval.	**C**		
16.3 CONVOY OPERATIONS REQUIREMENTS The payload project and/or the agencies responsible for the transportation of a load shall ensure the following items are performed:	**C**		
16.3.1. The load or commodity to be transported shall be identified.	**C**		
16.3.2. The convoy shall be scheduled through the appropriate local safety authority [CCAFS Cape Support (321-853-5211) at the ER and through Range Scheduling (805-606-8825) at the WR].	**C**		
16.3.3. A convoy commander shall be designated.	**C**		
16.3.4. If flight hardware or hazardous commodities are involved, a Security/HOS escort shall be arranged.	**C**		
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.	**C**		
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.	**C**		
16.3.7. The selected route shall be identified and the following items noted/documented:	**C**		
16.3.7.1. Horizontal and vertical clearances (i.e., bridges, construction, power lines, trees, signs, walls, railings, barriers, etc.).	**C**		
16.3.7.2. The hazardous commodity transported.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
16.3.7.3. Population along the route.	**C**		
16.3.7.4. Traffic that may be encountered.	**C**		
16.3.7.5. Condition of surface being traveled upon.	**C**		
16.3.7.6. Distance of route.	**C**		
16.3.8. Radio contact shall be maintained with the convoy commander for all elements of the convoy.	**C**		
16.3.9. At a minimum, the following items of equipment are required:	**C**		
16.3.9.1. Flashlights if transport occurs during periods of darkness.	**C**		
16.3.9.2. Emergency apparatus such as fire extinguishing equipment, reflectors, and flares.	**C**		
16.3.10. Proper environmental health required by the commodity transported shall be ensured.	**C**		
16.3.11. Areas shall be cordoned off as required by the appropriate local safety authority.	**C**		
16.3.12. Emergency actions shall be taken to secure the item being transported in the event of a mishap.	**C**		
16.3.13. A pre-operational check of the loaded vehicle and trailer shall be conducted.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
CHAPTER 17 LAUNCH OPERATIONS To view Launch Operations criteria, please see AFSPCMAN 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 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.	**C**		
18.2 SOLID ROCKET MOTOR AND ROCKET MOTOR SEGMENT TRANSPORTATION	**I**		
18.2.1. 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.	**C**		
18.2.2. 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.	**C**		
Diesel powered generators are preferred due to much lower flammability of the diesel fuel.	**I**		
18.2.3. 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.	**C**		
18.2.4. 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).	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
18.2.5. 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.	**C**		
18.2.6. Locomotives and tractors that transport solid rocket motor/segment cars and trailers shall be removed from processing facilities as soon as possible.	**C**		
18.2.7. 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.	**C**		
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. 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.	**C**		
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**		
18.3.2. 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.	**C**		
Protective measures, such as blankets, should be used to shield solid rocket motors/segments from damage during transport and storage where practical.	**I**		
18.3.3. 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.	**C**		
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**		
18.3.4. Extreme care shall be taken when inspecting and handling igniters.	**C**		
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**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
18.3.5. 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.	**C**		
18.3.6. For open grain inspections, wrist stats shall be used within five feet of the open grain.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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 exits at all times. Shipping containers shall be removed from the processing facility immediately as soon as possible after unpacking the hardware.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
18.4.1.13. Waste collection dumpsters shall not be located inside solid rocket motor/segment processing and storage facilities.	**C**		
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.	**C**		
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.	**C**		
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-aways.	**C**		
Vertical storage of built-up rocket motors is undesirable unless they are mated to the core vehicle.	**I**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
18.4.2.3. For open grain work, wriststats 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.	**C**		
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.	**C**		
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).	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 1 GROUND OPERATIONS PLANS	**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).	**C**		
A1.1.2. Content. This attachment contains the content preparation instructions for the data generated by the requirements delineated in Volume 6.	**C**		
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.	**C**		
A1.1.4. Submittal Process. The GOP submittal periods are delineated in NPR 8715.7 and 4.1 of Volume 6.	**C**		
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.	**C**		
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.	**C**		
A1.2.2. Format. Payload project format is acceptable provided the information described below is provided.	**C**		
A1.2.2.1. Table of Contents and Glossary. The GOP shall contain a table of contents and a glossary.	**C**		
A1.2.2.2. Introduction. The "introduction" section shall address the purpose and scope of the GOP.	**C**		
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:	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.2.3.1. General flow of system integration and testing.	**C**		
A1.2.2.3.2. Facilities to be used.	**C**		
A1.2.2.3.3. Generic timeline with sufficient granularity to identify the major hazardous and/or FTS operations.	**C**		
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:	**C**		
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.	**C**		
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.	**C**		
A1.2.2.4.3. Procedure Task Summaries. Task summaries for each procedure shall include the following information:	**C**		
A1.2.2.4.3.1. Each separate task.	**C**		
A1.2.2.4.3.2. Responsible agency.	**C**		
A1.2.2.4.3.3. Objective.	**C**		
A1.2.2.4.3.4. Initial and final configuration.	**C**		
A1.2.2.4.3.5. Equipment and support required.	**C**		
A1.2.2.4.3.6. Description.	**C**		
A1.2.2.4.3.7. Hazards and precautions.	**C**		
A1.2.2.4.3.8. List of approved PPE and detection equipment used in ground operations.	**C**		
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:	**C**		
A1.2.2.4.4.1. Identifier for each procedure.	**C**		
A1.2.2.4.4.2. Procedure number.	**C**		
A1.2.2.4.4.3. Hazardous, non-hazardous, or safety critical designation.	**C**		
A1.2.2.4.4.4. Task summary number(s).	**C**		
A1.2.2.4.5. Identification of emergency and abort/back-out actions.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.2.4.6. A list of personnel training, certification, 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.	**C**		
A1.2.2.5. Off-Site Processing. The "off-site processing" section shall include the following information:	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
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.	**C**		
A1.2.2.6.2. O&SHAs shall be conducted for activities such as testing, installation, maintenance, support, transportation, storage, operations, and training.	**C**		
A1.2.2.6.3. O&SHAs shall coincide with the flow chart task summaries in A1.2.2.4.	**C**		
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:	**C**		
A1.2.2.6.4.1. The general hazard group.	**C**		
A1.2.2.6.4.2. The specific hazard condition.	**C**		
A1.2.2.6.4.3. The effect if the hazard is not controlled.	**C**		
A1.2.2.6.4.4. Hazard control hardware.	**C**		
A1.2.2.6.4.5. The hazard control procedure.	**C**		
A1.2.2.6.4.6. Hazard control personnel.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A1.2.2.6.4.7. Reference to the flow block task number. *Note: NF 1825 The NASA ELV Payload Safety Hazard Report Form found on the ELV Payload Safety Program's website at: http://kscsma.ksc.nasa.gov/ELVPayloadSafety under the ELV Payload Safety Forms button should be used to record all identified hazards.*	**C**		
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.	**C**		
A1.2.2.7.1. Payload Project Training Plan.	**C**		
A1.2.2.7.2. Accident Notification Plan.	**C**		
A1.2.2.7.3. Emergency Response Plans for Graphite Epoxy Composite Overwrapped Pressure Vessels.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 2 HAZARDOUS AND SAFETY CRITICAL PROCEDURES	**I**		
A2.1 INTRODUCTION	**I**		
A2.1.1. Determination of Hazardous and Safety Critical 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 procedure 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 hazardous, non-hazardous, and safety critical procedures. Once the classification of hazardous, non-hazardous, and safety critical is determined, the procedures are submitted to the local safety authority for review and approval as described in the documentation part of this volume. The PSWG and Range Safety shall determine if select local safety authority notification or attendance shall be required during review of the initial draft procedures. During review of the initial draft procedures that will take place on an Air Force range, Range Safety shall determine if Pad Safety notification or attendance shall be required. The review of the draft procedures allows a second opportunity to ensure the classification is appropriate.	**C**		
A2.1.2. Purpose. Hazardous and safety critical procedures 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.	**C**		
A2.1.3. Content. This attachment contains the content preparation instructions for the data generated by the requirements delineated in Volume 6 of this document.	**C**		
A2.1.4. Applicability. This attachment is applicable to the following:	**C**		
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.	**C**		
A2.1.4.2. Construction and management contracts for hazardous facilities.	**C**		
A2.1.5. Submittal Process. The hazardous procedure 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 Air Force Ranges, the hazardous procedure submittal process is as follows:	**C**		
A2.1.5.1. One copy of procedures involving hazardous or safety critical operations shall be submitted to Range Safety for review and approval 55 days prior to the operation. For operations on Air 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 Range User shall review, approve, and sign the final procedures to be submitted to Range Safety or the appropriate local safety authority for approval.	**C**		
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 the procedure.	**C**		
A2.1.6. Final Approval. Hazardous and safety critical procedures shall be approved before starting any hazardous or safety critical operations at the payload processing facility and launch site area.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2 PREPARATION INSTRUCTIONS	**I**		
A2.2.1. Content. Hazardous or safety critical procedures shall be written in a manner complying with local requirements. 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.	**C**		
A2.2.2. Cover Page	**I**		
A2.2.2.1. A cover page with the procedure title and required approval signatures, to include the Payload Organization Safety Engineer and date shall be provided. The signature page shall contain a block for signature approval by the appropriate safety authority.	**C**		
A2.2.2.2. The words Draft or Preliminary shall appear on any signed procedure that does not have the required safety approval.	**C**		
A2.2.2.3. The cover sheet shall state "Warning: This Procedure Contains Hazardous (or Safety Critical) Operations" and shall be outlined with a border and marked in bold print.	**C**		
A2.2.2.4. The cover sheet shall indicate revision level.	**C**		
A2.2.3. Purpose Section	**I**		
A2.2.3.1. The "purpose" section shall provide a brief synopsis of all major tasks in each operating procedure.	**C**		
A2.2.3.2. The synopsis shall include the following information:	**C**		
A2.2.3.2.1. A brief description of the tasks, operations, tests, or checkouts to be performed.	**C**		
A2.2.3.2.2. The facility and area where the procedure is to take place.	**C**		
A2.2.3.2.3. The departure and arrival locations if transportation is required.	**C**		
A2.2.3.2.4. For launch vehicle and payload tests, when the test is normally performed in relation to launch day (for example, L-5).	**C**		
A2.2.4. Identification of Specific Hazards. The following specific hazards shall be identified in each procedure:	**C**		
A2.2.4.1. The quantity and hazard classification of ordnance and propellants involved.	**C**		
A2.2.4.2. The hazardous and non-hazardous configurations of the system before, during, and upon completion of the operation.	**C**		
A2.2.5. 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:	**C**		
A2.2.5.1. Warnings.	**C**		
A2.2.5.2. Cautions.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.5.3. Note inhibits.	**C**		
A2.2.5.4. Safety devices.	**C**		
A2.2.5.5. Control areas.	**C**		
A2.2.6. Facility Configuration Inspections. The procedure shall indicate the specific facility and safety clearance zone control area to be used.	**C**		
A2.2.6.1. The requirements for the performance of facility configuration inspections shall be incorporated in the procedures.	**C**		
A2.2.6.2. The facility configuration inspection requirements shall address verification of the following:	**C**		
A2.2.6.2.1. Facility explosive limits.	**C**		
A2.2.6.2.2. Facility personnel limits.	**C**		
A2.2.6.2.3. Posting of fire symbols when ordnance and propellants are moved into or out of a facility.	**C**		
A2.2.7. PPE and Emergency Equipment	**I**		
A2.2.7.1. PPE, fit testing, and emergency equipment requirements for each operation shall be incorporated in hazardous procedures.	**C**		
A2.2.7.2. The PPE and emergency equipment shall address the following:	**C**		
A2.2.7.2.1. PPE requirements according to the manufacturer model number, MIL-SPEC, or standard for compliance.	**C**		
A2.2.7.2.2. The occasions for the use of PPE.	**C**		
A2.2.7.2.3. Types of emergency equipment required.	**C**		
A2.2.7.2.4. Location of the emergency equipment during the operation.	**C**		
A2.2.7.2.5. The number of emergency equipment units required. No substitution or configuration alteration of PPE shall be allowed without specific appropriate local safety approval.	**C**		
A2.2.8. Pre-Operational Checklist of Required Tools and Equipment	**I**		
A2.2.8.1. A pre-operational checklist of all tools and equipment required for safe operations shall be incorporated in the procedures.	**C**		
A2.2.8.2. For safety critical equipment, the following information shall be included:	**C**		
A2.2.8.2.1. Manufacturer, model, and serial number.	**C**		
A2.2.8.2.2. Location of the equipment during the operation.	**C**		
A2.2.8.2.3. The number of units required.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.8.2.4. The required monitoring devices and their alarm settings.	**C**		
A2.2.8.2.5. Proof test requirements.	**C**		
A2.2.8.2.6. Nondestructive examination requirements.	**C**		
A2.2.8.2.7. Calibration requirements.	**C**		
A2.2.9. Support Personnel Requirements	**I**		
A2.2.9.1. 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.	**C**		
A2.2.9.2. The following support personnel requirements shall be addressed:	**C**		
A2.2.9.2.1. The hazardous periods when personnel limits shall be enforced.	**C**		
A2.2.9.2.2. The minimum essential personnel by functional title and number required.	**C**		
A2.2.9.2.3. 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.	**C**		
A2.2.9.2.4. Special training, certifications, or experience requirements.	**C**		
A2.2.10. References to Applicable Documents	**I**		
A2.2.10.1. All applicable documents, drawings, and specifications shall be referenced in the procedures.	**C**		
A2.2.10.2. If a specific operations safety plan or other safety plans apply to the procedure, they shall be listed in the procedure reference section.	**C**		
A2.2.10.3. This document and AFSPCMAN 91-710 shall be listed in the procedures.	**C**		
A2.2.10.4. Procedures shall not use excessive second tier references.	**C**		
Use of excessive second tier references means to incorporate references in such volume that the meaning is lost and use of the procedure becomes confusing, unnecessarily complex, or irrelevant.	**I**		
A2.2.11. CCAFS 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. CCAFS Cape Support (321-853-5211) and Range Scheduling (321-853-5941) on the ER and Range Scheduling (805-606-8825) on the WR.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.12. Pre-Task Briefing	**I**		
A2.2.12.1. A step for the conduct of a pre-task briefing shall be incorporated in the procedures.	**C**		
A2.2.12.2. The following topics shall be addressed:	**C**		
A2.2.12.2.1. Operational hazards.	**C**		
A2.2.12.2.2. Precautions.	**C**		
A2.2.12.2.3. Emergency actions.	**C**		
A2.2.12.2.4. Critical task items.	**C**		
A2.2.12.2.5. Procedure flow.	**C**		
A2.2.12.2.6. Operational discipline.	**C**		
A2.2.12.2.7. Communication discipline.	**C**		
A2.2.12.3. Specification that the briefing shall be repeated if a shift change is required.	**C**		
A2.2.13. Step-by-Step Directions	**I**		
A2.2.13.1. Step-by-step directions, written in clear language, with sufficient detail to allow a qualified technician or mechanic to clearly understand and follow them, shall be incorporated.	**C**		
A2.2.13.2. The procedure shall contain applicable data sheets, figures, and schematics to document or clarify system parameters and connect points.	**C**		
A2.2.14. Identification of Hazardous and Safety Critical Portions of Procedures	**I**		
A2.2.14.1. The beginning and end of a hazardous or safety critical portion of a procedure shall be incorporated according to the following criteria:	**C**		
A2.2.14.1.1. A “Warning” shall be used to identify hazards to personnel.	**C**		
A2.2.14.1.2. A “Caution” shall be used to identify hazards to equipment.	**C**		
A2.2.14.1.3. A “Note” shall be used to indicate an operating procedure of such importance that it must be emphasized.	**C**		
A2.2.14.2. 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.	**C**		
A2.2.14.3. 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.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
A2.2.15. 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.	**C**		
A2.2.16. 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:	**C**		
A2.2.16.1. Need Date (minimum of 55 calendar days review time required).	**C**		
A2.2.16.2. Procedure title and number.	**C**		
A2.2.16.3. Program identified or other identifier to ensure that the proper safety point of contact receives the procedure.	**C**		
A2.2.16.4. Special instructions for such items as review and comment and final copy for filing.	**C**		
A2.2.16.5. 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."	**C**		
A2.2.16.6. If the procedure has been previously submitted as a draft or with a different revision number, clarification of the extent of the changes.	**C**		
A2.3 EXAMPLES OF HAZARDOUS PROCEDURES Examples of hazardous procedures include, but are not limited to, the following topics: (1) Pressurized propellant systems - pressurization (pneumastat and hydrostat), loading and unloading, sampling, leak testing, venting. (2) Launch vehicle and payload systems - pressurization, loading and unloading, leak test, erection and lifting with ordnance and/or propellant, application of power with ordnance and/or propellant, safe and arm pin removal, mate and demate operation. (3) Hazardous facilities - high pressure systems, propellant flows in ground systems, propellant cart loading, ordnance checkout and installation, X-ray operations, cryogenic operations, fixture proof tests, emergency blackout procedures. (4) Ordnance - bore scope, X-ray, continuity test, propellant trimming, installation, electrical connection and disconnection. (5) Work involving lasers, high energy RF emissions, radioactive materials, and hazardous materials.	**I**		
A2.4 CHANGES. Changes to previously submitted procedures shall be noted with change bars or a similar method of marking.	**C**		

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 3 INDEX OF OPERATIONS/AREAS SAFETY PLANS	I		

Eastern Range Operations Safety Plans

A3.1.1. Atlas V Program Operations Safety Plans (approval pending).
A3.1.2. ATLAS/CENTAUR Complex 36 Operations Safety Plan.
A3.1.3. DELTA II AREA 55 Safety Plans and SOPs.
A3.1.4. DELTA II AREA 57 Safety Plan and SOPs (Solid Motor Facility).
A3.1.5. DELTA II COMPLEX 17 Operations Safety Plan and Safety Operations Plans (SOPs).
A3.1.6. DELTA II HANGAR M AREA Safety Plans and SOPs.
A3.1.7. DELTA II HAZARDS PROCESSING FACILITY AREA Safety Plan/SOP.
A3.1.8. Delta IV Complex 37 Operations Safety Plan.
A3.1.9. Delta IV Processing Solid Rocket Motors at the RIS and SRS Operations Safety Plan.
A3.1.10. Delta Launch Vehicles at Horizontal Integration Facility (HIF) Operations Safety Plan.
A3.1.11. DELTA VEHICLE at the Booster Processing Facility Operations Safety Plan.
A3.1.12. DSCS PROCESSING Facility Operations Safety Plan.
A3.1.13. Hanger AO/ Delta Storage Facility Operations Safety Plan.
A3.1.14. LOCC Operations Safety Plan
A3.1.15. NAVSTAR Processing Facility Safety Plan.
A3.1.16. Operations Safety Plan for METEOROLOGICAL ROCKETS.
A3.1.17. Payload Spin Test Facility Safety Plan.
A3.1.18. Propellant Conditioning Facility Safety Plan.
A3.1.19. Propellant Servicing Facility Safety Plan.
A3.1.21. SLC-46 Commercial Assembly and Launch Operations, OSP and Safety Operating Plans.
A3.1.22. Solid Motor Assembly and Readiness Facility Operations Safety Plan.
A3.1.23. Solid Motor Assembly Building Operations Safety Plan.
A3.1.24. Spacecraft Processing and Integration Facility Operations Safety Plan.
A3.1.25. TITAN IV COMPLEX 40 Operations Safety Plan and SOPs.
A3.1.26. TRIDENT I (C4)/II (D5) Operations Safety Plan.
A3.1.27. X-Ray Facility Operations Safety Plan.

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
Western Range Operations Safety Plans A3.2.1. LMSC Building 3000 Safety Plans. A3.2.2. SLC-4 Launch Complex Safety Plan. A3.2.3. Lockheed Martin Astronautics Integrated Safety Plan for SLC-3E and SLC-3W. A3.2.4. NASA Ground Safety Plan Off-Site Facility. A3.2.5. Integration Processing Facility Safety Plan Space Launch Complex 6. A3.2.6. Integration Processing Facility (IPF) Safety Plan. A3.2.7. Astrotech Space Operations, L.P. Safety Standard Operating Procedure at VAFB. A3.2.8. Orbital Sciences Corporation Space Systems Division Facility Safety Plan for VAFB. A3.2.9. Delta, SLC-2 VTC Safety Plan. A3.2.10. United Paradyne Corporation Operations Safety Plan. A3.2.11. Taurus and OSP/TLV Launch Vehicle Safety Plan TD 2401 Rev. G. A3.2.12. National Missile Defense VAFB Ground Operations Plan. A3.2.13. Pegasus Facility Safety Plan TD 0193 Rev E. A3.2.14. MSLS Launch Complex Safety Plan. A3.2.15. California Spaceport Space Launch Facility Safety Plan. *Note: Additional plans shall be developed for facilities, systems, and operations as needed*			

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 4 INDEX OF EXPLOSIVE (OPERATING AND AREA) SAFETY PLANS	**I**		
1 Conducting Scheduled Inspections of Explosives and Propellant Facilities on CCAFS and Downrange Stations.			
2 Disposition of Unserviceable, Obsolete, Excess, and Suspended Ordnance Items.			
201 Fuel Storage Area l (FSA-1.			
302 Handling Explosives at CCAFS Wharves.			
303 Loading and Unloading Aircraft with Explosives or Other Hazardous Material at CCAFS Auxiliary Air Field.			
304 Loading and Unloading Aircraft with Explosives at Downrange Bases.			
307 HANDLING TRIDENT Missile Motors between the TITAN ITL Transfer Dock.			
308 Handling OTTO Fuel.			
310 Handling Commercial Solid Rocket Motors at the Titan ITL Transfer Dock.			
501 Demonstrations Involving Explosives.			
502 Conducting Hazardous Operations in Explosives Operating Buildings.			
601 Storage of Explosives at Downrange Bases.			
901 Transporting Explosives at CCAFS.			
902 Transporting Explosives at Downrange Bases.			
903 Motor Vehicle Transportation of Liquid Propellants and other Hazardous Chemicals at CCAFS.			
Note: Additional plans shall be developed for facilities, systems, and operations as needed.			

ORIGINAL TEXT	STATUS	TAILORED TEXT	RATIONALE/ COMMENTS
ATTACHMENT 5 MISCELLANEOUS SAFETY PLANS	**I**		
ER Miscellaneous Safety Plans A5.1.1. Cape Canaveral Spaceport Consolidated Comprehensive Emergency Management Plan (CCEMP). A5.1.2. Danger Area Information Plan. A5.1.3. SOP for Hazardous Material Debris Water Recovery Operation. **WR Miscellaneous Safety Plans:** A5.2.1. 30 SWI 91-101 for 30 SW LDCG. A5.2.2. Launch Support Plans. A5.2.3. 30 SWI 91-106 for Toxic Hazard Assessments. A5.2.4. AFI 91-110 30 SW Sup 1 for Ionizing Radiation and Radioactive Material. A5.2.5. 30 SWI 91-119 for Process Safety Management. A5.3.1. KNPR 8715.2 Comprehensive Emergency Management Plan (CEMP)			
ATTACHMENT 7 LAUNCH COMMIT CRITERIA (To view Range Safety Launch Commit Criteria please see AFSPCMAN 91-710)	**C**		

From: NASA-STD-8719.24 Annex Rev. A

VOLUME 7: GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

10 CFR	Energy
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 1910.95	Occupational Noise Exposure
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 1910.169	Air Receivers
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 1910.1200	Hazard Communication
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.105	Safety Nets
29 CFR 1926.550	Cranes and Derricks
29 CFR 1926.550 (g)	Crane or Derrick Suspended Personnel Platforms
29 CFR 1960	Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters
30 SW OPLAN 32-1	Vandenberg Air Force Base Disaster Preparation Operations Plan
30 SW OPLAN 32-40020A	Hazardous Materials (HAZMAT) Emergency Response Plan
30 SW OPLAN 32-4002-C	Hazardous Materials (HAZMAT) Emergency Response
30 SWI Supplement 1, AFI 91-110	Radiation Protection Plan
30 SW 31-101	Convoy Operations

30 SWI 40-101	Managing Radioactive Materials on VAFB
30 SWI 48-102	Control of Radiofrequency Radiation
30 SWI 91-106	Toxic Hazard Assessments
40 CFR 68	Chemical Accident Prevention Provisions, Subpart G, Risk Management Plan
45 Space Wing	Launch Toxic Hazard Control Plan
45 and 30 Space Wing Operations Plan 19-14	Petroleum Products and Hazardous Waste Management Program
45 SPW/JOP 15E-3-50	Transportation of Oversized Loads
45 SW IEMP 10-2	Installation Emergency Management Plan
45 SW OPLAN 15-1	Weather Operations Plan
45 SW Range Safety Operations Requirements, Number 19	Toxic Hazard Control Daily and Launch Operations
45 SWI 40-201	Radiation Protection Program
45 SWI 91-204	Launch Vehicle Toxic Plume Instruction for On-Base Personnel
45 SW IEMP 10-2	
49 CFR	Transportation
49 CFR 173.52	Classification Codes and Compatibility Groups of Explosives
49 CFR 173.56	New Explosives – Definitions and Procedures for Classification and Approval
49 CFR 174.81	Segregation of Hazardous Materials
49 CFR 175.78	Stowage Compatibility of Cargo
49 CFR 176.83	Segregation
49 CFR 173.185	Lithium Batteries and Cells
49 CFR 177.848	Segregation of Hazardous Materials
49 CFR, Subpart 6, Parts 1000 through 1199	Surface Transportation Board, Department of Transportation
ADA 086259	Joint Services Safety and Performance Manual for Qualification of Explosives for Military Use
AFI 32-1063	Electrical Power Systems
AFI 32-1064	Electrical Safe Practices
AFI 32-1065	Grounding Systems
AFI 32-2001	The Fire Protection Operations and Fire Prevention Program
AFI 32-4002	Hazardous Material Emergency Planning and Response Compliance
AFI 40-201	Managing Radioactive Materials in the USAF
AFI 91-110	Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems
AFI 91-202	The US Air Force Mishap Prevention Program
AFI 91-204	Safety Investigations and Reports
AFJMAN 24-204	Preparing Hazardous Materials for Military Air Shipments
AFJMAN 24-306	Manual for the Wheeled Vehicle Driver
AFJMAN 32-1083	Facilities Engineering - Electrical Interior Facilities
AFMAN 32-4013	Hazardous Materials Emergency Planning and Response Program

AFMAN 91-201	Explosives Safety Standards
AFOSHSTD 91-68	Chemical Safety
AFOSHSTD 91-119	Process Safety Management of Highly Hazardous Materials
AFOSHSTD 161-21	Hazard Communication
AFPD 91-1	Nuclear Weapons and Systems Surety
AFPD 91-2	Safety Programs
AFPD 63-12	Assurance of Occupational Safety, Suitability, and Effectiveness
Air Force Damage Tolerant Design Handbook	Guidelines for the Analysis and Design
AFSPCMAN 91-710	Range User Requirements
AIA/NAS 1514	Radiographic Standard for Classification of Fusion Weld Discontinuities
ANSI/AIAA S-080	Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components
ANSI/AIAA S-081	Space Systems Composite Overwrapped Pressure Vessels (COPVs)
ANSI/NANSI/SIA A92.2	Vehicle Mounted Elevating and Rotating Aerial Devices
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 A10.14	Construction and Demolition Operations - Requirements for Safety Belts, Harnesses, Lanyards and Lifelines for Construction and Demolition Use
ANSI B30 series	Material Handling Equipment
ANSI B30	Cranes, Hoists, and Lifting Devices
ANSI B30.5	Mobile and Locomotive Cranes
ANSI B30.9	Slings
ANSI B30.10	Hooks, Special Notice
ANSI/ASME B30.20	Below Hook Lifting Devices
ANSI/ASME B56.2	Type Designated Area, Use Maintenance, Operator
ANSI B56.3	Electric Battery-Powered Industrial Trucks
ANSI C84.1	Electric Power Systems and Equipment - Voltage Ratings (60 Hz)
ANSI Z49.1	Safety in Welding and Cutting
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 Z136.6,	Safe Use of Lasers Outdoors
ANSI Z244.1	Safety Requirements for the Lockout/Tagout of Energy Sources
ANSI Z358.1	Emergency Eyewash and Shower Equipment
ANSI Z359.1	Personnel Fall Arrest Systems, Subsystems, and Components
ANSI/ASME B1.1	Unified Inch Screw Threads
ANSI/ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flange
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings

From: NASA-STD-8719.24 Annex Rev. A

ANSI/ASME B16.9	Factory Made Wrought Steel Butt Welding Fittings
ANSI/ASME B18.2.1	Square and Hex Bolts and Screw Inch Series
ANSI/ASME B18.2.2	Square and Hex Nuts (Inch Series)
ANSI/ASME B31.3	Process Piping
ANSI/ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ANSI/ASME B40.1	Gauges, Pressure Indicating Dial Type
ANSI/IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
ANSI/IEEE C95.1	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 Khz to 300 Ghz
ANSI/NFPA 780	Lightning Protection Systems
ANSI Y32.2-1975	Graphic Symbols for Electrical & Electronics Diagrams
ASCE/SEI 7-10	Minimum Design Loads for Buildings and Other Structures
ASME B30.23	Personnel Lifting Systems
ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination, Article 10	Appendix IV, Helium Mass Spectrometer Test – Detector Probe Technique
ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination, Article 10	App. V, Helium Mass Spectrometer Test – Tracer Probe and Hood Techniques
ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessel Rules	Appendix G, Suggested Good Practice Regarding Piping Reactions and Design of Supports and Attachments
ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels	Division 1, Pressure Vessel Rules
ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels, Division 1	Appendix M, Installation and Operations
ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels	Division 2, Alternative Rules
ASME Boiler and Pressure Vessel Code	Section X, (ASME S001100), Fiber-Reinforced Plastic Pressure Vessels
ASTM A182	Forged Or Rolled Alloy-Steel Pipe Flanges, Forged
ASTM A304	Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements
ASTM A312	Standard Specifications for Seamless and Welding Austenitic Stainless Steel Pipes
ASTM A316	Specification for Low-Alloy Steel Covered Filler Metal Arc-Welding Electrodes
ASTM A340L	Standard Terminology of Symbols and Definitions Relating to Magnetic Testing
ASTM A403	Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM E1417	Standard Practice for Liquid Penetrant Inspection
ASTM E1742	Radiographic Inspection
ASTM F51-68	Standard Method for Sizing and Counting Particulate Contaminant In and On Clean- room Garments

ASTM MNL 36	Safe Use of Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation
AWS D17.1	Specification for Fusion Welding for Aerospace Applications
CCEMP/JHB 2000	Cape Canaveral Spaceport Consolidated Comprehensive Emergency Management Plan
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
CPIA 394	Chemical Propulsion Information Agency, Hazards of Chemical Rockets and Propellants
CPIA 394, Volume III	Liquid Propellants
Department of Defense Directive 3100.10	Department of Defense Space Policy
Department of Defense Directive 3200.11	Major Range and Test Facility Base
DoD 6055.9-STD	Ammunition and Explosives Safety Standards
DoD-E-83578	Explosive Ordnance for Space Vehicles, General Specification for
Eastern and Western Range 127-1, Range Safety Requirements	Range User Handbook
FEMA 74	Reducing the Risks of Nonstructural Earthquake Damage, A Practical Guide
IEEE/EIA 12207	Standard for Information Technology
International Civil Aviation Organization (ICAO)	Technical Instructions for the Safe Transport of Dangerous Goods by Air
International Air Transport Association (IATA)	Dangerous Goods Regulations
Joint Software System Safety Committee	Software System Safety Handbook
JSCM 5322	Contamination Control Requirements Manual
KDP-KSC-P3008	Hazardous Materials Emergency Response
KHB 1700.7	Payload Ground Safety Handbook
KNPR 1820.3	KSC Hearing Loss Prevention Program
KNPR 1860.1	KSC Ionizing Radiation Protection Program
KNPR 1860.2	KSC Nonionizing Radiation Protection Program
KNPR 8715.2	Comprehensive Emergency Management Plan
KNPR 8715.3	Kennedy NASA Procedural Requirements
KSC-C-123	Surface Cleanliness of Fluid Systems, Specifications for
KSC-DE-512-SM	Facility, System and Equipment General Design Requirements
KSC-GP-425	Engineering Standards
KSC/MMA-1985-79	Standard Test Method for Evaluating Triboelectric Charge Generation and Decay
KSC/MTB-175-88	Procedure for Casual Exposure of Materials to Hypergolic Fluids: Exothermic Reaction Method
KSC-SPEC-Z-0006	Specification for Induction Brazing, Aerospace Tubing Fittings
KSC-SPEC-Z-0007	Specification for Tubing, Steel Corrosion Resistance Type 304, 316, Seamless, Annealed

KSC-SPEC-Z-0008	Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies
KSC specification 80K51846	Flex Hose Handling and Installation Requirements
KSC-STD-E-0002D	Hazardproofing of Electrically Energized Equipment
KSC-STD-E-0012	Bonding and Grounding
KTI-5210	NASA/KSC Material Selection List for Oxygen and Air Services
KTI-5211	NASA/KSC Material Selection List for Reactive Fluid Service
KTI-5212	NASA/KSC Material Selection List for Plastic Films, Foams, and Adhesive Tapes
MIL-C-43122G	Cloth, Sateen, Cotton, Flame Retardant Treated
MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-17	Plastic for Aerospace Vehicles, Part 1, Referenced Plastics
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-461E	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-464	Systems Electromagnetic Environmental Effects Requirements
MIL-STD-810	Environmental Engineering Considerations and Laboratory Testing
MIL-STD-882C	Department of Defense Standard Practice for System Safety
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
MIL-STD-1540	Test Requirements for Space Vehicles
MIL-STD-1576	Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems
MIL-STD-1751	Safety and Performance Tests for Qualification of Explosives
MS33584	Tubing End, Standard Dimensions for Flared
MSFC 20MO2540	Assessment of Flexible Line and Flow-Induced Vibration
MSFC-STD-1249	Standard NDE Guidelines and Requirements for Fracture Control Program
MSFC-STD-3029	NASA/MSFC Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments
MSS-SP-6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings
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-STD-5006	General Fusion Welding Requirements for Aerospace Material Used in Flight Hardware
NASA/FLAGRO (JSC-22267)	Fatigue Crack Growth Computer Program
NASA-STD-5005	Standard for the Design and Fabrication of Ground Support Equipment
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-5019	Fracture Control Requirements for Space Flight Hardware
NASA-STD-6001	Flammability, Offgassing, and Compatibility Requirements and Test Procedures
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-STD-8719.13	Software Safety Standard
NASA-STD-8719.14	Process for Limiting Orbital Debris
NASA-STD-8719.17	NASA Requirements for Ground-based Pressure Vessels and Pressurized Systems (PV/S)
NASA-STD-8739.8	Software Assurance Standard
NAVSEA 9310	High Temperature Test
NAVSEA OP 5	Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation and Shipping
NEC Article 250-102	Bonding Jumpers
NEC Article 500	Hazardous (Classified) Locations
NEC Article 504	Intrinsically Safe Systems
NEPA	National Environmental Policy Act
NFPA 30	Flammable and Combustible Liquids Code
NFPA 70	National Electric Code
NFPA 70 Article 501	Class I Locations
NFPA 70 Article 700	Emergency Systems
NFPA 70 Article 702	Optional Standby Systems
NFPA 70E	Electrical Safety Requirements for Employee Workplaces
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
NFPA 780	Standard for the Installation of Lightning Protection Systems
NHB 8060.1B	Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments that Support Combustion
NPR 1800.1	NASA Occupational Health Program Procedures
NPR 7120.5	NASA Space Flight Program and Project Management Processes and Requirements
NPR 7150.2	NASA Software Engineering Requirements

From: NASA-STD-8719.24 Annex Rev. A

NPR 8000.4	Risk Management Procedural Requirements
NPR 8621.1	NASA Procedures and Guidelines for Mishap Reporting, Investigating and Recordkeeping
NPR 8715.1	NASA Occupational Safety and Health Programs for NASA Facilities
NPR 8715.2	NASA Emergency Preparedness Plan Procedural Requirements
NPR 8715.3	NASA General Safety Program Requirements
NPR 8715.7	Expendable Launch Vehicle Payload Safety Program
NSTS 1700.7	NASA Safety Policy and Requirements for Payloads Using the Space Transportation System
PD/NSC 25	Presidential Directive/National Security Council 25 Scientific or Technological Experiments with possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space
SHI-ASO-M0008	ASO FL Facility Safety Manual
SHI-ASO-M0011	ASO VAFB Facility Safety Manual
ST/SG/AC.10/1	Recommendations on the Transport of Dangerous Goods - Model Regulations
SNT-TC-1A	American Society for Non-Destructive Testing Standards
T.O. 00-25-203	Contamination Control of Aerospace Facilities
T.O. 00-25-223	Integrated Pressure Systems and Components (Portable and Installed)
T.O. 31Z-10-4	Electromagnetic Radiation Hazards
T.O. 42C-1-11	Cleaning and Inspection Procedures for Ballistic Missile Systems
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

Abbreviations and Acronyms

°C	degree Centigrade
°F	degree Fahrenheit
30 SW/SE	30th Space Wing/Chief of Safety
30 WS	30th Weather Squadron
A-50	Aerozine 50 (UDMH)
AC	Alternate Current
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFJMAN	Air Force Joint Manual
AFMAN	Air Force Manual
AFOSH	Air Force Occupational Safety and Health
AFPD	Air Force Policy Directive

AFSPC	Air Force Space Command
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	cubic centimeters
cc/sec	cubic centimeters per second
CCAFS	Cape Canaveral Air 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
cm3/secdiv	cubic centimeters per second per division
CMAA	Crane Manufacturers Association of America
COPV	composite overwrapped pressure vessel
COTS	computer off-the-shelf
CPIA	Chemical Propulsion Information Agency
CPLD	Complex Programmable Logic Devices
CPU	central processing unit
CPS	cycles per second
CW	continuous wave
dB	decibel
dBA	decibels on the A scale
DC	direct current
DFMR	Design for Minimum Risk
DoD	Department of Defense
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
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
FTS	flight termination system
GH2	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
IBC	International Building Code

ICAO	International Civil Aviation Organization
IEEE	Institute of Electrical and Electronics Engineers
INSRP	Interagency Nuclear Safety Review Panel
IPF	Integration Processing Facility
ISI	inservice inspection
JP	jet propellant
JTA	Joint Technical Architecture
KDP	Kennedy Documented Procedure
KHB	Kennedy Handbook
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
LH2, LH2	liquid hydrogen
LHe	liquid helium
LID	laser initiated device
Li-Ion	Lithium Ion
LIO	laser initiated ordnance
LIOS	laser initiated ordnance system
LN2	liquid nitrogen
LO2	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	monomethylhydrazine
MOP	maximum operating pressure
MPE	maximum predicted environment; maximum permissible exposure
MRB	Material Review Board
MSA	Mine Safety Appliances
MSDS	Material Safety Data Sheet
N2H4	hydrazine
N2O4	nitrogen tetroxide
NACE	National Association of Corrosion Engineers
NASA	National Aeronautics and Space Administration
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
NIOSH	National Institute of Occupational Safety and Health
NPR	NASA Procedural Requirements
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	pentaerythritoltetranitrate
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
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
sec	second, seconds
SEE	single event effects
SEU	single event upset
SFP	single failure point
SGI	service group I
SHA	system hazard analysis
SLC	space launch complex
SMA	safety and mission assurance
SNT-TC	Society for Nondestructive Testing-Testing Certification
SOC	System on Chip
SOP	standard operating procedures
SPR	software problem report

SR	safety review
SSHA	subsystem hazard analysis
SSP	System Safety Plan
STD	software test description
STD	Standard
STP	standard temperature and pressure
STR	software trouble reports
SW	Space Wing
SWI	Space Wing instruction
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
UT	ultrasonic test
VAFB	Vandenberg Air Force Base
V	Volt
Vdc	volts, direct current
Vrms	volts, root mean square
WOCC	Wing Operations Control Center
WR	Western Range

Terms

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.

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 percent as determined by a Bruceton test. Recommended operating level is all-fire current, as determined by test, at ambient temperature plus 150 percent 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.

antenna - a device capable of radiating or receiving radio frequency energy.

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.

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.

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.

brittle materials - see *materials, brittle*.

burst factor - a multiplying factor applied to the MEOP to obtain the design burst pressure; synonymous with ultimate pressure factor.

catastrophic hazard (payloads prelaunch) - a payload-related hazard, condition, or event occurring prior to launch (on ground) that could result in a mishap causing fatal injury to personnel or loss of spacecraft, launch vehicle, or ground facility.

catastrophic hazard (payloads post-launch) - a payload-related hazard, condition or event occurring post-launch (airborne) through payload separation that could result in a mishap causing fatal injury (including fatal injuries to the public) or loss of flight termination system.

catastrophic hazard (sample return to earth) **-** a sample recovery-related hazard, condition or event occurring during sample recovery operations that could result in a mishap causing fatal injury to personnel.

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.

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.

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.

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 authority - a single commercial user on-site director and/or manager, a full time government tenant director and/or commander, or United States Air 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.

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 used to process high value hardware; a facility or structure that contains or is used to process systems determined by Range Safety to be hazardous or critical; or a facility or structure determined by Range Safety 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 Range User; see also *safety critical*.

critical hazard - a hazard, condition or event that may cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware.

critical load - a load consisting of critical hardware and/or any personnel.

cryogen - a super cold liquid such as liquid nitrogen or oxygen.

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*.

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 and Western Range 127-1 - Eastern and **W**estern Range 127-1, Range Safety Requirements refers to the previous Range Safety requirements directive that controlled range and Range User activities at the Eastern and Western Ranges.

Eastern Range - part of the National Launch Range facilities, operated by the 45th Space Wing, part of Air Force Space Command, and located at Patrick Air Force Base, Florida; the range includes the operational launch and base support facilities located at Cape Canaveral Air Force Station, Florida, radar tracking sites and ground stations located in the eastern Caribbean as well as the Jonathan-Dickson Missile Tracking Annex (Jupiter, Florida) and Argentia, Newfoundland sites.

electrical component - a component such as a switch, fuse, resistor, wire, capacitor, or diode in an electrical 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 vehicle that, once launched, is typically not retrieved and reused.

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 compan**y**, 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 philosoph**y**, analysis method, manufacturing technolog**y**, 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 - equipment, system, operation, or condition with an existing or potential condition that may result in a mishap; a state or a set of conditions, internal or external to a system, that has the potential to cause harm.

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 - those operations classified as hazardous according to the following criteria: (1) consideration of the potential or kinetic energy involved; (2) changes such as pressure, temperature, and oxygen content in ambient environmental conditions; (3) presence of hazardous materials; for example, operations involving equipment or systems with potential for a release of energy or hazardous material that can result in a mishap.

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 250 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 particular type of Range User procedure; a document containing specific steps in sequential order used to safely process hazardous materials or conduct hazardous operations; hazardous procedures have specific content requirements delineated in Volume 6, Attachment 2 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.

Hydraset - 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 ai**r**.

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 prime**r**.

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 immediate**ly**.

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 interrupte**r**.

intrinsically safe - incapable of producing sufficient energy to ignite an explosive atmosphere and two fault tolerant against failure with single fault tolerance against its most hazardous failure at 1.5 times the maximum voltage or energ**y**.

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 Air Force squadron commanders; this is the on-base component of public safet**y**.

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, facilit**y**, 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 **W**estern 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; projectiles, torpedoes, and air-dropped bodies.

LDEM-Lifting Device and Equipment Manager: 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 expected 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.

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

marginal hazard - a hazard, condition or event that may cause minor injury or minor occupational illness to personnel.

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 - the maximum pressure at which a component or system can continuously operate based on allowable stress values and functional capabilities.

maximum expected operating pressure - the highest pressure that a pressure vessel, pressurized structure, or pressure component is expected to experience during its service life and retain its functionalit**y**, in association with its applicable operating environments; synonymous with maximum operating pressure or maximum design pressure includes the effect of temperature, pressure transients and oscillations, vehicle quasi-stead**y**, and dynamic accelerations and relief valve operating variabilit**y**.

Megger - high voltage resistance mete**r**.

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, injur**y**, occupational illness, or damage to or loss of equipment or property or damage to the environment.

mismating - the improper installation and/or connection of connectors.

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).*

no-fire level - 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.

nonessential 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 onl**y**.

Office of the 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, humidit**y**, 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 in AFMAN 91-201 and DoD 6055.9-STD.

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.

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 – A working group formed for each NASA ELV 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.

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 MEOP 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 - (1) the product of maximum expected operating environment and a proof factor accounting for the difference in material properties between test and service environment (such as temperature); used to give evidence of satisfactory workmanship and material quality; for example, demonstrating that the component and/or system will not deform, leak or fail; (2) may be used to establish maximum initial flaw sizes for safe-life demonstration.

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.

radio frequency 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 equipment or device - equipment or devices that generate, or are capable of generating, ionizing radiation including 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.

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 Air Force Station, Kennedy Space Center, and Patrick Air Force Base, and the Western Range at Vandenberg Air 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 Air Force assigned to the 30/45 Space Wing/Wing Safety office or a contractor employee designated and authorized by 30/45 Space Wing/Wing 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 Space Wing Commander has the authority to waive the safety rest period requirements for Mission Ready (Category A) personnel; see also *crew rest*.

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 Safet**y**, 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 - 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 - an operation, process, system, or component that controls or monitors equipment, operations, systems, or components to ensure personnel, launch area, and public safety; may be hazardous or non-hazardous.

safety critical computer system function - a computer function containing operations that, if not performed, if performed out of sequence, or if performed incorrectly, may result in improper or lack of required control functions that may directly or indirectly cause a hazard to exist.

safety critical facility - a hazardous facility or a facility that is used to store, handle, or process systems determined to be safety critical by Range Safet**y**.

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 – software deemed to be safety critical per the litmus test in NASA-STD-8719.3, NASA Software Safety Standard.

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 holdfire 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 energ**y**.

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 Wing Commander - in this document, the term *Space Wing Commander* refers exclusively to the commanders of the 30th Space Wing and the 45th Space Wing; 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 Wing Commander; the terms *Range Commander* and *Spacelift Commander* refer to tasks or functions performed by the Space Wing Commander; see AFSPCI 10-1202, *Crew Force Management*, for further information.

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.

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 the 30th Space Wing, part of Air Force Space Command, and located at Vandenberg Air Force Base, California; the range includes the operational launch and base support facilities located at Vandenberg Air Force Base and those radar tracking sites and ground stations located on sites uprange 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.