Revision I changes are detailed in the Revision History on page two.
Note: 3/29/2011 - Administratively changed to update links in Chapter 15. Section 15.3.3.3, 15.3.3.4a., and 15.4.2.
Note: 6/23/2010 - Administratively changed to clarify the new requirements in section 9.2.6 a. & b.

Kennedy NASA Procedural Requirements

Effective Date: **June 1, 2010**

Expiration Date: **June 1, 2015**

Responsible Office: **Safety and Mission Assurance**

KSC Safety Practices Procedural Requirements

Revision History for Revision I

To identify the changes made during this revision, a change matrix detailing Revision I changes can be found at the following location:

https://tdksc.ksc.nasa.gov/servlet/dm.web.Fetch/KNPR_8715.3_Rev_I-1_Change_Matrix_.pdf?gid=95587

The change matrix details requirements as they existed in Revision H-2 and presents the new requirements presented in Rev I. In some cases, where necessary, a description of the changes that were made is included.

In Revision H-2, Shuttle-specific requirements were moved to Chapter 18 in preparation for future programs and to capture existing Shuttle-specific requirements for use through the end of the program, and International Space Station-specific requirements were moved to Chapter 19 to generalize this KNPR. Upon completion of the Shuttle Program, Chapter 18 and all references to Chapter 18 will be deleted, leaving a non-program-specific KNPR. This system has been continued in Revision I.

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PREFACE

P.1 PURPOSE

This document establishes consolidated safety procedural requirements that serve as a framework to define the parameters and boundaries required during design, operations, and maintenance activities at the Kennedy Space Center (KSC) and other areas where KSC has jurisdiction. These requirements represent combined efforts to identify and mitigate the unique hazards associated with daily institutional operations and ground processing operations of flight hardware. It is a living document subject to change. It should be emphasized, however, that each employee has a responsibility for safety, both his/her own and that of others who may be impacted by the employee's actions.

P.2 APPLICABILITY

a. The provisions of these procedural requirements apply to all organizational elements at KSC, to their associated contractors and subcontractors, to service providers to the extent of their contracts, to other Government agencies and their contractors operating at KSC, and to all persons performing official NASA business on NASA KSC property or NASA KSC-controlled property. These provisions are also applicable at offsite facility areas where KSC has operational responsibility. In joint-use facilities (e.g., a facility used both by NASA and the Air Force), when there is a difference in safety requirements, the more stringent requirement shall apply.

b. As specified in their contract, Construction Contractors on NASA KSC property or NASA KSC controlled property are required to follow the requirements in this KNPR and may also be obligated to meet the requirements of KNPR 8715.7, KSC Construction Contractor Safety and Health Practices Procedural Requirements.

c. In the event of a conflict between the requirements set forth in this document and:

(1) Program or Agency requirements, the program or Agency requirements shall take precedence.

(2) Existing contract provisions, the contract provisions shall take precedence.

(3) Sub-tier documents, the provisions of this document shall take precedence.

(4) Other documents at an equivalent level (e.g., other KNPR documents), the respective document Offices of Primary Responsibility (OPR) shall resolve the conflict on a case-by-case basis and provide appropriate guidance.

d. If disagreement exists over which of the aforementioned documents takes precedence, the NASA KSC Director of S&MA shall make the final determination.

P.3 AUTHORITY

a. NPD 8700.1, NASA Policy for Safety and Mission Success

b. NPR 8715.3, NASA General Safety Program Requirements

c. Executive Order 12196, Occupational Safety and Health Program for Federal Employees

d. Title 29 CFR, Part 1960, Basic Program Elements for Federal Employees Occupational Safety and Health Program

e. Title 29 CFR, Parts 1910 to 1990, Occupational Safety and Health Administration

f. Title 40 CFR, Protection of the Environment, Environmental Protection Agency

g. Title 49 CFR, Parts 171 to 178, Transportation, Department of Transportation

P.4 APPLICABLE DOCUMENTS

a. NFPA 70, National Electric Code

b. NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems

c. NPR 8621.1, NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping

d. NPR 8715.3, NASA General Safety Program Requirements

e. NPR 8715.5, Range Safety Program

f. NPR 8715.7, ELV Payload Safety Program

g. KNPD 1800.2, KSC Hazard Communication Program

h. KNPD 8700.1, Safety and Mission Assurance Policy Directive

i. KNPR 1840.19, KSC Industrial Hygiene Programs

j. KNPR 1820.3, KSC Hearing Loss Prevention Program

k. KNPR 1820.4, KSC Respiratory Protection Program

l. KNPR 1860.1, KSC Ionizing Radiation Protection Program

m. KNPR 1860.2, KSC Nonionizing Radiation Protection Program

n. KNPR 4000.1, Supply and Equipment System Manual

o. KNPR 8700.2, KSC System Safety and Reliability Analysis Methodology Procedural Requirements

p. KNPR 8715.2, Comprehensive Emergency Management Plan

q. KNPR 8715.7, KSC Construction Contractor Safety and Health Practices Procedural Requirements.

r. KNPR 8720.2, KSC Reliability and Maintainability Procedural Requirements

s. KNPR 8730.2, Quality Assurance Procedural Requirements

t. NSS 1740.12, NASA Safety Standard for Explosives, Propellants, and Pyrotechnics

u. NASA-STD-5005, Standard for the Design and Fabrication of Ground Support Equipment

v. NASA-STD-6001/NASA-STD-(I)-6001A (as applicable per contract), Flammability, Odor, Off-gassing and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion

w. NASA-STD-8719.9, NASA Safety Standard for Lifting Devices and Equipment

x. NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S)

y. AFSPCMAN 91-710, Air Force Space Command Manual (AFSPCMAN) 91-710, Eastern and Western Range Safety User Requirements

z. EWR 127-1. Eastern and Western Range Safety User Requirements

aa. ACGIH, Threshold Limit Value and Biological Exposure Indices

bb. ANSI B30 Series, American National Standard Safety Standards for Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, latest issue

cc. ANSI/ASME B31.3, Piping and Tubing

dd. ANSI/NB-23, National Board Inspection Code

ee. ANSI/ASSE Z359.1, Safety Requirements for Personal Fall Arrest Systems

ff. ASME Section VIII, Div 1&2, ASME Boiler and Pressure Vessel Code

gg. CPIA #394, Chemical Rockets/Propellant Hazards, Vol. III, Liquid Propellant Handling, Storage and Transportation, Sept 84

hh. Society of Automotive Engineers (SAE), Standards

ii. JSC 08934, Shuttle Operational Data Book, Volume I, Shuttle Systems Performance and Constraints Data

jj. KSC-PLN-1705, KSC Shuttle Program Contingency Plan

kk. KSC-PLN-2001, ISS/Payload Processing Contingency Action Plan

ll. KSC-PLN-2807, KSC Mishap Preparedness and Contingency Plan

mm. LSP-PLN-365.01, NASA Launch Services Program Mishap Preparedness and Contingency Plan

nn. KTI-5212, Material Selection List for Plastic Films, Foams, and Adhesive Tapes

oo. KSC-STD-Z-0005, Pneumatic Ground Support Equipment, Design of

pp. KSC-STD-Z-0009, Cryogenic Ground Support Equipment, Design of

qq. GP-14-2, Facility Utilization Charts

rr. GP-435, Vol. 1, Engineering Drawing Practices, Ground Support Equipment

ss. KSC-DF-502, SRM/VAB Inadvertent Ignition Effects Study

tt. KSC/MMA-1985-79, Standard Test Method for Evaluating Triboelectric Charge and Decay

uu. SSP 30599, Safety Review Process

vv. SSP 50004, Ground Support Equipment Design Requirements

ww. SSP 50021, Safety Requirements

xx. NSTS 1700.7B, Policy and Requirements for Payloads Using the Space Transportation System

yy. NSTS 1700.7B ISS Addendum, Safety Policy and Requirements for Payloads using the International Space Station (ISS Addendum)

zz. NSTS 13830C, Payload Safety Review and Data Submittal Requirements

aaa. KSC Drawing 81K04331, Specification for Marking of Propellant Portable Containers

bbb. KSC Drawing 81K00643, Specification for Marking of Mobile GSE

P.5 CANCELLATION/SUPERSESSION

This document supersedes KNPR 8715.3, Revision H-2, KSC Safety Practices Procedural Requirements.

Original signed by
Michael E. Wetmore
Director, Safety and Mission Assurance

CHAPTER 1: GENERAL REQUIREMENTS

1.1 GOAL

a. From a safety perspective, the primary goals of NASA KSC and this document are to provide and maintain safe, reliabile Ground Support Equipment (GSE), Flight Hardware, and facility systems and to perform operations in a manner that minimizes risk to personnel, hardware and KSC facilities.

b. The Safety and Mission Assurance (S&MA) Directorate is the organization which ensures that all KSC Safety activities are planned, implemented, managed, and coordinated with all other KSC program/project and directorate organizations for an effective and integrated safety effort.

1.2 OBJECTIVE

The objective of this KNPR is to document Center safety requirements, to establish procedural requirements unique to KSC; and to effectively and efficiently convey safety requirements to the Center that protect KSC employees, the workforce at KSC, visitors, and the public.

1.3 RESPONSIBILITY

a. Final authority and responsibility for implementing the NASA Safety Program at KSC rests with the Center Director. KSC program/project and directorate organizations have responsibilities for implementing the program developed by the Safety and Mission Assurance Directorate (S&MA) involving safety, reliability, maintainability, and quality assurance (SRM&QA) at the Center. Programs/projects will need to develop specific safety requirements similar to those in Chapter 18 of this document to cover program or project designs/operations. The Center Director has delegated the responsibility for assessing and ensuring compliance with SRM&QA programs at the Center to the Director, Safety and Mission Assurance. These responsibilities and those assigned to other Center organizational elements are set forth in detail in Kennedy NASA Policy Directive (KNPD) 8700.1, KSC Safety and Mission Assurance Policy Directive.

b. Ownership of this KNPR resides with S&MA Integration Division. The interpretation of the requirements in this KNPR is the responsibility of the appropriate S&MA organizations that support the program/project and directorates. The Director of S&MA is the final authority for interpretation of these requirements.

1.4 COMPLIANCE WITH FEDERAL, CONSENSUS, AND NASA STANDARDS

a. Federal Agencies are mandated to provide a safe workplace for their employees in accordance with the Occupational Safety and Health Act, 1970, per Executive Order 12196, “Occupational Safety and Health Programs for Federal Employees,” dated February 26, 1980, and with 29 CFR 1960 “Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters.”

b. Applicable Industry Standards shall be used to the extent practical to meet NASA and Occupational Safety and Health Administration (OSHA) design and operational needs.

c. A listing of authority and applicable documents is provided in section P.3 AUTHORITY and P.4 APPLICABLE DOCUMENTS of this KNPR.

1.5 CHANGE RECOMMENDATIONS

Recommended changes to KNPR shall be in accordance with the KSC Directives Process, KDP-KSC-P-1058. Changes shall be submitted on KSC Form 31-393, "Document Change Request" (DCR), to the Director of S&MA, or designee. The form shall identify the exact language of the proposed change and the rationale for the change. The DCR shall be reviewed by all affected organizations and all comments shall be dispositioned.

1.6 SAFETY VARIANCE PROCESSING

1.6.1 OVERVIEW

1.6.1.1 The primary objective of the safety variance processing procedural requirements is to define the roles and requirements of Center management, KSC program/project, and Safety and Mission Assurance (S&MA) Directorate personnel in such a way that KSC will maintain control over:

a. Agency S&MA policy and requirements that it administers, and

b. Center S&MA policy and requirements that it sets.

1.6.1.2 Whenever it is deemed necessary to vary from established safety requirements in order to accomplish a task, risk management techniques shall be used and documented so that informed decisions can be made regarding the approval or disapproval of the safety variance.

1.6.2 APPLICABILITY

1.6.2.1 At KSC, it is expected that all safety requirements be met and that all employees report unsafe conditions or acts, work with management to resolve them, and stop imminently dangerous activities. Proposed safety variances may be granted after completing an assessment of the risk associated with the request so that management can make an informed decision regarding its acceptability. In addition, safety variances shall be processed in advance except as noted in section 1.6.6, Real-Time Operational Considerations. Failure to adhere to safety requirements without an approved safety variance is considered a violation and may be subject to disciplinary action.

1.6.2.2 The safety variance processing procedural requirements documented herein implement the requirements of NASA Procedural Requirements (NPR) 8715.3, NASA General Safety Program Requirements. These procedural requirements apply when requirements of Center safety documentation cannot be met as specified in Kennedy NASA Policy Directives (KNPDs) and Kennedy NASA Procedural Requirements (KNPRs); higher-level Agency requirements such as NASA Policy Directives [NPDs], NASA Procedural Requirements [NPRs], NASA Standards (NASA-STD), and NASA Safety Standards [NSSs]); or other Federal regulations.

1.6.2.3 If the requirement that cannot be met is within one of the requirements documents listed below, and there is a specific safety variance process defined within that same requirements

document, those requirements shall supersede the safety variance requirements herein. The applicable requirements documents are:

a. Safety variances affecting the safety of Space Shuttle and ISS payloads, experiments, and cargo requirements shall be processed through the Ground Safety Review Panel (GSRP) in accordance with Chapter 20 of this KNPR.

b. Variances against Range Safety requirements shall be processed in accordance with NPR 8715.5, Range Safety Program.

c. Safety variances against Range requirements shall be processed in accordance with the appropriate Range requirements document (e.g., EWR 127-1 or AFSPCMAN 91-710 for CCAFS or VAFB).

d. Safety variances against Expendable Launch Vehicle (ELV) Payload Safety requirements shall be processed in accordance with NPR 8715.7, Expendable Launch Vehicle Payload Safety Program.

1.6.3 DEFINITIONS

Definitions applying to the KSC safety variance processing procedural requirements established herein and in accordance with NPR 8715.3, NASA General Safety Program Requirements are contained in Appendix A, Definitions.

1.6.4 SAFETY VARIANCE GENERATION

1.6.4.1 When Center or higher-level Agency or Federal safety requirement(s) cannot be met, the initiating organization (contractor or NASA) shall process a safety variance request. When the unmet requirement(s) resides in both a Center and a higher-level safety document, the safety variance will be generated against the requirement in the higher-level document.

1.6.4.2 To generate and submit a safety variance request:

a. Acquire a KSC safety variance number

A safety variance number may be obtained by contacting the S&MA Launch Vehicle Processing Division or the S&MA Integration Division. The S&MA Integration Division is also responsible for managing safety variance processing and for maintaining a KSC safety variance database/depository.

b. Fill out the request form KSC Safety Variance Form (KDP-KSC-F-3614) and perform risk assessment.

The appropriate NASA KSC S&MA Division, in conjunction with the initiating organization, shall assess the need for a variance, coordinate the review and risk assessment, and establish the appropriate duration of the variance and the corresponding rationale.

(1) System safety is an integral part of the overall program risk management decision process. The risk assessment process is a principal factor in the understanding and management of technical risk. Hazards are identified and resultant risks are assessed by considering probability

of occurrence and severity of consequence. The safety variance shall include a 5 x 5 risk matrix with defined probability (likelihood) and consequence (severity) categories.

(2) The approval duration for safety variances shall be based on the operational event and circumstances involved. The duration must be pre-coordinated with the appropriate NASA KSC S&MA Division. At the end of this time period, the variance expires. In situations where it is necessary to renew the variance for an additional time period, the safety variance must be resubmitted in accordance with these procedural requirements. In addition, progress made toward future compliance with the unmet requirement(s) will also be considered during the safety variance review process. Requests of this nature shall be accompanied by detailed rationale describing why the specific unmet requirement(s) should remain intact.

(3) All safety variance requests shall be accompanied by documentation (provided by the initiating organization), including comments from any affected employees or their representatives. Utilizing the KSC Safety Variance Form (KDP-KSC-F-3614), document the variance data elements. This form is available in KSC Business World, from the appropriate NASA KSC S&MA Division or from the S&MA Integration Division.

1.6.5 SAFETY VARIANCE COORDINATION/APPROVAL

a. Safety variances shall be approved prior to execution of operations except as noted in section 1.6.6 below. Coordination, approvals, final risk acceptance, and required timelines for safety variances are based on the level of the requirement document being considered, and they are all documented below.

b. When the review of the associated risk assessment results in a non-concurrence, the reviewer shall provide detailed rationale for the non-concurrence recommendation. The safety variance can continue through the process even if there are non-concurrences. It is the responsibility of the approval authority and the risk acceptance authority to decide if they will approve/accept the variance with the documented non-concurrences.

1.6.5.1 For safety variances against contractor-imposed safety requirements, the contractor management is the approval and final risk acceptance authority.

1.6.5.2 For safety variances against NASA KSC safety requirements:

a. The initiating organization shall provide the safety variance or request for extension to the Ground Risk Review Panel (GRRP) chair as soon as practical but no later than two weeks prior to the operation or expiration date (except as stated in section 1.6.6). In addition, all signatures (or nonconcurrence rationale) except the GRRP chair, the Director(s) of the affected NASA Directorate(s), the S&MA Director, and Center Director shall be obtained prior to attending the GRRP meeting scheduled by the GRRP chair (usually scheduled for one week after receiving the safety variance). This will allow adequate time for the GRRP, S&MA Director, and Center Director to review the safety variance. If there are circumstances that do not allow the safety variance to be sent to the GRRP chair two full weeks prior to the operation, there may not be adequate time to obtain all the required signatures, although every attempt will be made. For real time variances, reference section 1.6.6.

b. The Director(s) of the affected NASA Directorate(s) and the Center Director are the approval and final risk acceptance authorities. In the case of a safety variance affecting more than one

NASA KSC program, project, or organization, all involved Directors shall provide approval and final risk acceptance via signature.

c. If the initiating organization is non-NASA, the Director of the initiating organization (KSC Center Director equivalent) shall also approve/non-concur the safety variance.

d. The following shall review and concur/non-concur:

(1) The appropriate NASA KSC S&MA Division Chief

(2) The Safety Program Manager (as applicable, see section 1.6.5.6)

(3) The GRRP Chair

(4) The KSC S&MA Director

1.6.5.3 For safety variances against NASA Headquarters policy documents (NPDs):

a. The initiating organization shall provide the safety variance or request for extension to the GRRP chair as soon as practical but no later than three weeks prior to the operation or expiration date (except as stated in section 1.6.6). In addition, all signatures (or non-concurrence rationale) except the GRRP chair, the Director(s) of the affected NASA Directorate(s), the S&MA Director, Center Director, and NASA HQ shall be obtained prior to attending the GRRP meeting scheduled by the GRRP chair (usually scheduled for one week after receiving the safety variance). This will allow adequate time for the GRRP, S&MA Director, Center Director, and NASA HQ to review the safety variance. If there are circumstances that do not allow the safety variance to be sent to the GRRP chair three full weeks prior to the operation, there may not be adequate time to obtain all the required signatures, although every attempt will be made. For real time variances, reference section 1.6.6.

b. The Enterprise Associate Administrator (AA) or the NASA HQ Institutional Program Officer (IPO) is the approval authority.

c. The Director(s) of the affected NASA Directorate(s) and the Center Director are the approval and final risk acceptance authorities. In the case of a safety variance affecting more than one NASA KSC program, project, or organization, all involved Directors shall provide approval and final risk acceptance via signature.

d. If the initiating organization is non-NASA, the Director of the initiating organization (KSC Center Director equivalent) shall also approve/non-concur the safety variance.

e. The following shall review and concur/non-concur:

(1) The appropriate NASA KSC S&MA Division Chief

(2) The Safety Program Manager (as applicable, see section 1.6.5.6)

(3) The GRRP Chair

(4) The KSC S&MA Director

1.6.5.4 For NASA Headquarters procedural requirements documents (NPRs, NSSs, NASA-STDs):

a. The initiating organization shall provide the safety variance or request for extension to the GRRP chair as soon as practical but no later than two weeks prior to the operation or expiration date (except as stated in section 1.6.6). In addition, all signatures (or non-concurrence rationale) except the GRRP chair, the Director(s) of the affected NASA Directorate(s), the S&MA Director, and Center Director shall be obtained prior to attending the GRRP meeting scheduled by the GRRP chair (usually scheduled for one week after receiving the safety variance). This will allow adequate time for the GRRP, S&MA Director, and Center Director to review the safety variance. If there are circumstances that do not allow the safety variance to be sent to the GRRP chair two full weeks prior to the operation, there may not be adequate time to obtain all the required signatures, although every attempt will be made. For real time variances, reference section 1.6.6.

b. The Center Director is the approval authority [as delegated from NASA Headquarters Office of Safety and Mission Assurance (OSMA)].

c. The Director(s) of the affected NASA Directorate(s) and the Center Director are the approval and final risk acceptance authorities. In the case of a safety variance affecting more than one NASA KSC program, project, or organization, all involved Directors shall provide approval and final risk acceptance via signature.

d. If the initiating organization is non-NASA, the Director of the initiating organization (KSC Center Director equivalent) shall also approve/non-concur the safety variance.

e. The following shall review and concur/non-concur:

(1) The appropriate NASA KSC S&MA Division Chief

(2) The Safety Program Manager (as applicable, see section 1.6.5.6)

(3) The GRRP Chair

(4) The KSC S&MA Director

1.6.5.5 For safety variances against other Federal Agency documents:

a. The issuing Federal Agency is the approval authority

b. The Director(s) of the affected NASA Directorate(s) and the Center Director are the approval and final risk acceptance authorities. In the case of a safety variance affecting more than one NASA KSC program, project, or organization, all involved Directors shall provide approval and final risk acceptance via signature.

c. If the initiating organization is non-NASA, the Director of the initiating organization (KSC Center Director equivalent) shall also approve/non-concur the safety variance.

d. The following shall review and concur/non-concur:

(1) The appropriate NASA KSC S&MA Division Chief

(2) The Safety Program Manager (as applicable, see section 1.6.5.6)

(3) The GRRP Chair

(4) The KSC S&MA Director

(5) The appropriate NASA Headquarters office of record.

1.6.5.6 Proposed safety variance submittals involving Cranes/Lifting Devices; Explosives, Pyrotechnics, and Propellants; Pressure Vessels (ground fixed and mobile); Fire Protection; and Lightning/Grounding shall be routed for review and concurrence (via signature) to the appropriate safety program manager. Safety program managers at KSC include the KSC Lifting Devices and Equipment Manager (S&MA Launch Vehicle Processing Division); the KSC Explosives Safety Manager (Institutional S&MA Division); the KSC Pressure Systems Manager (Spaceport Services Propellants and Life Support Branch); the KSC Authority Having Jurisdiction (Spaceport Services Protective Services Office); and the KSC Lightning Safety Assessment Committee Chairman (S&MA Launch Vehicle Processing Division).

1.6.5.7 The American Federation of Government Employees (AFGE) Union shall be notified for review and signature. The AFGE Local 513 shall address concerns, if any, to the GRRP.

1.6.6 REAL TIME OPERATIONAL CONSTRAINTS

a. In the case of off-shift/real-time safety variances against KSC or NASA level requirements, it is the responsibility of the initiating organization (contractor or NASA) to obtain, as a minimum, required risk assessments, concurrence from the appropriate NASA KSC S&MA Division representative, and review and final risk acceptance (may be verbal) from the appropriate NASA KSC program/project or organizational Director. The initiating organization shall complete the safety variance process outlined herein by the end of the next regular business day. For safety variances against requirements of other Federal Agency documents, the NASA Headquarters Office of S&MA (OSMA) shall additionally concur.

b. During terminal launch countdown, safety variances may be approved on a recorded net. This approval will include a discussion of the risk assessment. Completion of the approved safety variance application shall follow within 24 hours or by the close of business on the next regular business day.

1.6.7 SAFETY VARIANCE RECORDKEEPING/FOLLOW-UP

a. After safety variance processing has been completed (final risk disposition obtained), the S&MA Integration Division shall ensure that all safety variance data (and accompanying risk assessment) is entered into the KSC Safety Variance Database/Depository (enter the data if the initiating organization or the appropriate NASA KSC S&MA Division has not already entered the data). The S&MA Integration Division will send a copy of the safety variance to the appropriate NASA KSC S&MA Division for distribution and filing. The S&MA Integration Division will also send a copy to NASA HQ OSMA. The S&MA Integration Division will file the electronic original.

b. The safety variance initiating organization is responsible for implementation and maintenance of procedural and/or operational controls specified as requirements by the safety

variance, and for their own closed loop tracking and timely safety variance renewal, when required. The appropriate NASA KSC S&MA Division will track the implementation through normal surveillance activities.

c. The initiating organization shall provide a status to the GRRP on the implementation and maintenance of procedural and/or operations controls specified in the safety variance, when requested.

1.7 SAFETY JURISDICTION

a. KSC civil service or contractor employees, and visitors (e.g., other Center's employees, payload customers, students, international partners, etc.) are expected to comply with KSC safety and health policies/requirements/procedures, and to perform all work in a safe and healthful manner. When unsafe and/or unhealthful conditions/acts pose a danger to personnel or property, all employees have the right and obligation to stop work and/or refuse to perform work they feel is unsafe and/or unhealthful, and work with their management to determine how the work can be performed in a safe and healthful manner.

b. All violations of KSC safety and health policies/requirements/procedures shall be taken seriously. Violations by civil service personnel may result in disciplinary actions, up to removal from government service, while violations by contractor employees or visitors could result in being barred from the Center. Open, nonretaliatory communications are essential to improving and maintaining KSC's safety and health program. Employees shall notify their supervision of unsafe and/or unhealthful conditions or acts. Reprisal or disciplinary action against an employee who initiates a safety concern will not be tolerated.

c. Safety personnel shall have the right to enter any facility and to monitor any operation(s), but shall be subject to safety practices and reasonable security requirements.

CHAPTER 2: WEATHER

2.1 GENERAL

a. Real-time warnings shall be issued for the purpose of protecting personnel and property from the hazards associated with adverse weather.

b. Advisories shall be provided to personnel conducting hazardous operations with sufficient lead-time to secure the operation before the forecasted weather system arrives.

c. Detailed weather requirements are identified in Operations and Maintenance Instructions (OMI) S0018 “Adverse Environment and Lightning Monitoring at LC-39.”

2.2 ADVERSE WEATHER NOTIFICATION

Shuttle-Specific Requirements for this section are contained in Chapter 18.

2.2.1 The Prime Launch Vehicle Processing Contractor shall establish and maintain a process to receive Adverse Weather Warnings from Cape Weather.

2.2.2 Upon receipt of an Adverse Weather Warning from Cape Weather, the Prime Launch Vehicle Processing Contractor shall:

a. Make an area page (LC-39 Area, Industrial Area, or All-Area), preceded by a special tone, announcing the adverse Weather Warning.

b. Notify the Institutional Services Contractor (ISC) and the Checkout, Assembly, and Payload Processing Services (CAPPS) contractor of the Adverse Weather Warning.

2.2.3 Upon receipt of an Adverse Weather Warning notification from the Prime Launch Vehicle Processing Contractor, the CAPPS contractor shall notify the ISS and Spacecraft Processing Directorate.

2.2.4 Phase 2 Lightning Warning notifications and Severe Weather Warnings shall be repeated every hour until the advisory is terminated.

2.2.5 Adverse weather shall be announced on applicable KSC radio nets by the respective Duty Officer (DO)/Monitor. Phase 2 Lightning Warning notifications and Severe Weather Warnings shall be repeated every hour until the advisory is terminated.

2.2.6 Termination and change of state of adverse conditions shall be announced in a similar manner.

2.3 ADVERSE WEATHER

2.3.1 LIGHTNING

2.3.1.1 Lightning activity detected at or near KSC shall be defined as a two-phase process:

a. Phase 1 lightning notification shall be the “Lightning Advisory.”

b. Phase 2 lightning notification shall be the “Lightning Warning.”

2.3.1.2 To avoid damage or injury from lightning strikes:

a. Personnel working outside a lightning protected area shall be notified of Phase 2.

b. Personnel working inside a facility shall not be exposed to wiring that may conduct electricity from a lightning strike.

c. All facility doors shall be closed when a Phase 2 notification is made.

d. Flight hardware shall be protected from lightning strikes.

2.3.1.3 The program/project or directorate organization shall establish lightning strike protection controls based upon a safety engineering assessment of the following criteria:

a. Personnel exposure outside a lightning protected facility or area.

b. Flight hardware exposure, area exposed.

c. Move of flight hardware, hazardous chemicals, and explosives outside a lightning protected facility or area.

d. Protection of personnel performing hazardous operations inside or outside a lightning protected facility or area.

2.3.2 WIND

The program/project or directorate organization shall establish wind restrictions based upon a safety engineering assessment of the following criteria:

a. Personnel exposure.

b. Sail areas.

c. Mass.

d. Wind speed.

CHAPTER 3: PERSONNEL

3.1 GENERAL

The number and functions of personnel required to perform a hazardous operation shall be defined in the applicable Technical Operating Procedure (TOP).

3.2 PERSONNEL CONTROLS

Personnel controls shall be implemented as follows:

a. Access shall be limited for hazardous areas and/or operations.

b. Safety control areas shall be clearly marked to indicate the control boundary. Personnel shall not enter a safety-controlled area unless authorized to do so by the controlling authority. Personnel shall not remove or alter posted safety signs or ropes. Only the organization installing the safety sign or rope shall be authorized to remove or alter it.

c. Personnel shall not enter an area that is posted with a radiation warning sign or barrier unless specifically authorized to do so by the radiographer responsible for the area.

d. All hazardous operations shall require the buddy system as defined in Appendix A, Definitions.

e. Personnel working in or visiting processing areas and support testing facilities shall adhere to the following clothing requirements:

(1) On structures and areas with grate flooring/ exposed cables, personnel/visitors shall be attired in long slacks and wear shoes that cover the entire foot with low- and wide-heels,having soles heavy enough to provide adequate protection.

(2) In areas/facilities where hazardous liquids or fuels are handled/processed, canvas or cloth sneakers, porous or open-toed shoes, tank tops, mesh shirts, skirts, Capri pants, and shorts shall be prohibited.

f. While hazardous operations are being conducted or hazardous conditions are present, persons incapable, without the assistance and/or resistance of others, of ascending and/or descending ladders or stairs within both the direct and/or alternate evacuation routes from the hazardous facility shall not be permitted access requiring such ascent or descent. An individual may not be permitted access to work in any facility conducting hazardous operations if the individual is not capable of performing the essential functions of a position in question, either with or without reasonable accommodation, without endangering the health and safety of that individual or others.

3.2.1 NON-OPERATIONAL PERSONNEL WITH OFFICIAL TOURS/TOUR GROUPS

a. Approval

(1) All visitor tours shall be scheduled through NASA KSC External Relations.

(2) VIP Guests accessing the VAB roof must also comply with the requirements of section 3.2.2, “Special Requirements for VAB High Bay Roof Access for Non-operational Personnel,” below.

(3) Tours of facilities or buildings shall be prohibited during hazardous operations with control areas greater than 25 feet.

(4) Prior to the commencement of tours of facilities/buildings where hazardous operations with control areas less than 25 feet are being conducted, tour escorts shall obtain approval from the controlling authority having ownership of the hazardous process(es). Tour escorts shall report to the controlling authority at the time of the tour to confirm that the approved tour can be conducted.

NOTE: The controlling authority varies by facility but may be the NASA Test Director (NTD), Chief Test Conductor (CTC), Facility Operations Desks, or the Test Team Director/Manager/Lead.

b. Escorts

(1) All tours must be led by a qualified and designated escort.

(2) A qualified escort is one who:

(a) Has completed escort training provided by NASA KSC External Relations.

(b) Is familiar with the facilities being visited and the associated hazards.

(c) Has unescorted access approval for all areas being visited.

(3) There shall be a minimum of 1 escort for every 15 tour participants for the OPF, and 1 escort per 25 participants for VAB, with a max of 30 guests at any time in the OPF and 50 guests at any time in the VAB.

(4) The escort shall remain with the tour participants at all times.

(5) Tour escorts shall ensure that the tour does not deviate from the planned itinerary.

(6) The escort is responsible for ensuring tour participants understand and comply with all rules and requirements.

(7) For tours inside LC39 facilities, the escort shall call the Chief Test Conductor (CTC) a minimum of 24 hours prior to the commencement of the tour to verify the itinerary.

c. Attire

(1) All tour participants shall be attired in long pants, and completely closed shoes with low- and wide-heels.

(2) For tours inside processing facilities, all participants must be uniquely and obviously identifiable as part of a tour group through the use of approved badges, stickers, or other approved methods.

d. Age Restrictions

(1) Due to potential hazards, tour participants shall be at least 12 years of age in order to enter processing facilities.

(2) Exceptions to this age restriction may be made on a very limited basis and require a formal written approval signed by the KSC Center Director or designee. The tour escort must have a copy of the approval with them while conducting the tour. If underage children are allowed in a processing area, at a minimum, there will be one responsible adult per child, and a NASA Safety Specialist will be required to accompany each tour group that includes underage children.

e. Mobility Restrictions

Persons participating in the tour who are incapable, without the assistance of others, of ascending and/or descending ladders or stairs or negotiating other potential obstacles to reach both the direct and/or alternate evacuation routes from a hazardous facility shall not be permitted access requiring such egress.

f. Controlled Areas

(1) Personnel wishing to conduct tours within safety-controlled/hazardous areas during periods when no ongoing hazardous operations are taking place shall obtain consent from the NASA KSC safety organization and (where applicable) the contractor safety organization having operational jurisdiction.

(2) Personnel shall not be allowed to enter safety-controlled/hazardous areas for tours during ongoing hazardous operations.

g. Special Requirements for Tours Associated with Launch Activities

In order to allow continued safe and efficient operations in hazardous operating facilities while accommodating official tours and protecting tour guests, the following requirements shall apply to all official tours associated with shuttle launch activities beginning at the start of the launch countdown.

The following limits are placed on specific facilities:

(1) One 50 passenger bus per available OPF bay per hour

(2) Two 50 passenger buses per hour in the VAB

(3) One 50 passenger bus per hour in the SSPF

(4) Launch Pad tours (inside Pad perimeter) shall not be conducted after the S0071 Stage Two Hyper Press activity which is determined on a launch-by-launch basis, and which could occur on L-6, L-5, or L-4 days.

h. Tour Buses

Tour buses shall not enter the fenced perimeter of a flight hardware processing facility with the following exceptions:

(1) Special tours as defined by the Center Director. These tours shall be coordinated in advance with NASA KSC Safety

(2) Approved buses are permitted inside the VAB fence to drop off guests and may remain parked inside the fence until guests return. Approved buses are GSA buses, buses operated by the KSC Visitor Center contractor when supporting NASA tours, or buses that have been checked by Security.

i. Access Above Floor Level In OPF Bays or VAB, or Above the Surface Level of the Launch Pads

Tour participants are not allowed above ground floor level in the VAB and OPF bays, or above the surface level of the Pads unless it is part of the official agenda which is released by NASA KSC External Relations. The agenda must be coordinated though the Director of Launch Vehicle Processing or designee. Prior to accessing an upper level, the tour leader shall check with the facility operations desk for clearance.

3.2.2 SPECIAL REQUIREMENTS FOR VAB HIGH BAY ROOF ACCESS FOR NON-OPERATIONAL PERSONNEL

Only certain nonoperational personnel considered “high level KSC stakeholders” shall be allowed VAB roof access as approved by senior management on a case-by-case basis. The following requirements and restrictions apply.

a. Approvals

Shuttle-Specific Requirements for this section are contained in Chapter 18.

(1) Access to the VAB roof shall be coordinated by the sponsoring organization and approved in advance and in writing by the Director of Launch Vehicle Processing OR the Director of External Relations; AND the Chief, Institutional S&MA Division, or designee.

(2) The approval letter shall include the date, anticipated time of the visit, the size of the group and any other pertinent information, and be distributed to the CTC Office, NASA Test Director (NTD) Office, the VAB Site Manager, VAB Site Safety, and Launch Vehicle Operations Contractor Security. Any last minute changes to group size (increases) shall strictly adhere to the requirements stated herein.

b. Escort Requirements

(1) Visitors shall be accompanied by a KSC sponsoring organization escort, and the VAB Site Manager or VAB Site Safety appointed designee.

(2) Escorts shall be trained in VAB emergency evacuation procedures, including locations of the Marshalling Areas.

(3) The VAB Site Manager or site safety representative shall possess a 2-way radio with access to radio nets 105 and 205.

(4) Escorts shall provide a safety briefing including requirements, restrictions, and emergency egress procedures.

c. Personnel Limits

A group granted VAB roof access shall be limited to eight or less, exclusive of the escorts.

d. Hazardous Operations

VAB roof access for these non-operational personnel will be allowed only when there are no hazardous operations being conducted in or around the VAB area including launch countdown and landing. The VAB Site Manager or VAB Site Safety appointed designee shall coordinate with the CTC to ensure that no hazardous operations are occurring during the visit.

e. Personnel Requirements

The following requirements shall be discussed with the tour participants prior to touring the VAB as part of the safety briefing mentioned above. It will be the responsibility of the tour sponsor to ensure they are included in that briefing.

(1) All visitors must comply with NASA, KSC, and other applicable safety and health policy directives, guidelines, and procedures.

(2) All tour participants shall be attired in shoes and clothing that satisfy the requirements presented in section 3.2.e of this KNPR.

(3) VAB roof tours are limited to visitors aged 18 and over. VAB roof visitors under the age of 18 require formal written approval from the Director of Launch Vehicle Processing, the Director of External Relations, the Director of Safety and Mission Assurance, and the Center Director. In addition, for visitors under the age of 12, the requirements of section 3.2.1.d apply.

(4) Personnel shall be physically able to exit by staircase without assistance in the event of an emergency. The VAB is equivalent to a 52-story building. Elevators shall not be used during emergency evacuation or drill.

(5) No sharp objects, backpacks, coolers, untethered cameras, cell phones, or talk-back pagers are allowed.

(6) Loose items at risk of falling shall be removed and stored, tethered, or otherwise secured.

NOTE: Due to the brightness and reflection on the VAB roof, ultraviolet protective sunglasses are recommended.

f. Access limitations

(1) VAB roof access shall be limited to the large flat area within the railings.

(2) VAB roof access shall be allowed only during times when the weather is acceptable (e.g. no weather advisories for high wind, rain, lightning, etc).

(3) VAB roof access may be denied as circumstances may warrant, such as roof construction, and is at the discretion of the CTC, NASA NTD, VAB Site Manager, VAB Site Safety appointed designees, their NASA counterparts, or the official escorts.

g. Emergency scenarios

In the event of any type of emergency, the VAB Site Manager or VAB Site Safety appointed designee shall have full authority regarding egress from the building. The emergency egress route is marked by arrows on the roof leading to the west stairwell.

3.3 PERSONNEL ACCESS TRAINING

Personnel requiring access to operations areas shall complete required area access training or be escorted by trained personnel. The operational area training course requirement listing is available from computers having connection to the System for Administration, Training, and Educational Resources for NASA (SATERN). Supervisors shall ensure that employees are familiar with designated facilities where they work or routinely visit. All training will be automatically recorded in SATERN.

3.3.1 AREA AND SPECIAL ACCESS REQUIREMENTS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

These requirements are program-specific and shall be developed by the program and documented elsewhere, if applicable.

3.3.2 SPECIAL CREW TRAINING REQUIREMENTS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

These requirements are program-specific and shall be developed by the program and documented elsewhere, if applicable.

3.4 REFRESHER TRAINING

a. Employees working on an assigned basis in and around the areas for which access has been granted shall not be required to attend formalized classroom or videotaped area access safety training for maintaining currency. The supervisor shall ensure that emergency procedures are covered during periodic safety meetings.

b. Employees not working on an assigned basis in and around the areas for which access has been granted shall comply with the three-year refresher training requirements. However, Emergency Life Support Apparatus (ELSA) training is required each year.

c. Supervisors shall ensure the employee record is updated in SATERN.

3.5 MAXIMUM WORK TIME

3.5.1 GENERAL

The KSC Maximum Work Time (MWT) requirements are in place to ensure that people do not work excessive hours. Work for prolonged hours or for extended periods without adequate time off can contribute to fatigue, which can lead to an unsafe act or condition. Long work hours can negatively impact a person's life away from work, as well as compromise safety and mission success at KSC. Therefore it is necessary to mitigate the risks associated with excessive work by imposing work hour limits.

a. Civil Service and Contractor supervisors shall ensure employee knowledge and enforcement of KSC MWT requirements. Supervisors are also encouraged to ensure that workers are educated on the causes and effects of fatigue.

b. All on-duty periods for employees shall be recorded and counted towards their total work time hours.

c. For situations involving unpaid duty time (e.g., NASA travel to required duty stations), supervisors shall ensure persons in critical positions receive adequate rest periods prior to performing critical tasks.

d. NASA supervisors shall ensure that all work performed by individuals in their organizations beyond normal duty hours is processed in accordance with section 3.5.5 of this KNPR.

e. Contractor organizations shall abide by the applicable documents addressing such compensation issues for them.

3.5.2 APPLICABILITY

a. The KSC MWT limits shall apply to persons in critical and noncritical positions as described in Figure 3-1.

To Whom MWT Applies	**1) When MWT Applies** **2) Which MWT Provisions Apply** **3) Approval Reporting and Recording Requirements for Deviations and Violations**	**Where MWT Applies**
KSC Civil Service Employees and KSC Contractors **Working in Positions Designated as Critical**	1) Always 2) All MWT provisions 3) Yes (per this document)	Any duty station
KSC Civil Service Employees and KSC Contractors **Working in Noncritical Positions**	1) Always 2) All MWT provisions 3) No	Any duty station

FIGURE 3-1: MAXIMUM WORK TIME (MWT) APPLICABILITY TABLE

b. Visiting employees (i.e., NASA and contractor) from other NASA Centers shall adhere to their Center's MWT policies and requirements.

c. Host KSC organizations shall familiarize other visitors (e.g., Launch Service Providers, Payload Customers, International Partners, Academia) with the KSC MWT requirements herein to the maximum extent possible.

d. Visitors shall not work in excess of 16 consecutive hours. No MWT records are required for visitors.

3.5.3 CRITICAL POSITIONS

a. A critical position is one in which the worker's job performance can directly impact ground safety, flight safety or mission success. In the types of positions delineated herein, there is not more than one level of check and balance regarding the employee's decisions or actions. This includes but is not limited to:

(1) Workers dealing directly with flight hardware/software or ground support equipment.

(2) Employees having authority to make decisions on flight hardware or software processing.

(3) Workers involved in launch or landing activities.

(4) Personnel who work on ground systems that have a functional or physical interface with flight systems.

(5) Employees working hazardous sequences of hazardous procedures.

NOTE: The phrase "not more than one level of check and balance" is clarified as follows for the types of positions delineated above. A technician performing and directly checking a task alone is considered to be a "Zero level of check and balance". Examples of "one level of check and balance" includes, but is not limited to: Technicians performing tasks that are directly checked by a quality control specialist; technicians performing tasks that are directly checked by an engineer; technicians performing tasks that are directly checked by a supervisor; and engineers performing tasks that are directly checked by a supervisor. [For these instances, both the individual performing the task and the individual directly checking the task are incumbents of a critical position.]

b. Examples of positions that can be designated as critical include, but are not limited to: NASA Test Directors, systems engineers, and quality assurance personnel. KSC Civil Service and KSC Contractor employees whose duties require that they be in a critical position only occasionally are considered to be in a critical position for the entire fiscal year.

3.5.4 MAXIMUM WORK TIME PROVISIONS

a. Supervisors are responsible for monitoring and maintaining accurate records of employees work hours and forecasting their work schedules to ensure MWT requirements conformance.

b. Employees shall not work in excess of:

(1) 12 consecutive hours [16-hours during a Program Declared Emergency (PDE)/Center Declared Emergancy (CDE)]

(2) 60 hours during a workweek (7-day period)

(3) 7 consecutive days without at least 1 full day off

(4) 240 hours during a 4-week period, or

(5) 2500 hours during a rolling 12-month period.

3.5.5 EXCEEDING MWT LIMITS FOR PERSONS IN CRITICAL POSITIONS

As noted in section 3.5.1.d, it is the responsibility of the program/project or organizational Director to ensure that persons in critical positions adhere to the MWT provisions herein. It is recognized that there are situations when the MWT limits must be exceeded. However, when possible, these situations shall be preapproved in the form of a deviation.

3.5.5.1 Approval/Recordkeeping of MWT Deviations

a. For persons in critical positions, the program/project or organizational directorate shall document MWT deviations including the date, rationale, required approvals, and mode (verbal or written) of approval.

b. Verbal and electronic approvals shall be permitted if a written one is not possible.

c. All verbal/electronic approvals shall be documented within 24-hours of the event or by close of business the next regular work day.

d. Deviations shall be maintained and made available for review by the approving organization.

e. Program/project or directorate organizations shall report deviations from these MWT requirements to their organizational Director on an ongoing basis.

3.5.5.2 MWT Violations

a. Events that result in the maximum work time requirements being exceeded without preapproval are classified as MWT violations.

b. Program/project or directorate organizations shall immediately report MWT violations by persons in critical positions to their organizational Director.

3.5.5.3 MWT Requirements For Persons In Critical Positions

a. Persons in critical positions shall not work in excess of 12 consecutive hours, except when no other alternatives are available, and only with an approved deviation from the employee's immediate supervisor or higher. The deviation authorizes the employee to work up to an additional 4-hours, for a total of 16 consecutive hours.

b. 16 consecutive hours shall be exceeded only during a Program Declared Emergency (PDE) or Center-wide Declared Emergency (CDE) (PDE and CDE are described in section 3.5.6.a and section 3.5.6.b, respectively).

c. Under PDE or CDE conditions, the immediate supervisor and organizational Director or designee must approve the deviation for additional hours before the employee is to work them.

d. Under no circumstances shall employees be required to work so that they do not have a minimum of 8-hours off duty between shifts.

e. Persons in critical positions shall not work in excess of 60 hours during a workweek (7-day period).

f. Preapproval from the immediate supervisor (or higher) shall be required for deviating from the 60-hour workweek limit.

g. A separate deviation shall be required for each additional day that the employee needs to work during the 7-day period.

NOTE: For example, if an employee has an approved deviation to work more than 60 hours, the deviation is good only for the day on which 60 hours within a 7-day period is exceeded. Another deviation will be required for each additional day that the employee needs to work during the 7-day period.

h. Persons in critical positions shall not work in excess of 7 consecutive days without at least 1 full day off.

i. Preapproval from program/project or organizational directorate [NASA Division Chief, Contractor Director direct report level (or higher)] shall be required to deviate from the restrictions regarding working in excess of 7 consecutive days.

j. Program/project or organizational directorate (NASA Division Chief; Contractor Director direct report level [or higher]) approval of an additional deviation is required to extend the employee to work up to a total of 14 consecutive days.

k. Extensions allowing up to 14 days of consecutive work shall require that the requesting program/project or organizational directorate specify the additional day(s) requested (not to exceed seven additional days), as well as provide justification detailing how the additional days requested matches the work profile of the operational/processing scenario.

l. At the end of the extension period (i.e., for 8 through 13 consecutive days worked), the employee must be given a minimum of 1 full day off.

m. It is recognized that certain, limited operational/processing scenarios prohibit full compliance with the 14 consecutive day limit. In these situations, the contractor program/project or organizational Director [with government counterpart Director (or designee) signature] shall be permitted to preapprove an additional deviation to extend the employee to work up to a total of 18 consecutive days.

n. For NASA civil servants, the preapproval of an additional deviation to extend the employee to work up to a total of 18 consecutive days shall require approval of the program/project or organizational Director (or designee) and the Director of S&MA .

o. The requesting program/project or organizational directorate shall specify the additional day(s) requested (not to exceed four additional days), as well as provide justification detailing

how the additional days requested match the work profile of the operational/processing scenario.

p. At the end of the extension period (i.e., for 14 through 18 consecutive days worked), the employee shall be given a minimum of 2 full days off.

q. Employees shall not work more than 18 consecutive days unless a PDE or CDE (PDE and CDE are described in section 3.5.6.a and section 3.5.6.b, respectively) is in effect.

r. Specific operational/processing scenarios approved by the S&MA Director shall be exempted from the consecutive day deviation requirements, since the work profile is such that exceeding the limits is a reasonably expected condition, and the nature of the work is such that the limits can be exceeded without causing excessive employee fatigue."

s. Persons in critical positions shall not work in excess of 240 hours during any 4 consecutive work weeks (e.g., Sunday through Saturday).

t. A deviation from the restriction of working beyond 240 hours during 4 consecutive work weeks shall require preapproval from the immediate supervisor (or higher).

u. Persons in critical positions shall not exceed 2,500 hours during a rolling 12-month period.

v. Approval from the immediate supervisor, program/project or organizational Director or designee, and the Director of S&MA or a designee shall be required for deviations from the restrictions on working beyond 2,500 hours during a rolling 12-month period.

3.5.6 PLANNING FOR DEVIATION SURGES AMONG CRITICAL POSITIONS

a. A process called a Program Declared Emergency (PDE) provides program/project or organizational Directors a planning tool to account for a large number of deviations in advance of an event or circumstance.

(1) A PDE shall be issued by a program/project or organizational Director or a designee during a phase of their planning when they determine that the task ahead exceeds their available resources for addressing the task within the MWT requirements.

(2) The normal MWT approval and recording process described in section 3.5.5.4 of this KNPR shall be required for deviations during such a period.

(3) After declaring the PDE, the program/project or organizational Director shall provide the rationale to the Director of S&MA.

b. MWT limits may also be exceeded when a Centerwide Declared Emergency (CDE) is issued. A CDE goes into effect by the authority of the Center Director or designee, in the event of an emergency or a threat to the Center (e.g., natural disaster or terrorism).

3.5.7 RECORDKEEPING FOR CRITICAL POSITIONS

a. The approving program/project or organizational directorate shall maintain work time data. Individual program/project or directorate organizations may utilize MWT deviation/violation

documentation approached (e.g., forms, logs, summary lists) as deemed appropriate for their organization.

b. With the exception of the 2500-hour MWT limit, the fiscal year (Oct. 1 – Sept. 30) and the fiscal day, which changes at midnight, shall be used for data evaluation and maintenance of records.

c. Approving organizations shall ensure that work time data is available for review.

d. Program/project or organizational Directors shall ensure the development and maintenance of a list that identifies and documents critical jobs and individuals assigned to critical positions.

e. Updates to the list identifying and documenting critical jobs and individuals assigned to critical positions shall be accomplished when changes occur.

f. A copy of this listing shall be provided to the Institutional S&MA Division, Institutional Safety Branch at the beginning of each fiscal year (no later than Oct. 15th).

g. Program/project or organizational Directors shall ensure records preparation, retention, and periodic review of the monthly MWT deviations.

h. Records shall be retained for a minimum three-year period.

i. Program/project or organizational Directors shall prevent deviations from becoming the norm by analyzing MWT data for trends to prevent system abuse.

j. Organizations shall implement corrective actions, which may result in actions such as schedule changes, staffing adjustments, and employee counseling.

k. Program/project or directorate organizations Directors shall submit a monthly maximum work time report no later than the 15th day of the following month, to the Institutional S&MA Division.

l. In addition to the preceding requirement, KSC Contractors shall also send work time data to their corresponding NASA contract oversight organization by the 15th day of the following month.

m. The reports from NASA and contractors shall include all work time deviations in each of the categories (e.g., 12-hours worked in one day) the number of maximum work time violations that have occurred in each category.

n. In the event that an employee has multiple deviations at the same time (e.g., in order for employee to perform the required work, he must exceed 12-hours for one day and that will result in more than 60-hours work in a 7-day period), then the employee requires two separate deviations to perform the work, and each deviation must be documented in the report.

CHAPTER 4: CONTROL AREAS

4.1 GENERAL

4.1.1 For launch operations at Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base, impact limit lines shall be as established by the 45th Space Wing and 30th Space Wing respectively. For other launch sites, impact limit lines shall be established by the appropriate range safety organization as determined by NASA Range Safety.

4.1.2 Control areas for radiation hazards are addressed in KNPR 1860.1, "KSC Ionizing Radiation Protection Program," KNPR 1860.2, "KSC Nonionizing Radiation Protection Program," and as specified in the user organization's Radiation Use Authorization.

4.1.3 **Reserved**

Shuttle-Specific Requirements for this section are contained in Chapter 18.

4.2 FACILITY CONTROLS

4.2.1 Controls shall be established for use of and entry into any facility where internal combustion engines are used or are located in close external proximity to the facility where exhaust gasses could be introduced into the building's breathing air.

4.2.2 Access to building roofs, elevated structures, and motor vehicle roofs shall be limited to personnel performing authorized work or as designated for the performance of launch and landing requirements. Where building rooftops or elevated structures are designated for personnel traffic, controls and safeguards shall be established for personnel protection.

4.2.3 An Emergency Procedure Document (EPD) shall be produced for work areas where hazardous operations are performed in order to provide the processing team with procedures to be followed if an emergency occurs at anytime in the facility. Reference KNPR 8715.2, Comprehensive Emergency Management Plan, for specific details.

4.3 CONTROL AREA ANALYSIS

4.3.1 A control area shall be established by the program/project or directorate organization for each hazardous operation.

4.3.2 A safety engineering assessment shall be performed by the program/project or directorate organization to establish a control area for a new operation or to change an existing control area. The assessment shall identify the reason for the change, the impact if the proposed change is not approved, and address, as a minimum, the areas listed below. The format of the assessment is at the discretion of the user organization, provided all areas are adequately addressed. The assessment shall be disseminated to the appropriate organizations, including affected contractors.

a. Operation Description

Describe the task to be performed.

b. Operation Location

State the location of the operation. Describe how the immediate environment and atmospheric conditions affect the operation. Also state the possible impacts on the location and surrounding environment in the event of an accident during the operation.

c. Hazard Potential

Identify all credible hazards associated with this operation, including the worst case scenario.

d. Proximity of People

Describe how the operation, or an accident during the operation, will affect personnel who were not involved in the operation and were outside of the control area.

e. Proximity of Other Hardware

Describe how the operation, or an accident during the operation, will affect hardware that was not involved in the operation.

f. System Design

Describe elements of the system design that could have an impact on the safety or accident potential of the operation.

4.4 MANLOADING LIMITATIONS OF HAZARDOUS OPERATIONS CONTROL AREAS

4.4.1 Manloading shall be determined and implemented for each hazardous control area.

4.4.2 Hazardous operations shall expose the minimum number of people, to the smallest quantity of hazard for the minimum period of time.

4.4.3 A safety engineering assessment shall be performed by the program/project or directorate organization to establish new manloading requirements or to change existing manloading. The assessment shall identify the reason for the change, the impact if the proposed change is not approved, and address, as a minimum, the items listed below. The format of the assessment is at the discretion of the user organization, provided all areas are adequately addressed. The assessment shall be disseminated to the appropriate organizations, including affected contractors.

a. Personnel Essential to the Operation:

Identify essential personnel roles and responsibilities

b. Area Structural Capabilities

Verify that structural capabilities of the area are adequate to support the proposed manloading level. No increase in previously approved/documented structural capabilities is authorized with this assessment.

c. Rescue Capabilities

Verify that rescue capability of the area for the proposed manloading level is adequate.

d. Ergonomics

Verify that adequate workspace is available to safely perform work at the proposed manloading level.

e. Means of Egress Capabilities

Verify that adequate means of egress of the area for the proposed manloading level exist. Any changes shall include an additional safety engineering assessment as part of the rationale.

4.5 MANLOADING LIMITATIONS OF COMPARTMENTS

4.5.1 Hazardous manloading controls for KSC compartments shall reduce the exposure to the minimum number of people, the smallest quantity of hazard, and the minimum period of time.

4.5.2 A safety engineering assessment shall be performed by the program/project or directorate organization to establish new manloading requirements or to change existing manloading requirements for compartments. The assessment shall identify the reason for the change, the impact if the proposed change is not approved, and address, as a minimum, the items listed below. The format of the assessment is at the discretion of the user organization, provided all areas are adequately addressed. The assessment shall be disseminated to the appropriate organizations, including affected contractors.

a. Working Environment/Air Quality

Verify that adequate air quality exists to support the proposed manloading level based on compartment volume, delivered flow rate, and air exchange rates.

b. Ergonomics

Verify that adequate workspace in the compartment is available to safely perform work at the proposed manloading level.

c. Compartment Structural Capabilities

Verify that structural capabilities of the compartment are adequate to support the proposed manloading level.

d. Rescue Capabilities

Verify that adequate rescue capability of the compartment exists for the proposed manloading level.

e. Means of Egress Capabilities

Verify that adequate means of egress of the compartment exists for the proposed manloading level.

CHAPTER 5: OPERATIONAL SAFETY

5.1 SAFETY MONITORING OF HAZARDOUS OPERATIONS

The program/project or directorate organization shall perform a safety engineering assessment for all hazardous operations to ensure compliance with established safety and health requirements and standards. The format of the assessment is at the discretion of the user organization, provided all areas are adequately addressed. The assessment shall be disseminated to the appropriate organizations, including affected contractors. The assessment shall identify, as a minimum, the areas listed below.

a. The appropriate control.

b. The acceptable level of safety coverage (full-time, part-time, or optional) during the operation based on the likelihood that, in the event of an emergency, the effect will:

(1) Extend outside the specified control area.

(2) Cause personnel injury/exposure.

(3) Result in major equipment/facility damage.

5.2 NONROUTINE HAZARDOUS OPERATIONS/TESTS REQUIREMENTS

Hazardous operations/tests shall be considered nonroutine when all of the following characteristics are present:

a. The operation/test has the risk of injuring personnel or damaging facilities, equipment, or flight hardware.

b. The operation/test is not considered standard/recurring work.

c. The operation/test is not covered by technical operating procedures (per Chapter 9 of this KNPR).

d. The operation/test is not covered by a construction safety program.

5.2.1 Directorate and Organization

a. Directors of the organizations performing nonroutine hazardous operations/tests shall be held accountable for the safety of these operations/tests.

b. Organizations shall include in their planning process sufficient time to allow for the appropriate safety review.

c. Each directorate involved in research and test activities shall:

(1) Maintain a list of nonroutine hazardous operations/tests conducted at onsite/offsite KSC locations and utilizing KSC-owned facilities, laboratories, equipment, or flight hardware.

(2) Establish internal procedures to review the potential safety and health impacts of these operations/tests and ensure proper mitigation is in place.

d. Directorates conducting nonroutine hazardous operations/tests shall make available to senior management a schedule of all nonroutine hazardous operations/tests to allow tracking of these activities on the Center.

e. Directorates conducting the nonroutine hazardous operations/tests shall provide status of ongoing nonroutine hazardous operations/tests in the Center Director Weekly Notes.

5.2.2 Hazard Analyses and Test Procedures

a. The directorate-level organization performing the operation/test shall perform and document a hazard analysis for the operation/test to be conducted.

b. The hazard analysis shall:

(1) Identify safety and health hazards associated with injury/death of personnel or loss of/damage to facilities, equipment, or flight hardware for these activities.

(2) Address concerns associated with nonroutine hazardous operations/tests that pertain to compliance with OSHA, EPA, NASA, KSC, and other applicable Federal and state regulations.

(3) Show the use of appropriate S&MA analysis methods.

(4) Clearly identify mitigations and residual risk associated with identified hazards.

c. The organization performing the operation/test shall develop formal detailed procedures:

(1) In accordance with the requirements of Chapter 9 of this KNPR.

(2) Adhering to general industrial safety and health requirements for these activities.

(3) Ensuring that hazards are clearly controlled.

(4) Including clearly identified criteria to stop the test.

(5) Defining a minimum set of specific instructions that are required to safely perform a test.

5.2.3 Directorate-Level Safety and Health Review Board

a. All directorates performing nonroutine hazardous operations/tests shall establish a Directorate-Level Safety and Health Review Board that includes representation from directorate management, the organization performing the test, and the Institutional Safety and Mission Assurance Division.

NOTE: Representation from the Aerospace Medicine and Occupational Health Branch, Protective Services Office, Propellants and Life Support Branch, and other organizations may be required.

b. The Directorate-Level Safety and Health Review Board shall:

(1) Ensure appropriate safety and health review of the proposed operation/test to include the hazard analysis and required procedures.

(2) Propose a risk assessment classification for the operation/test to the Institutional Safety and Mission Assurance Division board member based on the definitions of “consequence” and “likelihood” as presented in Appendix A of this KNPR.

c. Based on the risk assessment proposed by the Directorate-Level Safety and Health Review Board, the Institutional Safety and Mission Assurance Division shall assign a risk level to the nonroutine hazardous operation/test.

d. Directorates who perform nonroutine hazardous operations/tests infrequently and therefore do not have an established Directorate-Level Safety and Health Review Board shall utilize the NASA safety organization supporting them to review their operations/tests.

5.2.4 Approval Process

a. The approval level required for the nonroutine hazardous operation/test shall be determined by the risk level assigned by the Institutional Safety and Mission Assurance Division as detailed in the following 5x5 risk matrix.

Likelihood							
	Very Likely	5	Responsible Safety Organization[1]	SA Director	CD	CD	CD
	High	4	Responsible Safety Organization[1]	GRRP	SA Director	CD	CD
	Moderate	3	Responsible Safety Organization[1]	SA-E	GRRP	SA Director	CD
	Low	2	Responsible Safety Organization[1]	SA-E	SA-E	GRRP	SA Director
	Very Low	1	Responsible Safety Organization[1]	SA-E	SA-E	GRRP	GRRP
Note 1: The “Responsible Safety Organization” is the safety organization that supports the operating organization.			1	2	3	4	5
			Very Low	Low	Moderate	High	Very High
			Consequence				

Figure 5-1: Nonroutine Hazardous Operations/Tests Risk Approval

b. The Responsible Directorate Management shall approve all nonroutine hazardous operations/tests.

c. The risk level shall assign the highest level of approval authority for a given nonroutine hazardous operation/test; the approval process is escalating, beginning with the Responsible Safety Organization, moving through increasingly higher levels of approval authority, and ending at the highest level approval authority indicated by Figure 5-1.

5.2.5 Operational Requirements for Hazardous Operations/Tests

a. When testing beyond previously demonstrated conditions, the test setup shall be designed for the worst case scenario, with proper safety mitigations implemented.

b. If any anomalous event occurs, testing shall be suspended and the issue recorded, examined, and the results determined acceptable prior to continuing the test.

5.3 TOOLS

a. All tools and equipment shall be tethered when in processing facilities above and around flight hardware or when in working environments where there is the potential for personnel injury, equipment damage, or where the tools may become Foreign Object Debris (FOD) in an inaccessible area.

b. Tools used in flight hardware processing facilities shall be traceable to their storage location.

5.4 PRETASK AND PRETEST BRIEFINGS

Pretask and pretest briefings shall be performed as follows:

a. A pretask briefing shall be performed prior to all hazardous sequences within a technical operating procedure (TOP) when two or more personnel are involved.

b. If shift change occurs prior to the completion of the hazardous sequence, then the appropriate briefings shall be repeated for the relieving employees.

c. The following items shall be addressed in pretask briefings: specific hazards to which personnel will be exposed; safety protective equipment; emergency alarms; evacuation routes; emergency instructions; Emergency Procedures Documents (EPDs); and the specific revision of TOPs to be used.

d. A pretest briefing is required for integrated TOPs that require a major control area. The pretest briefing shall be held within 72 hours (96 hours in the event of a Center-wide 3-day weekend) prior to the start of the operational or control sequences of a TOP.

5.5 SAFETY INSPECTIONS AND WALKDOWNS

The program/project or directorate organization shall perform the following safety inspections and walkdowns for their assigned work area(s). All discrepancies shall be documented in accordance with Chapter 9 of this KNPR. Required inspections and walkdowns shall be conducted as follows:

a. Readiness Inspections

A readiness inspection shall be accomplished and documented for areas/facilities/systems that have undergone construction or modification work which changes configuration or hazards involved in the process.

b. Preoperational Inspections

A preoperational inspection shall be accomplished and documented within 24 hours prior to the start of all operations having a major control area.

c. Operations Inspections

An operations inspection shall be accomplished and documented immediately prior to the start of any hazardous operation.

5.6 HEAT-PRODUCING DEVICES

5.6.1 NONFLAME, HEAT-PRODUCING DEVICES

a. Nonflame/heat producing devices used within 10 feet of flammable, combustible or explosive materials shall require the applicable organization to obtain a Welding and Burning Permit (KSC Form 2-271), or shall utilize a controlling TOP that contains documented engineering risk assessment controls approved by a safety professional.

b. When heat-producing devices are used in areas protected by a Halon extinguisher system, the system shall be placed in the manual mode prior to start of the operation.

5.6.2 ARC/FLAME-PRODUCING DEVICES

A Welding and Burning Permit (KSC Form 2-271) shall be obtained from the applicable office if a flame-producing device is required to be used within:

a. Areas containing hazardous materials.

b. The perimeter of hazardous processing facilities.

c. A control area.

5.6.3 ROOFING OPERATIONS

a. Roofing operations involving use of a tar kettle require obtaining a Tar Kettle Operation Hot Work Permit (KSC Form 2-272).

b. Roof torch down operations require obtaining a Torch Down Roof Operations Hot Work Permit (KSC Form 2-270).

5.6.4 SPARK-PRODUCING DEVICES AND SMOKING

Shuttle-Specific Requirements for this section are contained in Chapter 18.

Spark-producing devices and smoking shall be prohibited within the following areas:

a. **Reserved**

b. 100 feet of propellant storage containers.

c. 25 feet of propellant transfer lines.

d. 25 feet of explosives.

e. 50 feet of Launch Vehicle Transporter operations

f. 100 feet of Launch Vehicle Transporter operations with stacked or partially stacked segments.

5.7 USE OF PHOTOGRAPHIC EQUIPMENT

5.7.1 A safety engineering assessment shall be performed by the program/project or directorate organization prior to the use of all photographic equipment used within 10 feet of open grain, explosive materials, Category A Electro-Explosive Devices (EEDs) [Faraday cap removed/firing circuit exposed], open containers of flammable/combustible fluids, or when used in confined spaces where a hazardous atmosphere may be present. The assessment shall evaluate the potential for the equipment to produce an arc or spark and the ability for components to remain securely installed within or on the camera or in remotely located equipment. The format of the assessment is at the discretion of the user organization, provided all areas are adequately addressed.

5.7.2 In addition, the following requirements shall be in effect:

a. The camera and all attached parts shall be tethered to the photographer.

b. All camera parts shall be self-contained and unable to fall into flight hardware.

c. Single-use, heat-producing flashbulbs, flashcubes, or sunguns shall not be permitted.

d. In hazardous atmospheres, remote-operated, hazardproofed photographic equipment shall be utilized.

e. Lighting for remote cameras shall be either Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), or Bureau of Mines approved, or shall be hazardproofed, specified for the hazard, and enclosed or shielded.

5.7.3 Cameras and electronic flash assemblies to be used inside a Solid Rocket Motor (SRM) bore shall be specified for that particular use and shall include the above requirements.

5.8 USE OF ELECTRONIC EQUIPMENT

a. All Radio Frequency (RF) transmitting devices shall be assessed and approved by the controlling safety organization prior to use in “controlled access areas.”

b. The use of headphones or earphones with personal, portable electronic devices shall be prohibited in controlled access areas where hazardous operations are conducted.

c. Electronic/Electrical equipment shall meet the National Fire Protection Agency (NFPA) 70 National Electric Code (NEC) for hazardous locations (e.g. Class I, Division 2) when used in controlled access areas during hazardous operations where combustible dusts, flammable vapors, or flammable liquids have the potential of release.

d. Cellular phones, answer back pagers, portable computers and transceivers (e.g., radios) shall not be used within 25-feet of the following:

(1) Exposed explosives or pyrotechnics

(2) Unshielded electro-explosives

(3) Unshielded electrically initiated devices

e. Only the wireless devices that appear on the Electronic, Electrical, Electromechanical (EEE) list of approved devices shall be used within an ordnance facility with a Wireless Local Area Network (WLAN).

5.9 ATMOSPHERIC MONITORING SYSTEMS

5.9.1 OXYGEN DEFICIENCY MONITORING SYSTEM (ODMS)

a. If an ODMS indicates a low oxygen condition, the applicable room, area, or compartment shall be cleared and controlled. Reentry into the affected area will require a preliminary hazard assessment for the entry under the direction of the responsible site safety representative or on-scene commander, as appropriate. The assessment will take into consideration the alarm type (deficiency vs. fault alarm), operations taking place in the location that may contribute to the alarm, safe entry procedures, and use of portable oxygen detectors and respiratory protection PPE, or other mitigations, as required.

b. A safety engineering assessment shall be performed by the program/project or directorate organization to establish requirements for areas with the potential for oxygen deficient conditions. The format of the assessment is at the discretion of the user organization, provided all areas are adequately addressed. The assessment shall be disseminated to the appropriate organizations, including affected contractors.

Shuttle-Specific Requirements for item b. are contained in Chapter 18.

5.9.2 PORTABLE OXYGEN ANALYZERS

a. Prior to the installation of a portable oxygen analyzer, the following shall be determined:

(1) The unit is operational and the battery is charged per manufacturer's specifications.

(2) The audible alarm can be heard above the noise in all areas of the compartment in which it is to be used or shall be placed in such a location that all occupants will hear it.

b. The unit shall be checked once per eight-hour shift and a log shall be maintained documenting the time, location, and the name of the person performing the check.

c. The unit(s) shall be checked and a normal oxygen (O_2) atmosphere shall be verified at the beginning of each shift prior to any work in the controlled area when the area has been left unoccupied on the prior shift.

5.9.3 HAZARDOUS GAS DETECTION SYSTEM (HGDS)

Shuttle-Specific Requirements for this section are contained in Chapter 18.

Since these requirements are program-specific, programs shall analyze the detection system, develop controls to ensure a safe operation, and document the requirements elsewhere, if applicable.

5.9.4 HYPERGOL VAPOR DETECTION

5.9.4.1 Toxic Vapor checks (TVC) shall be performed prior to entering a closed area and once per shift. If the area is closed due to a weather warning, and re-opened during the same shift TVC are not required prior to re-entering unless it is deemed required by a safety professional. Where available, a fixed continuous monitoring system for the toxic vapors present may substitute for toxic vapor checks.

5.9.4.2 If the facility has a Hypergol Vapor Detection System (HVDS):

a. The HVDS (fixed or portable) shall be operational prior to the start of all hypergolic transfer operations.

b. Sensors (fixed or portable) shall be placed in areas having the greatest potential for leaks.

c. The HVDS shall operate continuously during all hypergolic transfer operations.

5.10 CRYOGENICS

a. Any vehicle compartments that could be exposed to gaseous hydrogen accumulation shall be inerted to less than 1 percent O_2 prior to cryogenic LH_2 servicing or loading.

Shuttle-Specific Requirements for item a. are contained in Chapter 18.

b. Cryogenic fluid systems shall be depressurized, made safe, and evaluated for safe handling with respect to low temperatures before attempting any type of maintenance.

c. The oxygen content in Liquid Hydrogen (LH_2) transfer lines shall be verified less than 1% (inert) prior to start of LH_2 flow.

5.11 HAZARDOUS OPERATIONS SUPPORT REQUIREMENTS

5.11.1 COMMUNICATIONS AND TELEVISION SUPPORT

a. All hazardous operations shall require primary and backup communications between the operation's control point and the operation.

b. Recorded voice communication and Operational Television (OTV) coverage shall be required during the performance of all hazardous operations having a major control area.

5.11.2 SAFETY RADIO NET

a. Emergency forces supporting hazardous operations shall be required to maintain continuous monitoring on Safety Net 105 or Net 205. Verification of operational status shall be accomplished a minimum of once per day.

b. The Safety Net shall be used during transit and when Self-Contained Atmospheric Protective Ensemble (SCAPE) personnel are off Operational Intercommunications System (OIS).

c. Telephones or other means of radio communications shall be available for summoning assistance in emergencies in areas where hazardous operations are conducted.

5.11.3 Loss of support and equipment during any phase of the operation shall be reported immediately to the appropriate program/project organization for assessment of necessary actions.

5.12 HANDLING OF FLAMMABLE/COMBUSTIBLE LIQUIDS NEAR FLIGHT HARDWARE

Since materials and distances are specific to flight hardware, these requirements are program-specific and shall be developed by the program and documented elsewhere, if applicable.

Shuttle-Specific Requirements for this section are contained in Chapter 18.

5.13 SAFETY WARNINGS

Flashing safety warning lights, warning signs, and public address systems shall be installed at the control point, in appropriate work areas or facilities where hazardous operations exist as a part of routine work.

5.13.1 WARNING LIGHTS

Warning light designations at KSC shall be:

a. Flashing red: A danger period exists and personnel shall be cleared from the control area immediately.

b. Flashing amber: A hazard period exists and entry to the control area shall be limited to essential personnel.

5.13.2 WARNING SIGNS

Warning signs will be used in conjunction with and adjacent to warning lights as follows:

a. Warning signs adjacent to red lights shall read as follows and may contain more specific response instructions:

EMERGENCY SITUATION EXISTS
CLEAR AREA IMMEDIATELY

b. Warning signs adjacent to amber lights shall read as follows and may contain more specific response instructions:

ENTRY ON CONTROLLED BASIS
HAZARDOUS MATERIALS/OPERATIONS PRESENT
ESSENTIAL PERSONNEL ONLY

c. Paging and Area Warning System (PAWS)

An announcement, preceded by a high-pitched warbling sound (where available), shall be made when an emergency condition necessitates clearing the area immediately of all personnel.

5.14 ELEVATORS

a. All maintenance of elevators and any work performed in the elevator shaft shall require the affected elevator to be locked out.

b. Protective screens must be installed between the elevator shaft being worked on and adjacent operational elevator shafts at all levels where work shall be performed.

c. Adjacent elevators shall be locked out during protective screen installation and removal.

5.15 HAZARDOUS OPERATIONS EMERGENCY POWER

Adequate emergency power shall be required for all hazardous operations that utilize electrical power for safing or securing.

5.16 CONCURRENT OPERATIONS

Concurrent hazardous operations involving major control areas within the same facility shall require:

5.16.1 Utilization of a TOP, providing a single control point, for one or more similar operations.

5.16.2 For concurrent hazardous operations involving significant loss potential or high energy, the following shall be met:

a. The operations can be safely and quickly terminated.

b. Personnel performing the operations are provided a route of rapid exit in the event of an emergency.

c. Emergency vehicles have ready access to an emergency without proceeding through another operational cleared/controlled area.

5.17 EMERGENCY EYEWASH AND SHOWER REQUIREMENTS

5.17.1 The preservation of sight, and the minimization of the effects of chemical exposure, are the most important aspects of the policies of section 5.17. When it is determined that engineering and administrative controls cannot eliminate the hazard then the use of personal protective equipment (PPE) such as safety glasses, goggles, face shields, chemical resistant gloves and aprons, or body suits are the primary means of protecting the eyes, face and body from chemical exposure. In the event of exposure to injurious corrosives, Emergency Eyewash and Shower Equipment (EE&SE) is the best first aid measure until medical personnel arrive.

5.17.2 The EE&SE on Kennedy Space Center shall comply with OSHA and American National Standards Institute (ANSI)/International Safety Equipment Association (ISEA) Z358.1 (latest revision) with the following clarifications:

5.17.2.1 The determination for the installation/removal of EE&SE is the responsibility of the controlling entity, i.e., the “owner” of the EE&SE who is responsible for the protection of their employees.

5.17.2.2 For the installation/removal of plumbed units, the justification will be sent to the NASA KSC EE&SE Program Manager (Institutional S&MA Division). The justification for installation shall include who will perform the required inspections and maintenance and the justification for removal shall state whether or not other organizations would be impacted by the removal. The EE&SE Program Manager will review the EE&SE installation or removal justification and either concur/non-concur. This concur/non-concur will not be for the justification that a unit is required as this is the responsibility of the controlling entity, rather it will be to ensure that the installation/maintenance/inspection of the unit has been planned for, or that the removal will not negatively impact other KSC employees.

5.17.2.3 The EE&SE shall be maintained and inspected per the following:

a. Plumbed Units (potable water)

(1) Annual Inspection: Documentation that an ANSI compliant annual inspection was performed and the records of that inspection shall be maintained by the controlling entity for a period of two years. Additionally, the completed inspection of plumbed EE&SE shall be documented on KSC Form 20-202/KSC Emergency Eyewash/Shower Inspection, and affixed to the unit.

(2) Weekly Inspection:

(a) Inspections shall be documented on KSC Form 20-202, KSC Emergency Eyewash/Shower Inspection, and affixed to the unit where practical.

(b) In areas exposed to inclement weather or to salt air, the form shall be kept indoors in a known location.

NOTE: Pad A and Pad B are exempt from having the inspection form attached to the unit due to the higher incidence of FOD from launch blast.

(3) Operational Check: All EE&SE shall be verified operational, include verification that the path to the EE&SE is unobstructed, and that the inspection is current prior to commencement of operations requiring such equipment.

NOTE: Potable water on KSC is near the Mean Low Temperature of 63F, and the Mean High Temperature of 81F therefore it is assumed that the EE&SE supplied water at KSC is in the tepid range.

b. Self-Contained Units (Pressurized Units, Non-Pressurized Sealed Units)

(1) Annual Inspection: An annual inspection will be performed to ANSI or manufacturer instructions.

NOTE: ANSI inspection criteria need not include the discharging of self-contained EE&SE. Perform all other inspection criteria that can be accomplished without interfering with the integrity of the equipment.

All recommended inspections of self-contained EE&SE shall be documented on KSC Form 20-202, and affixed to the unit. Records of that inspection shall be maintained by the controlling entity for a period of two years.

(2) Other Inspections: As required by the manufacturer and documented on KSC Form 20-202, and affixed to the unit.

(3) Operational Check: All EE&SE shall be verified operational prior to commencement of operations requiring such equipment. This shall only include verification that the path to the EE&SE is unobstructed, that a current inspection is showing on the inspection tag, and that the EE&SE has not been tampered with or activated since the most recent inspection.

5.17.3 Personal eyewash (bottles) shall not be used as Emergency Eyewash; it can be provided only for irrigation and/or for removal of dirt or other particles from the eye, or for personal hygiene.

EXCEPTION: Sealed water rinse or neutralizing packs may be substituted for the quick drenching facilities where sealed storage batteries of the enclosed type are in use {CFR 29 Part 1910.268(b)(2)}. If batteries require servicing, i.e., adding electrolytes, fully functioning EE&SE equipment is required per this policy.

5.17.4 Plumbed EE&SE in facilities that are unoccupied or are not operationally required will not be verified operational until work in the facility requires the EE&SE, and shall be identified with KSC Form 20-165/Danger – Do Not Use or Operate. The EE&SE shall have a documented inspection on KSC Form 20-202 before KSC Form 20-165 may be removed and the EE&SE considered available for use. A documented annual inspection of the plumbed EE&SE shall be performed if one was required during the period of time the EE&SE was identified with KSC Form 20-165.

5.17.5 If existing EE&SE meets the requirements of OSHA 29 CFR 1910.151c, (“Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use”) but cannot feasibly meet the requirements of ANSI/ISEA Z358.1, a safety variance will be submitted per section 1.6 of this KNPR.

5.17.6 When a non-compliant EE&SE is found, KSC Form 20-165, shall be immediately affixed. Operations that require the use of the EE&SE shall not be conducted if the EE&SE is found to be non-compliant unless a documented Safety (controlling entity) approved work-around is in place. EE&SE having KSC Form 20-165, remaining after one year shall be assessed by NASA KSC EE&SE Program Manager and the controlling entity.

5.18 FOREIGN OBJECT DEBRIS (FOD)

The program/project shall implement and abide by the FOD policy in KNPR 8730.2, Quality Assurance Procedural Requirements, Chapter 17.

5.19 HYPERGOLICS

a. Hypergolic systems shall have remote safing unless NASA KSC S&MA concurs with the analysis showing it is not needed.

b. Hypergolic fluid systems shall be placed in a safe configuration (e.g., depressurized, isolated, etc.) before attempting any type of maintenance.

c. During handling of hypergolics, emergency showers shall be available for immediate use.

CHAPTER 6: UNIQUE HAZARDOUS FACILITIES REQUIREMENTS

6.1 GENERAL

a. The Vehicle Assembly Building (VAB) and Rotation, Processing and Surge Facility (RPSF) are designated as explosives handling facilities. Explosives operations shall limit the exposure to a minimum number of persons, for a minimum time, to the minimum amount of explosive material consistent with safe and efficient operations.

b. Flight hardware containing hazardous solids, liquids, or vapors shall only be permitted inside facilities which have been specifically designed for operations involving these substances, or provided with capabilities and safeguards that allow for safe storage or operations involving these substances.

6.2 VEHICLE ASSEMBLY BUILDING

6.2.1 DUAL OPERATIONS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

a. Additional crane operations involving the other 175/250/325 ton cranes shall not be permitted during lifting of flight hardware to/from the transfer aisle and high bay.

b. Confined space entry into flight hardware, fire protection outages, and Operations and Maintenance (O&M) activities requiring personnel above the tank checkout cells or on the VAB roof shall not be scheduled during the above crane operations.

c. Major hardware moves and other operations requiring opening the VAB doors shall be evaluated for impact on other operations within the building.

6.2.2 HOUSING

Personnel housing shall be minimized.

6.2.3 HIGH BAY ROOF ACCESS

Stair tower egress doors shall be configured to permit access from the interior to the roof. Only west side perimeter roof doors shall remain unlocked. East side perimeter doors shall require a key to access off the roof.

6.2.4 AFT BOOSTER AND SEGMENT LIFT

Shuttle-Specific Requirements for this section are contained in Chapter 18.

Aft booster and segment lifts shall only be permitted from the transfer aisle to within 3 feet of the holddown posts and clevis, respectively, between the hours of 4:30 p.m. to 6:30 a.m., Monday through Friday. Exceptions must have the concurrence of the KSC Launch Director, KSC S&MA Launch Vehicle Processing (LVP) Division Chief, and the Ground Operations Contractor Safety Organization Director.

6.2.5 DOOR CONFIGURATION

Shuttle-Specific Requirements for this section are contained in Chapter 18.

6.3 ROTATION, PROCESSING, AND SURGE FACILITY

The following requirements apply for processing of 1.3 Propellant.

6.3.1 DUAL OPERATIONS

Concurrent Operations - The following shall not be done concurrently in the Rotation Building:

a. Grain inspection (when man is in bore).

b. Segment lift or rotation to vertical. (Not applicable if crane is secured and segments suspended within five feet of floor.)

c. The following operations shall not be performed with (a) or (b) above. Unless the following operations violate another operation's control area or require unrelated work above open grain, no restrictions shall be imposed on performing the following operations concurrently with each other.

(1) NASA Standard Initiator (NSI) resistance measurements.

(2) Insta-Foam operations when personnel are on breathing air or inside enclosure.

(3) Nozzle preparation and mating operations require personnel inside the environmental enclosures. This also includes personnel inside the nozzle after mate.

(4) Air Load Debond Test.

(5) Personnel shall not be allowed above the build-up stands' upper levels, including roof during a. or b. above

6.3.2 HOUSING

a. The RPSF manloading level shall not exceed 80 personnel.

b. Personnel housing shall be limited to the Support Building.

c. Additional buildings, trailers, or workshops shall not be permitted within the facility perimeter fence.

6.3.3 SPECIAL REQUIREMENTS

a. Exterior doors in the Rotation Building shall be closed whenever a Faraday cap/shorting plug on an NSI or electrical cable attached to an NSI is removed.

b. Locomotives shall not enter the Rotation Building. The locomotive shall use a spacer car when moving railcars in or out of the building at all times.

c. The SRM Wagon/SRM Transporter may enter the Rotation Building without an Internal Combustion permit to move railcars or segments, providing there is no open grain. The SRM Wagon shall require a spacer car only when open grain exists in the building.

Shuttle-Specific Requirements for item c. are contained in Chapter 18

d. Work within the Surge Buildings shall be limited to periodic segment inspection and Ammonium Perchlorate (AP) cleanup when performed on each segment sequentially.

e. No more than three segments shall have open grain at any one time in the Rotation Building. Only one segment may be exposed at a time in the Surge Buildings.

f. Segments shall not be left unattended when open grain conditions exist.

g. No more than six segments shall be in the Rotation Building at a time (for a total of 22 segments located inside facility perimeter fence).

CHAPTER 7: MATERIALS PROCESSING

7.1 GENERAL

7.1.1 Materials to be used in KSC facilities in support of programs as well as KSC institutional activities [e.g., Research and Development (R&D) projects, propellant farms, laboratories, testbeds] shall be selected, tested, assessed, and approved per NASA-STD-6001A/NASA-STD-(I)-6001A (as applicable per contract), Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion (for material flammability and hypergolic ignition/breathrough characteristics) and KSC/MMA-1985-79, Standard Test Method for Evaluating Triboelectric Charge and Decay (for electrostatic discharge). For Ground Support Equipment materials, also reference NASA-STD-5005, Standard for the Design and Fabrication of Ground Support Equipment.

7.1.2 Currently approved plastic film, foam, and adhesive tape listings can be found in Kennedy Technical Instruction (KTI)-5212, Material Selection List for Plastic Films, Foams, and Adhesive Tapes.

7.1.3 KSC program and institutional organizations shall ensure associated contractor processes and procedures are implemented for safe materials selection, approval, and usage.

CHAPTER 8: KSC SUPPLEMENT TO OSHA 29 CODE OF FEDERAL REGULATIONS (CFR), PARTS 1910/1926

8.1 PERSONAL PROTECTIVE REQUIREMENTS

Personal Protective Equipment (PPE) is used as a protective barrier between an individual employee and hazardous materials or agents in the workplace. PPE is required when engineering controls have been shown to be infeasible or inadequate in eliminating or mitigating safety and health hazards (e.g., chemical, radiological, physical, electrical, mechanical). NASA KSC Civil Service and contractor organizations shall have PPE programs that are compliant with the Occupational Safety and Health Administration (OSHA) requirements referenced herein and which meet the following general requirements.

a. Splash (KSC vapor suit): The suit shall not be used for protection against hypergolic propellants.

b. Emergency Life Support Apparatus (ELSA)/Breathing Escape Unit (BEU): All breathing escape unit containers shall be “safety green” and white striped with four-inch black lettering, on a white background with a “safety green” border, stating “Breathing Escape Units.” The green and white stripes shall be two inches in width.

c. Minimum requirements for garments used at KSC during hazardous operations in noncleanroom environments are shown in Figure 8-1.

8.1.1 PPE EXCLUSIONS

This KNPR does not address the following PPE requirements areas:

a. PPE requirements associated with hearing conservation (addressed in KNPR 1820.3, KSC Hearing Loss Prevention Program and KNPR 1840.19, KSC Industrial Hygiene Programs).

b. PPE requirements associated with respiratory protection (addressed in KNPR 1820.4, KSC Respiratory Protection Program and KNPR 1840.19, KSC Industrial Hygiene Programs).

c. Unless specifically described within this KNPR, reqiurements for selection of chemical protection PPE are described in KNPR 1840.19, KSC Industrial Hygiene Program.

8.1.2 OVERALL PPE PROGRAM PREQUIREMENTS

NASA KSC Civil Service and contractor PPE programs must, as a minimum, include the following activities:

a. Conducting workplace hazard assessments to determine what equipment, operations, chemicals, and/or other workplace components could cause harm to employees.

b. Implementation of engineering, work practice, or administrative controls to eliminate or mitigate identified hazards, where feasible.

c. Selection of the correct type of PPE necessary to protect employees from identified hazards that cannot be eliminated or mitigated in accordance with section 8.1.3 of this KNPR.

d. Certification that PPE hazard assessments have been conducted.

e. Provisions for training and informing employees who utilize PPE.

f. Retraining of employees when there are workplace changes or other considerations are identified.

g. Documentation of PPE program actions taken and maintenance of PPE program records.

8.1.3 PPE SELECTIONS/USE

The selection and usage of appropriate PPE is an extremely important process, and requires an understanding of the workplace hazard(s) associated with the task, the level of protection required, and the physical/health capability of the employee using the PPE.

a. PPE usage is based on the specific safety and/or health hazards present, the type of operation to be performed, and the level of protection provided by the PPE. PPE selection must provide adequate protection for the employee while enabling the employee to perform the operation. For General Industry, PPE shall be selected and used in accordance with OSHA 29 Code of Federal Regulations (CFR) 1910, Subpart I, Personal Protective Equipment. For Construction Industry, PPE shall be seleted and used in accordance with OSHA 29 CFR 1926, Subpart E, Personal Protective and Life Saving Equipment.

b. PPE requirements for operations shall be determined based on a safety and health hazard assessment.

c. Personnel who are required to wear SCAPE Suits shall fall within approved body dimensions (min/max height and maximum girth).

d. PPE requirements shall be incorporated into the written technical operating procedure or other applicable shop instructions for an operation.

e. PPE selection for an operation shall be reviewed when changes in procedures and/or exposure hazards might alter PPE effectiveness.

f. PPE selection for chemical use shall be in accordance with the requirements of KNPR 1840.19, KSC Industrial Hygiene Programs, Section 2.6, Personal Protection Equipment.

8.1.4 PPE TRAINING/MAINTENANCE

Once PPE has been determined through the hazard assessment and selection process, employees shall be trained regarding different types of PPE and its associated usage and maintenance. This training shall be accomplished before PPE usage, and consider the following topics:

a. When PPE is necessary in the workplace.

b. What type(s) of PPE are necessary for different workplace tasks. In many cases, more than one type of PPE will provide adequate protection. In those cases, workers should be given a choice of PPE.

c. How particular PPE items are to be worn.

d. Limitations of various types of PPE, as well as proper PPE care, maintenance, useful life, and disposal.

EYE AND FACE PROTECTION	
Hazards to Consider	**Required PPE**
Splash/splatter/spray of chemicals or biological materials; cryogenic liquids	Chemical goggles or safety glasses with side shields covered by a full-face shield
High pressure cleaning or spraying	Chemical goggles covered by a full-face shield
Drilling – any flying particles or projectiles	Goggles or safety glasses with side shields
Power tools (air or electrical)	Safety glasses with side shields
Typical laboratory – chemical splash	Chemical goggles
Acetylene welding, cutting, burning, molten metals	Cutting goggles with appropriate filter lens numbers
Arc Welding and cutting	Safety glasses with side shields and welding hood with appropriate filter lens numbers
Chipping, grinding or machining – flying particles	Face shield and either goggles or safety glasses with side shield
HAND AND ARM PROTECTION	
Hazards to Consider	**Required PPE**
Skin exposure to solvents, pesticides, acids, caustic or corrosive liquids, other chemicals	Chemical resistant gloves *Contact Medical and Environmental Support Contractor (MESC) Environmental Health to conduct hazard assessment to identify exposure levels and identify required PPE*
Handling tools or materials likely to cause scrapes, cuts or bruises	Metal mesh, leather, canvas, Kevlar material or cloth gloves
Skin contact with hot surfaces	Oven mitts, Leather or aluminized gloves, arm protection
Cryogenic liquids, skin contact with cold surfaces	Cryogen mitts, leather gloves
Exposure to exposed high voltage electrical wiring, etc	Electrical insulating rubber gloves per electrical safety specifications
FOOT, LEG AND BODY PROTECTION	
Hazards to Consider	**Required PPE**
Hazards to feet related to sharp or heavy objects/equipment	Metatarsal guards, toe guards, combination foot-toe guards, safety shoes
Splash/splatter/spray of chemicals or biological materials	Pre-approved flame resistant, anti-static, clean room approved coveralls., Tyvek garment, rubberized apron, chemical splash garment, chemical resistant boots. *Contact MESC Environmental Health for hazard assessment and PPE requirement.*
Cryogenic materials, flammable liquids/gases	Pre-approved flame resistant, anti-static, clean room approved coveralls.
High voltage	Safety shoes and NFPA 70E clothing requirements.
HEAD PROTECTION	
Hazards to Consider	**Required PPE**
Work under elevated work platforms, suspended loads or low overhead clearance	Hard hats (ANSI 289.1-1986), including reduction of electric shock
HEARING PROTECTION	
Hazards to Consider	**Required PPE**
Refer to KNPR 1820.3 (KSC Hearing Loss Prevention Program) and KNPR 1840.19 (KSC Industrial Hygiene Programs) for specific recommendations	Refer to KNPR 1820.3 (KSC Hearing Loss Prevention Program) and KNPR 1840.19 (KSC Industrial Hygiene Programs) for specific recommendations
RESPIRATORY PROTECTION	
Hazards to Consider	**Required PPE**
Refer to KNPR 1820.4 (KSC Respiratory Protection Program) and KNPR 1840.19 (KSC Industrial Hygiene Programs) for specific recommendations	Refer to KNPR 1820.4 (KSC Respiratory Protection Program) and KNPR 1840.19 (KSC Industrial Hygiene Programs) for specific recommendations

FIGURE 8-1: PPE HAZARDS CONSIDERATIONS/SELECTION CHECKLIST

8.2 MACHINE SHOP SAFETY

To avoid becoming entangled in rotating machinery, gloves, identification badges, rings, and other jewelry shall not be worn, and long hair, neck-ties, and lanyards shall be restrained when working near operating rotating machinery.

8.3 SCAPE REQUIREMENTS

8.3.1 REST PERIODS/TIME-IN-SUIT RESTRICTIONS

a. When using Category I SCAPE (Figure 8-2), personnel shall observe a 60-minute rest period between consecutive SCAPE operations.

b. Time in Category IV suits (Figure 8-2) shall not exceed 4 consecutive hours.

c. The use of Category VI suits (Figure 8-2) is limited only to those operations requiring entry into a confined/limited access space not achievable by a Propellant Handlers Ensemble (PHE).

8.3.2 SHOWERING OF SCAPE PERSONNEL AND EQUIPMENT

a. All personnel shall shower immediately when exposed to Nitrogen Tetroxide (N_2O_4) liquid, and within 10 to 15 minutes when exposed to N_2O_4 vapors. Personnel may return to the workstation after showering.

b. All personnel directly involved in a fuel task shall shower thoroughly before proceeding from a fuel task to an oxidizer task or vice versa if toxic vapor parameters are exceeded. In case of actual or suspected hypergolic liquid contamination of the suit, personnel shall shower as required and shall change suits prior to switching tasks.

c. All personnel wearing a Category VI suit exposed to hypergolic liquid fuel or oxidizer or vapors heavy enough to envelop the suit shall shower for 5 minutes within 5 minutes of exposure.

d. Prior to leaving the work area for normal SCAPE operations, SCAPE personnel with:

(1) No or low hypergolic vapor residual exposure, shall shower for a minimum of 1 minute.

(2) Heavy hypergolic vapor or hypergolic liquid contamination, shall shower with all exposed tools and equipment a minimum of five minutes.

(3) Tools and equipment exposed as below shall be cleaned separately.

(a) Items exposed to hypergolic vapors only, shall be thoroughly washed by field flushing or water immersion and released for normal use.

(b) Items exposed to hypergolic liquids shall be field flushed, double bagged, and identified as “Hypergolic Contaminated.”

8.3.3 ELEVATOR SUPPORT FOR SCAPE OPERATIONS AT LAUNCH COMPLEX (LC) 39 A/B

Shuttle-Specific Requirements for this section are contained in Chapter 18.

Elevator support requirements shall be established by the program/project or directorate organization and approved by NASA S&MA for each SCAPE operation at the Launch Complex.

8.3.4 SCAPE SUPPORT

a. During periods of non-SCAPE operations, contingency SCAPE support shall be provided within 4 hours of notification.

b. During all SCAPE operations, adequate personnel shall be immediately available, onsite, to safe the system in the event of an emergency.

8.3.5 SCAPE AND COLD WEATHER OPERATIONS

The following are requirements during Category I SCAPE operations when ambient temperatures are at or below 50 degrees Fahrenheit:

a. Test Conductors/SCAPE operations supervisor shall inform the SCAPE Operators that there is a potential for Environment Control Unit (ECU) low airflow/freeze-up conditions in the cold temperature prior to operations.

b. Test Conductor/SCAPE operations supervisor shall inform all SCAPE operators, prior to operations, to egress the area if they notice reduced/no airflow, excessive fogging on the inside of the face shield, or experience discomfort due to the cold

c. The operators shall notify the Test Conductor/SCAPE operations supervisor in the event that they are experiencing low airflow/freeze-up condition.

d. Operators shall connect to a ventilator in case of low/no flow and egress operation.

e. There shall be SCAPE ventilators staged during cold weather operations for operators as required to facilitate safe egress in the event of a low/no airflow condition.

8.3.6 USE OF GLASSES

Eyeglasses worn in SCAPE, toxic vapor suits, or full-face respirators, shall be secured.

Protective Clothing and Ensembles					Approved for use with: (A = approved for use)				Hyper Ops Class		
Protective Garment Used			Type Air	Type Gloves							
Classification	Category	Type			N_2O_4	MMH	N_2H_4	Corrosives	A	B	C
SCAPE	I	PHE	Backpack	50 Mil (Note 1)	A	A	A		A	A	
SCAPE	IV	PHE	Hardline	50 Mil (Note 1)	A	A	A		A	A	
SCAPE	VI	CPS	Hardline	32 Mil (Note 1)	A	A	A	A		A	
Apron/Faceshield/ Goggles	N/A	None	None	Long Gauntlet (See Note 2)	Limited Use (see Hyper Ops Class C)						A
Apron/Supplied Air Respirator, Hyper Ops Modified Class C	N/A	None	Supplied Air Respirator (SAR)	Long Gauntlet (See Note 2)	Limited Use (see Hyper Ops modified Class C)						A

*

NOTES:

1. The standard glove for Category I and IV is 50 Mil. The use of “Thin” (32 Mil) gloves (p/n 81K00972) may be used as an option, only when the Work Authorization Document (WAD) calls for them and approval is given by the employee’s supervisor.

2. The standard glove for Category VI is 32 Mil gloves. Thin gloves are not adequate for use with N2O4 (Oxidizer) for longer than four (4) hours and will NOT be re-used due to glove deterioration.

3. Use Long Gauntlet (p/n 8BI3032), Pioneer rubber Pylox V20 or North butyl (p/n B174R) gloves.

Figure 8-2: PROTECTIVE CLOTHING AND ENSEMBLES

8.4 EMERGENCY EVACUATION REQUIREMENTS

8.4.1 Emergency evacuations shall be announced over the public address system. The announcer shall define the location and nature of the emergency specifying evacuation exits, alternate routes, and fallback area/location. The announcer shall also be responsible for activating area (flashing red) warning lights and/or the evacuation/fire alarm system, as appropriate.

8.4.2 A person shall be appointed to notify all personnel in areas of high noise level or those not within hearing range of public address speakers.

8.4.3 Upon completion of an emergency evacuation in designated areas, a head count shall be conducted in the designated marshaling area and then the Incident Commander, CTC, or Test Director (TD) shall be notified of any unaccounted for persons.

8.4.4 The Pad Emergency Egress System shall be operational at all times except during scheduled outages.

Shuttle-Specific Requirements for section 8.4.4 are contained in Chapter 18.

8.4.5 Breathing Escape Units (BEUs) are required in work areas where a potential exists for the rapid development of an Immediately Dangerous to Life or Health (IDLH) atmosphere, and no immediate means exists for the affected employees to egress the IDLH area to a safe atmosphere. Requests for permanent deployments or removal shall be made to the KSC Respiratory Protection Panel where a determination will be made and documented in accordance with KNPR 1820.4, KSC Respiratory Protection Program.

Shuttle-Specific Requirements for section 8.4.5 are contained in Chapter 18.

8.4.6 Emergency evacuation exercises shall be conducted annually for all facilities conducting hazardous operations. Exercises shall be conducted for each shift where ten or more employees commonly work.

8.5 LOCKOUT/TAGOUT (LOTO) PROGRAM

Lockout/Tagout (LOTO) is the process of configuring equipment in a temporary condition in which the unexpected release of energy is prevented from endangering personnel performing servicing or maintenance tasks.

8.5.1 General Requirements

a. Programs/Projects, contractors, and organizations shall develop and use procedures for controlling potentially hazardous energy.

b. The procedures shall be documented unless specifically exempted under 29 CFR 1910.147(c)(4)(i).

c. These procedures shall meet the requirements in this chapter and clearly and specifically outline the scope, purpose, authorization, rules, and techniques that will be used for controlling

hazardous energy, and the means to enforce compliance including, but not limited to, the following:

(1) A specific statement of the intended use of the procedure.

(2) Specific procedural steps for shutting down, isolating, blocking, and securing machines or equipment to control hazardous energy.

(3) Specific procedural steps for placing, removing, and transferring LOTO devices or tagout devices and the responsibility for them.

(4) Specific requirements for testing a machine or equipment to verify the effectiveness of lockout devices, tagout devices, and other energy control measures.

8.5.2 MANDATORY LOTO CONDITIONS

Before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, startup or release of stored energy could occur and cause injury, the machine or equipment shall be isolated from the energy source and rendered inoperative.

8.5.3 LOTO EXEMPTIONS

The following circumstances shall be exempt from LOTO:

a. When minor tool changes, adjustments, and/or other servicing activities are made during normal production operations that are routine, repetitive, and integral to the use of the equipment, where alternative methods are used that provide effective protection.

b. When work is done on cord and plug-connected electric equipment/machinery, where the cord is unplugged and is under the control of the employee performing the servicing or maintenance.

c. Hot tap operations involving transmission and distribution systems for substances such as gas, steam, water, or petroleum products on pressurized pipelines, provided that the project, contractor, or organization demonstrates that all of the following are true:

(1) Continuity of service is essential.

(2) Shutdown of the system is impractical.

(3) Documented procedures are followed and special equipment is used to provide proven and effective protection for employees.

8.5.4 GENERAL REQUIREMENTS AND ENFORCEMENT

a. All persons shall be prohibited from attempting to start, energize, or use a machine or equipment that is locked out or tagged out.

NOTE: It may be necessary for personnel involved in isolating all energy sources to violate this requirement as part of the isolation testing process. While taking part in this activity, personnel

are exempt from this requirement and should follow procedures guiding the safe completion of this activity.

b. Personnel found to be violating LOTO shall be subject to disciplinary measures imposed by their employer and/or NASA.

c. Authorized or competent personnel involved in the installation of new machines or equipment, or replacing, doing major repairs on, renovating, or modifying existing machines or equipment shall design the energy-isolating devices to accept a lockout device.

d. The following steps shall be taken prior to equipment service, repair, or maintenance when LOTO is used:

(1) Prior to shutdown, personnel involved in LOTO procedures shall prepare for shutdown by determining the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means by which to control the energy.

(2) Affected employees shall be notified of LOTO prior to equpment shutdown.

(3) Personnel involved in LOTO shall shut down equipment per JHA instructions established for that machine or equipment.

(4) All energy sources shall be isolated.

(5) LOTO isolation devices shall be attached.

(6) All potential or stored energy shall be released.

(7) Isolation shall be verified by methods that include testing.

e. The following steps shall be taken upon completion of work which required LOTO:

(1) Work shall be inspected to ensure that all nonessential items have been removed and that machine or equipment components are operationally intact.

(2) Employees shall move to a safe position outside the operational area before the equipment is re-energized.

(3) “Affected employees” shall be notified that lockout and/or tagout devices will be removed.

(4) Upon removal of the LOTO isolation devices, it shall be permissible to restore the equipment to operation.

NOTE: If the equipment to be worked on has already been locked and tagged out (LOTO), the employee performing new work is still required to perform LOTO of the equipment per this chapter before starting work.

8.5.5 LOTO DEVICES

a. Both a lock and a tag shall be used when performing LOTO procedures.

NOTE 1: The only exception is when a lock cannot be attached to the isolation device, or lockout is not otherwise feasible. For these situations, based on the approval of the authorized employee's supervision, a tagout device shall be applied and a procedure shall be written to demonstrate an effective way to isolate the hazard(s).

NOTE 2: Tags are warning devices and do not provide physical restraint.

b. Each authorized employee shall be issued locks, tags, multiple lock hasps, or other LOTO devices as deemed necessary, either individually or in a kit form (e.g., centralized locker) by his or her supervisor or designee.

8.5.5.1 Locks

Locks physically prevent the use of equipment or machinery. They shall be:

a. Durable.

b. Standardized according either to color, shape, or size.

c. Identified with KSC form 20-195a (Lockout Identifiers).

d. Substantial enough to prevent removal.

e. Clearly identified as to the employee who applied them.

f. Keyed individually.

NOTE: the individual who applies the lock must maintain possession of the key/combination at all times until the lock is removed.

g. Designated solely for LOTO purposes.

8.5.5.2 Tags

a. Tags alert workers regarding equipment/machinery status. KSC Form 20-195, LOTO Tag, shall be the only tag authorized for use at KSC.

b. Use of KSC Form 20-195, Lockout/Tagout Tag, shall be limited to authorized employees trained in LOTO only.

c. KSC Form 20-195, Lockout/Tagout Tag, shall only be used to indicate LOTO of equipment undergoing servicing and or maintenance and should never be used for purposes other than LOTO.

d. In addition to attaching KSC Form 20-195 to the lock, KSC Form 20-195a shall also be attached directly to the lock as a unique identifier.

8.5.5.3 Means of Attachment

The means of attachment for LOTO tags shall be:

a. Non-reusable.

b. Attachable by hand.

c. Self-locking.

d. Non-releasable.

e. Equipped with a minimum unlocking strength greater or equal to 50 lbs.

8.5.6 LOTO PROCEDURES

Procedures for the application of LOTO (energy control) shall cover the following elements and actions, and shall be done in the following sequence:

a. The equipment or machinery shall be turned off or shut down using established procedures for the equipment/machinery (e.g., technical operating procedure or manufacturer's procedure).

NOTE: An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of the equipment/machinery stoppage.

b. All energy isolating devices needed to control the energy to the equipment and/or the machinery shall be physically located and operated in a manner that isolates the equipment or machinery from the relevant energy source(s).

c. Only authorized employees shall affix LOTO devices to each applicable energy-isolating device.

d. Tagout devices shall be affixed so that it is evident that the operation or movement of energy-isolating devices from the "safe" or "off" position is prohibited.

e. Where a tag cannot be affixed directly to the energy-isolating device, the tag shall be located as close as safely possible to the device, in a position that will be immediately obvious to anyone attempting to operate the device.

f. Following the application of LOTO devices to energy-isolating devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, and otherwise rendered safe.

g. Prior to starting work on equipment or machinery that has been locked out or tagged out, an authorized employee shall verify that the equipment/machinery has been de-energized and that the sources of hazardous energy have been isolated.

h. If there is a possibility that the locked/tagged out equipment/machinery may accumulate stored energy to a hazardous level, verification of energy isolation shall be continued until the servicing and/or maintenance activity is completed or until the possibility of such accumulation no longer exists.

8.5.7 GROUP LOTO

a. Group LOTO procedures may be used if there are multiple locks required for a single piece of equipment/machinery and multiple employees are involved in maintenance and servicing activities. Group LOTO shall be conducted by one of two methods: Multiple Lock Attachment Devices or Lockbox Method. The method to be used depends on the unique characteristics of the job being worked and/or the preference of the authorized employee(s).

b. In addition to all other requirements, the following process shall be adhered to when applying group LOTO devices:

(1) Group LOTO shall be used when more than one employee is engaged in the performance of servicing and/or maintenance activities.

(2) Each employee performing servicing or maintenance activities shall be in control of the associated hazardous energy throughout the entire period of his/her exposure.

NOTE: Group energy control procedures may need to be tailored to the specific industrial operation.

(3) Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

(4) All LOTO procedures shall be followed until the job is complete.

(5) Specific procedures shall be utilized during shift or personnel changes to ensure the continuity of LOTO protection. This shall include provision for the orderly transfer of LOTO device protection between off-going and oncoming employees to minimize exposure hazards resulting from the unexpected energizing, startup, or release of stored energy from equipment/machinery.

8.5.8 LOTO DEVICE REMOVAL

a. Before LOTO devices are removed and equipment/machinery energy is restored, authorized employees shall implement the following procedures and actions:

(1) The work area shall be inspected to ensure all nonessential items have been removed and to ensure that equipment/machinery components are operationally intact.

(2) The work area shall be checked to ensure all employees have been safely positioned or removed.

(3) After LOTO devices have been removed and before equipment/machinery is started, affected employees shall be notified that the LOTO devices have been removed.

b. In situations where the authorized employee is not available to remove LOTO devices, it shall be permissible to remove the LOTO device under the direction of the authorized employee’s supervision provided that all of the following conditions are met:

(1) At least one attempt is made to contact the authorized person who applied the device(s), verifying that the authorized employee who applied the device is not at the facility.

(2) The person who performed the LOTO is notified that the device(s) have been removed prior to their return to work.

(3) The authorized employee's supervision and another authorized employee must be present.

(4) A determination is made that it is safe to startup the equipment/machinery prior to removing the LOTO device.

8.5.9 PERIODIC PROGRAM INSPECTIONS

a. Annual LOTO program inspections shall be conducted and documented.

b. An annual inspection shall be conducted in order to ensure the LOTO program is meeting the requirements of 29 CFR 1910.147 and to correct any identified deviations or inadequacies.

c. An authorized and properly trained employee shall perform the inspection. The periodic inspection shall be performed by an authorized employee other than the one(s) utilizing the energy control procedure being inspected.

d. After the inspection or observation, the results shall be reviewed with each authorized and affected employee.

e. Documentation certifying the completion of the inspection shall be maintained on file and include the following information:

(1) Date of the inspection.

(2) Identification of the machinery or equipment.

(3) Affected and authorized employees included in the inspection.

(4) Any deviations or inadequacies noted.

(5) A plan for correcting identified deficiencies.

(6) Name/signature of person conducting the inspection/observation.

8.5.10 TRAINING

8.5.10.1 GENERAL LOTO TRAINING REQUIREMENTS FOR AFFECTED AND AUTHORIZED EMPLOYEES

a. Training shall be conducted and documented for all affected and authorized employees to include the following:

(1) Employees shall receive initial training or instruction in LOTO to ensure that the purpose and function of the LOTO (energy control) program are understood.

(2) The employer shall ensure employees acquire the knowledge and skills required for the safe application, usage, and removal of the energy controls.

(3) Employees shall be trained in LOTO requirements in accordance with their assigned (or designated) level of responsibility.

(4) The employer shall certify that employee training has been accomplished and that employee training is current.

(5) The certification shall contain each employee's name and dates of training.

(6) A written/electronic test shall be completed as part of the training/certification.

b. Authorized and affected employees shall be retrained whenever there is a change in their job assignment, a change in machines, equipment, or processes that present a new hazard, when the LOTO procedures change and/or when an inspection indicates a lack of knowledge or deficiency in work practices.

8.5.10.2 ADDITIONAL TRAINING REQUIREMENTS FOR AUTHORIZED EMPLOYEES

Authorized employees are those employees who service or maintain equipment and perform LOTO procedures. In addition to the general LOTO training requirements, training for authorized employees shall ensure that these employees are able to:

a. Distinguish the various types of hazardous energy sources.

b. Identify the hazardous energy sources present in the workplace.

c. Understand dangers presented by workplace energy sources.

d. Understand and follow workplace LOTO procedures.

8.5.10.3 ADDITIONAL TRAINING REQUIREMENTS FOR AFFECTED EMPLOYEES

Affected employees are those who operate or use the equipment being serviced or maintained, or others in the area where equipment is locked and/or tagged out.

a. In addition to the general LOTO training requirements, training for affected employees shall ensure that these employees are able to:

(1) Recognize when LOTO procedures are being implemented.

(2) Understand the purpose of LOTO procedures and the importance of not attempting to startup or use equipment/machinery that has been locked and/or tagged out.

b. Employees who may have reason to enter or work in the area where LOTO may be implemented shall be instructed regarding the purpose of LOTO procedures and be informed of the prohibition against restarting or re-energizing equipment that is locked and/or tagged out.

8.5.11 RECORDKEEPING/DOCUMENTATION

a. Organizations shall develop and document energy control procedures for machinery and equipment.

NOTE: One procedure may be developed for multiple pieces of equipment/machinery with similar energy sources and controls.

b. Organizations shall maintain inventory records of locks and tags.

NOTE: NASA organizations should utilize KSC Form 28-912, Lock Control Record for locks and KSC Form 28-915, Tag Control Record for tags. Contractors may utilize these or other forms, provided that the data elements in Forms 28-912 and 28-915 are addressed.

c. All training and annual inspections shall be documented and available for review.

8.6 DANGER TAGS

a. The KSC Danger Tag, KSC Form 20-165, shall be used to identify defective or nonconforming equipment that presents a threat of death or serious injury to personnel or destruction of flight hardware or equipment.

b. Each organization issuing Danger Tags shall maintain accountability through the use of a log for all issued and returned tags.

c. Each organization using Danger Tags shall conduct an annual audit of the Danger Tag program.

8.7 BATTERY HANDLING

a. Equipment used for handling and servicing lead acid and potassium-hydroxide electrolyte batteries shall be kept separated from each other and shall be properly labeled.

b. Adequate ventilation and exhaust shall be provided to prevent acid vapors from entering nickel cadmium or silver zinc battery areas.

c. Charging benches and tables shall be coated with acid/electrolyte-impervious coatings and shall be equipped with splash/drip trays to prevent drips/ leaks from running onto the floor.

d. Individual/liquid-filled battery charging/ conditioning shall be accomplished in battery shops. Battery charging equipment shall be continuously monitored by personnel when operating. Battery-operated vehicles and equipment shall be recharged only with recharging equipment designed for that purpose.

e. Lithium Ion batteries shall be handled in accordance with JSC-20793.

NOTE: JSC Engineering Directorate, Energy Systems Division, will be the final certification authority for crewed vehicle and space flight batteries.

NOTE: Reference JSC-20793, EA-CWI-033, mission-specific documents, and FSOP 6100, Vol I.

f. Precautions shall be taken to ensure that battery terminals are protected against unintentional short-circuits (e.g. electrode covers).

8.8 ENVIRONMENTAL HEALTH

The requirements for the development, management, and implementation of a KSC compliant Environmental Health Program are contained in KNPR 1840.19, KSC Industrial Hygiene Program. Other applicable documents are KNPR 1820.4, KSC Respiratory Protection Program; KNPR 1820.3, KSC Hearing Loss Prevention Program; KNPR 1860.1, KSC Ionizing Radiation Protection Program; KNPR 1860.2, KSC Nonionizing Radiation Protection Program; and KNPD 1800.2, KSC Hazard Communication Program.

8.9 FALL PROTECTION ON ELEVATED STRUCTURES

8.9.1 POLICY STATEMENT

a. NASA Kennedy Space Center endeavors to protect all government employees, contractors, subcontractors, international partners, and persons who are exposed to falls through the course of their work. Fall hazards shall be eliminated, mitigated, and\or controlled before an employee is exposed to the hazard.

b. This policy is meant to strengthen existing fall protection programs, policies, and regulations. It does not replace OSHA regulations, NASA, KSC, or contractor safety programs requirements, except where this policy is more stringent. This policy does not attempt to repeat OSHA, but rather defines KSC's additional fall protection requirements. ANSI A92.2-2001 Vehicle Mounted Elevating and Rotating Work Platforms, ANSI Z359.0-2007 Definitions and Nomenclature Used for Fall Protection and Fall Arrest, ANSI Z359.1-2007 Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components will be followed, except where deemed inappropriate for the application by a qualified person.

c. Kennedy Space Center Fall Protection Policy states that persons involved in activities on “any walking working surface where a person is exposed to a fall to a lower level of 4 feet or greater shall be provided with fall protection.” Fall hazards lower than 4 feet require protection if the work is over an uncommon hazard (moving machinery, chemicals, electrical, impalement hazards, etc.).

d. Components and systems that are commercial off-the-shelf shall be supplied with complete installation and operation instructions, and those instructions must be followed. Only a qualified person may change the instructions, and those changes are documented prior to use.

e. Safety Nets are not permitted to be used at KSC.

f. Construction contractors working at KSC are required to submit a Site Specific Fall Protection Plan (SSFPP) that will address project specific fall hazards that will be encountered while working at heights. This SSFPP (see Figure 8-3 for a sample plan) will become a part of the

contractors overall Safety and Health Plan which addresses the contractor's approach to implementing the requirements of this KNPR and all applicable OSHA regulations.

8.9.2 DEFINITIONS RELEVANT TO FALL PROTECTION

Anchorage	A secure point of attachment for lifelines, lanyards, or deceleration devices that is capable of supporting 5000 pounds per person (exception is a fall restraint system which requires an anchorage of 1000 pounds) or designed by a Qualified Person with a safety factor of 2.
Authorized person (user)	Employee required to use fall protection in performance of their work and trained and certified to use fall protection PPE and systems.
Body Harness	Straps secured about the employee in a manner that shall distribute the fall arrest forces over the thighs, pelvis, waist, chest, and shoulders with means for attaching it to other components of personal fall arrest system.
Certification	The process to determine that criteria established by a designated standard has been met, and the documentation that records that the criteria was met. The process includes testing and is performed under the supervision of a qualified trainer or entity.
Competent Person	Employee trained and certified in fall protection and who is capable of identifying hazards, has the authority to take corrective actions, is knowledgeable of applicable regulations, standards, equipment, and systems, and understands the mandatory requirements for fall protection equipment and systems.
Competent Person Trainer	A person in possession of a recognized formal training certificate from an industry recognized trainer, training center, or an equivalent OSHA training program, who has successfully demonstrated their extensive knowledge and experience to perform Competent Person training.
Competent Safety Monitor	Person trained in duties and responsibilities of performing in position of Safety Monitor.
Connector	A device which is used to couple (connect) parts of the personal fall arrest system and positioning device systems together. It may be an independent component of the system, such as a carabineer, or it may be an integral component part of the system (such as a buckle or D-ring sewn into a body belt or body harness, or snap-hook spliced or sewn to a lanyard or self-retracting lanyard.)
Controlled Decking Zone (CDZ)	In Steel Erection, an area in which certain work (i.e. initial installation and placement of metal decking) may take place without the use of guardrail systems, personal fall arrest systems, fall restraint systems or safety net systems and where access to the zone is controlled.
Dangerous Equipment	Equipment (i.e. galvanizing tanks, degreasing units, machinery, electrical equipment, and other types) which, as a result of form or function, will be hazardous to employees who fall onto or into such equipment.
Deceleration Device	Any mechanism, such as a rope grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines/lanyards, etc., which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.

Deceleration Distance	The additional vertical distance a falling employee travels, excluding lifeline elongation and free fall distance, before stopping from the point at which the deceleration device begins to operate. It is measured as the distance between the location of an employee's body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the deceleration device during a fall, and the location of that attachment point after the employee comes to a full stop.
Drop Line	A vertical line from a fixed anchorage, independent of the work surface, to which the lanyard is affixed.
Engineered Fall Protection System	A fall protection system that has been designed and approved by a Qualified Person.
Fall Arrest System	A system designed to stop one or more persons from striking a lower level or obstructions if a fall occurs. Fall Arrest Systems require the use of a Full Body Harness, a Connecting Means, a suitable Anchorage, planned rescue procedures, and proper training of all users.
Fall Protection	Any equipment, device, or system that prevents an accidental fall from elevation or mitigates the effect of such a fall.
Fall Protection Plan	A plan prepared by a qualified person, developed specifically for the site where work at heights is performed. The Fall Protection Plan must be maintained up to date and must meet the requirements of 29 CFR 1926.502(k).
Fall Protection Program	Policy and guidelines established by an organization to protect all employees engaged in work activities exposing them to potential falls from elevation. The program covers all company facilities, jobsites, and employees of that company. The Fall Protection Program is used to develop the site-specific fall protection plan for individual jobsites.
Fall Restraint System	A fall protection system that prevents them from reaching an unprotected edge. The system is comprised of a body harness along with an anchorage, connectors, and other necessary equipment. The other components typically include a lanyard and may include a lifeline and other devices.
Floor Opening	An opening measuring 12 inches or more in its least dimension in any floor, platform, pavement, or yard through which persons may fall.
Free Fall	The act of falling before a personal fall arrest system begins to apply force to arrest the fall.
Free Fall Distance	The vertical displacement of the fall arrest attachment point on the employee's body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance, and lifeline/lanyard elongation, but includes any deceleration device slide distance or self-retracting lifeline/lanyard extension before they operate and fall arrest forces occur.
Guardrail System	A barrier to prevent employees from falling to lower levels.
Infeasible	It is impossible to perform the work using a conventional fall protection system, (i.e., guardrail system, or fall arrest/restraint, system) or that it is technologically impossible to use any one of these systems to provide fall protection.
Lanyard	A flexible line of rope, wire rope, or strap which has a connector at each end for connecting a body harness to a deceleration device, lifeline, or anchorage.

Leading Edge	The edge of a floor, roof, or formwork for a floor or other walking/working surface (such as a deck) which changes location as additional floor, roof decking, or formwork sections are placed, formed or constructed. A leading edge is considered to be an unprotected side and edge during periods when it is not actively and continuously under construction.
Lifeline	A component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.
Low Slope Roof	A roof having a slope less than or equal to 4 in 12 (vertical to horizontal).
Mechanical Equipment	All motor or human-propelled wheeled equipment used for roofing work, except wheelbarrows and mop carts.
Metal Roof	A roof with metal surface that engineering has determined is load bearing or is a structural support surface.
Non-Engineered Anchorage	An anchor point for which no engineering calculations have been performed.
Non-roof Work	Preventive maintenance (PM), repair of equipment on roofs such as heating, ventilation, and air conditioning, (HVAC), lightning protection systems, rigging of fall protection systems, etc.
Opening	A gap or void 30 inches (76 centimeters) or more high and 18 inches (46 centimeters) or more wide, in a wall or partition, through which employees can fall to a lower level.
Personal Fall Arrest System	A system (Type I) used to arrest a person in a fall from a working level. It consists of an anchorage, connectors, body harness and may include a lanyard deceleration device, lifeline or suitable combinations of these.
Positioning Device System	A body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning. It is not a fall protection system.
Positive Fall Protection	Fall protection by the use of a guardrail system or personal fall protection to include harness with a fall arrest/restraint system or the use of other means such as vehicle mounted platforms and/or scaffolding.
Prime System	The first mechanism that prevents a person from falling. Typically, this is the person's balance, climbing skills, and the safety of the structure or platform that they are standing or working on. Fall Protection is a Secondary System of protection.
Program Administrator	A person designated in writing to manage the Fall Protection Program.
Qualified Person	A person in possession of a recognized engineering degree and a formal training certificate from an industry recognized trainer, training center, or an equivalent OSHA training program, who has successfully demonstrated their extensive knowledge and experience to perform structural engineering for design, evaluation, and approval of fall protection systems.
Roof Work	The hoisting, storage, application, and removal of roofing materials and equipment, including related insulation, sheet metal, vapor barrier work, and leading edge work.
Rope Grabs	A deceleration device that travels on a lifeline and automatically engages the lifeline, by friction, and locks to arrest the fall.

Runway	A passageway for persons elevated above the surrounding floor or ground, such as a foot-walk along shafting or walkway between buildings.
Safety Monitoring System	A system in which a competent monitor is responsible for recognizing and warning employees of fall hazards. The person monitoring the other workers is to be on the same walking\working surface as employees being monitored; is to be within visual sighting distance of the employees being monitored; is to be close enough to communicate orally with the employees being monitored; must not have responsibilities which could take the monitoring attention from the monitoring function.
Secondary System	The "back-up" mechanism that protects a person if their Primary System fails. Secondary Systems include Guardrail Systems, Fall Restraint Systems, and Fall Arrest Systems. Users must be careful that a secondary systems DOES NOT become the Primary System when a user puts weight into the system, such as leaning against a guardrail.
Self-Retracting Lifeline/Lanyard (SRL)	A deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under slight tension during normal employee movement, and which, after onset of a fall, automatically locks the drum and arrests the fall.
Steep Roof	A roof having a slope greater than 4 in 12 (vertical to horizontal).
Toe-Board	A low protective barrier that prevents material and equipment from falling to lower levels and provides protection from falls for personnel.
Tower	Free-standing or guy-supported structure that is essentially vertical with access via vertical ladder or ships ladder; used to support antennas, boresite instruments, weather instruments, cameras, radars, lightning protection systems for protection of launch complexes, etc.
Tower Climber	Employee trained and certified as a Tower Climber and who, by possession of formal training certificate from an industry recognized trainer, training center, or an equivalent ANSI/OSHA training program, has successfully demonstrated their extensive knowledge and experience to perform tower climbs.
Unprotected Sides or Edges	Any side or edge (except at entrances to points of access) of walking/working surface (e.g., floor, roof, ramp, or runway) where there is no wall or guardrail system at least 39 inches high. Midrails shall be installed at a height approximately midway between the top edge of the guardrail system and the platform surface.
Walking/Working Surface	Any surface, whether horizontal or vertical on which an employee walks or works, including but not limited to floors, ramps, bridges, runways, formwork, and concrete reinforcing steel. Does not include ladders, vehicles, or trailers on which employees are located to perform their work duties.
Warning Line Systems	A barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge, and which designates an area in which roofing work may take place without the use of guardrail or personal fall protection system to protect employees in the area.

8.9.3 ROLES, RESPONSIBILITIES, AND TRAINING

8.9.3.1 Fall Protection Program Administrator

NASA KSC, NASA KSC prime contractors, contractors/subcontractors shall appoint in writing a fall protection program administrator and/or team.

a. The fall protection program administrator and/or team shall have the skills, experience, and abilities to ensure effective management of the employers fall protection program. This would include a working knowledge of current fall protection regulations, standards, fall protection equipment, and systems.

b. The program administrator shall ensure the development, implementation, and management of the employers' fall protection program.

c. The program administrator shall ensure an annual review and audit of the fall protection program is performed to address the use of new technology, regulations, industry practices, and to ensure compliance.

d. The program administrator shall ensure that this policy is adhered to as written.

e. Education and Training required for program administrators shall cover skills, including at least the following:

(1) Competent Person training

(2) Developing and maintaining a managed fall protection program

(3) Fall protection system selection

(4) Ensure development of equipment purchase controls

(5) Understanding of written fall protection and rescue procedures and plans

(6) Understanding of fall protection engineering system standards

(7) Fall Protection Training

f. The program administrator shall remain current with changing requirements, laws, and new fall protection systems.

8.9.3.2 Qualified Person

A qualified person shall be formally identified by the Fall Protection Program Administrator. A qualified person shall support the program administrator, competent and authorized person, and the fall protection program by supplying technical information and serve as a subject matter expert.

a. A qualified person shall be used when the authorized and/or competent person cannot select an appropriate non-engineered anchorage for a fall arrest or fall restraint system.

b. A qualified person shall be used to design any permanent anchorage, fall arrest system, fall restraint system, or lifeline (vertical and/or horizontal), and the design shall be documented and maintained.

c. The qualified person shall be familiar with fall protection practices, equipment, regulations, engineering principles, and the effects that permanent fall protection systems will have on the surrounding structure.

d. A qualified person shall be trained by an industry recognized trainer, training center, or locally developed Training Program equivalent to ANSI and OSHA compliant training program requirements. Qualified person education and training shall include at least:

(1) Engineering degree

(2) Fall hazard identification, elimination, and control methods

(3) Applicable fall protection regulations

(4) Responsibilities and requirements in accordance with the ANSI Standards and OSHA regulations

(5) Inspection of equipment components and systems

(6) Selecting fall protection systems

(7) Developing engineering system standards

(8) Determining system clearance requirements

(9) Designing and selecting anchorages

(10) Determining when fall protection systems are infeasible

(11) Designing new and evaluating existing horizontal lifelines

(12) Assessing system component compatibility

(13) Fall protection system assessments and determining when a system is unsafe

(14) Analyzing various anchorages

(15) Developing written fall protection procedures and rescue procedures

(16) Determining swing fall arresting forces

(17) Determining potential arresting forces

(18) Investigating fall protection related accidents/incidents/near misses

e. The qualified person shall remain current with changing requirements, laws, and new fall protection systems.

f. The qualified person shall ensure that this policy is adhered to as written.

8.9.3.3 Competent Person

A Competent Person shall be formally identified by the Fall Protection Program Administrator, and is responsible for the immediate application of fall protection work where fall protection is required. Competent persons shall be knowledgeable of applicable fall protection regulations, standards, equipment and systems, and mandatory requirements for fall protection equipment and systems used by their employers.

a. A competent person shall have work experience related to the application where fall protection is required.

b. The competent person shall have the ability to identify unsafe conditions or practices as they relate to fall protection during the course of the work and have the authority to take prompt corrective action.

c. The competent person shall be available to authorized persons when fall protection situations arise.

d. The competent person shall assist authorized persons when requested to ensure that non-engineered anchorages selected are acceptable, fall protection system(s) will work as intended, fall protection equipment is inspected prior to use, fall protection systems are used in accordance with manufacturer recommendations, OSHA requirements, qualified person designs, local policy, and rescue plans are in effect.

e. Competent person education and training shall be administered by an industry recognized trainer, training center, or locally developed Training Program equivalent to ANSI and OSHA compliant training, and shall include the following as a minimum:

(1) Use of all types of equipment and systems used in locations where the authorized persons work, including inspecting systems prior to use

(2) Installation, component compatibility, estimating free fall distances, total required clearance, dismantling, storage, and the common hazards associated with each system.

(3) Fall hazard elimination and controls methods

(4) Applicable fall protection regulations

(5) Development of written fall protection procedures and plans

(6) Understanding of fall protection engineering system standards

(7) The responsibilities under the ANSI Standards and OSHA regulations

(8) Detailed inspection of equipment components and systems

(9) Fall protection system assessments and determining when a system is unsafe

(10) Fall protection rescue procedures

(11) The selection and use of non-engineered anchorages

f. The competent person shall remain current with changing requirements, laws, and new fall protection systems or task applications.

g. The competent person shall be retrained a minimum of once every two years.

h. Non-engineered anchorages can be selected by a competent person, providing the competent person can predict the arresting force (<900 pounds) and the total required clearance of the system.

i. The competent person shall ensure that this policy is adhered to as written.

8.9.3.4 Authorized Person (User)

Each authorized person shall protect themselves by applying fall protection practices during the course of the work. When the nature of the work, the workplace, or the methods of control change to an extent that prior training is not adequate, the authorized person shall be retrained. Retraining is also required when it becomes apparent to supervision, a competent person, and/or qualified person that the authorized person does not have the required level of skills and knowledge or is not following the required means and methods.

a. Each authorized person shall inspect, install, use, and dismantle fall protection equipment according to manufacturer instructions, OSHA requirements, and local policy.

b. The authorized person shall not conduct any work where required fall protection is not in place or the performance of the fall protection system is unpredictable. In these situations the competent person for that work or area shall be notified for determination of the appropriate action to be taken.

c. Every authorized person shall receive formal classroom training in fall protection from a competent person or qualified person before they use fall protection systems or are exposed to a fall hazard. Training for authorized persons shall include:

(1) How to select a non-engineered anchorage that will support 5,000 pounds

(2) How to inspect, anchor, assemble, and use the fall protection equipment commonly used in locations where they work

(3) Fall hazard recognition

(4) Fall hazard elimination and control methods

(5) Applicable fall protection regulations

(6) Their responsibilities under OSHA regulations

(7) How to use written fall protection procedures

(8) Inspection of equipment components and systems before use

(9) Fall protection rescue procedures

(10) Limits of authority relevant to fall protection

(11) The use of applicable fall protection equipment, ensuring equipment meets OSHA and ANSI Fall Protection Standards, local fall hazards, and the employers' local equipment and systems

d. The authorized person shall remain current with changing requirements and shall be retrained a minimum of once every three (3) years.

e. The authorized user shall ensure that this policy is adhered to as written.

8.9.4 FALL HAZARD CONTROLS

The following controls, in order of preference, shall be used:

a. Hazard Elimination: The specific work that created the fall hazard should be evaluated to determine if a change in process, area, technology, or equipment would eliminate the fall hazard.

b. Guarding: Physical barriers between the worker and the fall hazard can be established so the barrier prevents the worker from falling (i.e. Guardrails, vertical netting, covers, etc.).

c. Fall Restraint: Fall protection personal protective equipment can be used to assemble a system (permanent or temporary) that will prevent a worker from reaching the fall hazard.

d. Fall Arrest: Fall protection personal protective equipment can be used to assemble a system (permanent or temporary) that allows a worker to fall, but arrests the fall safely before the worker strikes the ground or surrounding structure.

e. Administrative Controls: Administrative controls are reserved for situations where all other fall protection methods are deemed infeasible. This option is available only to employees engaged in leading edge work or precast concrete erection work. The methods used for this plan shall conform to 29 CFR 1926.502(k)(1) through (10).

8.9.5 FALL PROTECTION SYSTEM PERFORMANCE

8.9.5.1 Fall Restraint Systems

Fall Restraint Systems: Fall restraint systems shall be designed according to the following:

a. To prevent a worker from reaching the unprotected edge

b. Anchorage point must be able to hold 1,000 pounds.

c. Waist belts shall not be used for fall restraint.

d. Fall Restraint Systems shall be designed according to OSHA and ANSI.

8.9.5.2 Fall Arrest Systems

Fall Arrest Systems shall be designed to meet the requirements set forth in the applicable OSHA subpart(s). ANSI Fall Protection Standards will be followed except where deemed inappropriate by a qualified person. Fall arrest systems shall be used and installed to reduce the free fall distance.

a. When using fall arrest systems, the free fall distance of the system shall not exceed 6 feet and 900 pounds maximum arresting force except when designed by a qualified person. In no case shall the manufacturer instructions be violated without the approval and documentation of a qualified person, nor shall an arresting force of 1,800 pounds be exceeded in a fall greater than 6 feet.

b. The installer of the fall protection system (authorized / competent person) shall be knowledgeable of the arresting force and the total required clearance of the system.

c. If the system is being installed for workers other than the installer a procedure shall be provided to ensure that the authorized user can determine that the system is approved for use.

d. Acceptable anchorage structure may be I-beams, columns, tower legs, stairwell support structure, or other structure that is capable of holding 5,000 pounds per person or designed by a qualified person with a safety factor of 2. If the anchorage is questionable, the system shall not be used and a competent or qualified person shall be notified.

8.9.5.3 Fall Arrest and Restraint System Components

Fall arrest and restraint system components shall meet the OSHA standards, and ANSI Z359.1 Standard when applicable. Only a qualified person is permitted to approve not complying with ANSI and those cases must be documented as indicated in this policy.

8.9.5.4 Personal Fall Arrest System

A personal fall arrest system shall be used in conjunction with a work positioning system. It shall be rigged so the employee shall not free fall more than 2 feet.

8.9.6 FALL PROTECTION EQUIPMENT

a. Fall protection equipment shall be selected from equipment meeting or exceeding the OSHA and ANSI Fall Protection Standards. All new fall protection equipment must meet ANSI Z359.1 current at the time of purchase.

b. Fall protection equipment shall be used according to manufacturer instructions. Only a qualified person may change the instructions, and those changes are documented prior to use and maintained until the equipment is removed.

c. Equipment not designed for fall protection use shall not be used without prior approval of a qualified person, documented, and be labeled “For Fall Protection Use Only.”

d. The program administrator is responsible for ensuring that fall protection equipment procured is included in the training of competent, authorized and applicable qualified people.

8.9.7 FALL HAZARDS AND ASSESSMENTS

8.9.7.1 Fall Protection for Walking/Working Surfaces with Unprotected Edge/Opening or other Fall Potential of Four Feet or Greater to Surface Below.

a. If a vehicle or trailer is used as a walking/working surface other than normal operational modes such as operation, maintenance, transport, loading, off-loading, the need for fall protection shall be evaluated by a competent person.

b. If work requires employees to be closer than 6 feet from any unprotected edge or opening, positive fall protection (Guardrail system or personal fall protection to include harness w/arrest or restraint system) or the use of other means such as vehicle mounted work platforms and/or scaffolding is required.

NOTE: Be cautious when using guardrails or chains as a secondary means of positive fall protection. Such mechanisms may be subject to failure due to wear and tear and/or faulty design, construction, installation, and testing. Personnel should not lean on guardrails, gates, or chains.

8.9.7.2 Horizontal Life Lines

Commercially available ANSI approved temporary horizontal life lines are to be installed per manufacturer's written instructions. Only a qualified person may change the instructions, and those changes are documented prior to use. If not commercially designed, then a qualified person must design and provide installation.

8.9.7.3 Over/Near Water Operations

If employees are required to work Over/Near Water they shall be protected from falling as required by this policy. This section applies to construction activities, and is not intended to apply to marine operations that are governed by 29 CFR 1917, Subpart B, Marine Terminal Operations. For construction/maintenance activities the requirements of 29 CFR 1926.106 shall also be complied with.

8.9.7.4 Tower Climbing Operations

Climbing towers present unique hazards not associated with other jobs requiring fall protection. Prior to tower climbing it is required that the following be addressed: weather conditions, coordination with Fire Rescue, development of a rescue plan, safe transport of equipment/tools, tower energy sources have been safed, and at least two climbers are present and trained to climb towers.

8.9.7.5 Roofs - Fall Protection Requirements

a. Roof Work On Roofs

(1) Metal Roof: Work on metal roofs requires the use of positive fall protection at all times regardless of slope.

(2) Non metal roofs:

(a) Low-sloped or flat roofs:

(1) From unprotected edge to 6 feet: Positive fall protection required.

(2) From 6 feet to 15 feet: In lieu of positive fall protection a warning line and safety monitor system may be used.

(3) Fifteen feet or more from unprotected edge: In lieu of positive fall protection a warning line may be used without a monitor.

(b) Steep roofs require positive fall protection at all times.

b. Non-Roof Work on Roofs (Metal and non-metal)

(1) All work on steep roofs requires positive fall protection such as a personal fall arrest system or restraint system, guardrails or use of other means such as aerial lifts or scaffolding.

(2) Work on roofs with a pitch less than 4:12 above 4 feet requires:

(a) From unprotected edge to 6 feet: Positive fall protection is required.

(b) From 6 feet to 15 feet: A warning line will be used.

(c) Fifteen feet or more from unprotected edge: No warning line is required.

c. Roof Inspections and Assessments:

(1) Employees needing to access roofs for the sole purpose of performing roof inspections or assessments may do so only during pre and post construction work and shall follow the policy for “Non Roof Work on Roofs”.

(2) If access is required during construction activities, the policy for “Roof Work On Roofs” applies.

8.9.8 EXTENSIBLE / ARTICULATING LIFTS

An energy-absorbing length-adjustable lanyard and full body harness shall be used. The lanyard shall be connected to an approved anchor point in the basket and adjusted in length in such a manner that it reduces the possibility of the worker falling over the guardrails yet permits the work to be accomplished.

8.9.9 SCAFFOLD

a. Scaffold platforms where the potential for a fall four feet or greater exists shall be protected by the use of fall protection systems (guardrails, fall arrest, fall restraint). If these can’t be accomplished, a qualified person shall develop a fall protection plan for scaffolding up to ten feet in height. A scaffold greater than ten feet shall have positive fall protection.

b. A competent person shall evaluate the scaffold erection and dismantling to determine if fall protection systems (guardrails, fall arrest, fall restraint) can be used while erecting and

dismantling scaffolds. If these can't be accomplished a qualified person shall develop a fall protection plan.

8.9.10 SAMPLE SITE SPECIFIC FALL PROTECTION PLAN

Figure 8-3 illustrates an example site specific fall protection plan that satisfies the fall protection requirements of this KNPR and applicable OSHA and ANSI standards.

FIGURE 8-3: SAMPLE SITE-SPECIFIC FALL PROTECTION PLAN

1. General

a. ***COMPANY NAME*** shall identify and mitigate all work related fall hazards and has established methods to protect the employees from those fall hazards.

b. Fall protection is required at all times within six (6) feet of an unprotected edge with a fall hazard of four (4) feet or more. Where required, body harnesses meeting OSHA and ANSI requirements shall be used.

c. ***COMPANY NAME*** will have a fall protection program administrator, name a competent person(s) (fall protection), and use a qualified person (fall protection) as required by the applicable NASA regulations and OSHA Standards. On this project, these designated persons are:

(1) Fall protection administrator: **EMPLOYEE NAME**

(2) Fall protection competent person: **EMPLOYEE NAME**

(3) Fall protection qualified person: **EMPLOYEE NAME**

d. The fall protection administrator shall identify the competent and qualified persons listed above.

2. Training

a. All employees working at elevations shall receive training in recognition of fall hazards, hazard mitigation, and the proper use and inspection of fall protection equipment from a competent person (fall protection).

b. The employee training described above shall be certified in writing by the employer.

c. The latest certification documentation shall be maintained by the employer and include the name of the employee, the date of the training, areas trained and the signature of the training instructor and/or the employer.

d. The designated competent person (fall protection) conducting training shall be qualified in the following areas:

(1) The nature of fall hazards in the work area.

(2) The correct procedures for installing, inspecting, and disassembling fall protection systems.

(3) The use and operation of fall protection systems to be used.

(4) Each employee's role in the safety monitoring system, if this system is to be used.

FIGURE 8-3: SAMPLE SITE SPECIFIC FALL PROTECTION PLAN (cont'd)

(5) The limitations on the use of mechanical equipment on low-slope roofing jobs.

(6) The correct procedures for the handling and storage of equipment and materials and installation of overhead protection.

(7) Each employee's role in the fall protection plan.

(8) The OSHA fall protection standard.

e. If ***COMPANY NAME*** verifies and accepts training provided by another employer, the certification shall indicate the date ***COMPANY NAME*** determined the prior training was adequate rather than the date the training was performed.

3. Retraining of Employees

a. Employees suspected of not having the understanding or skills required shall be retrained.

b. Other circumstances that require retraining include:

(1) Changes in the workplace that make earlier training obsolete.

(2) Changes in the types of fall protection systems used.

(3) Observed inadequacies in an employee's use or understanding of fall protection systems.

4. Fall Protection Equipment

a. Fall protection equipment shall meet all OSHA, applicable ANSI, and manufacturer requirements for use, and be properly stored when not in use.

b. All fall protection equipment shall be inspected by the user before each use and by a competent person (fall protection) annually in accordance with applicable regulatory standards or per manufacturer's recommendations, whichever is more stringent.

c. Annual inspections of fall protection equipment shall be documented and meet the following criteria:

(1) All fall protective equipment to include safety harnesses, drop lines, lifelines, fall arrest, as well as positioning lanyards, ladder safety climb, and rigid rail sleeves (e.g., Skate's, Rope Grabs) shall be inspected.

(2) Self-retracting lanyards shall be visually inspected and checked according to the manufacturer's recommendations to ensure there are no obvious signs of damage due to wear and tear.

FIGURE 8-3: SAMPLE SITE SPECIFIC FALL PROTECTION PLAN (cont'd)

(3) All equipment shall have a manufacturer's serial number on it (e.g., tag, webbing) or it shall be serialized by using a method not destructive to the equipment.

(4) Maintenance servicing must only be completed by the manufacturer's approved service technician, trained to repair and service their equipment.

d. A documented equipment tracking system that uses the method identified from 4.c(3) above shall be used.

e. Any fall protection equipment that is missing an inspection tag or is past due for annual inspection shall be immediately removed from service.

5. List of Attachments

a. List of identified fall hazards.

b. List of all protection methods to be used to protect employees from the identified fall hazards.

c. List of controls, limitations, constraints, and procedures to be used with the fall protection methods.

d. List of employees trained and authorized to work in areas where fall protection is required.

e. Written certification of fall protection training for each employee.

f. A signature page where every employee authorized to work under the plan signs to indicate that they have read and understood the plan.

CHAPTER 9: TECHNICAL OPERATING PROCEDURES (TOPs) (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS)

9.1 GENERAL

9.1.1 Laboratory operations shall comply with 29 Code of Federal Regulations (CFR) 1910.1450 in lieu of the requirements of this chapter.

9.1.2 TOPs shall identify and direct work to be performed; provides detailed instructions necessary to accomplish the intended task; and are to be followed step-by-step unless otherwise permitted by section 9.9 of this chapter. The use of TOPs ensures an organized and systematic approach for performing work and to identify and control hazards.

9.1.3 TOPs shall be required when any of the following apply:

a. Equipment operations, planned or unplanned, are hazardous as defined in section 9.8 herein.

b. An operation constitutes a potential launch, test, vehicle, or payload processing constraint.

c. An operation is detailed or complicated and there is reasonable doubt that it can be performed correctly without written procedures.

9.1.4 TOPs shall be reviewed for KSC and offsite areas to ensure that hazardous operations are properly classified and the appropriate safety precautions have been specified.

9.1.5 TOPs shall be classified as hazardous or non-hazardous. Each operation shall be evaluated for the task and location. Hazardous operations are defined in section 9.8 herein.

9.1.6 A Category II TOP may be used for one-time-only hazardous operations when work is of limited scope, and for repetitive non-hazardous operations when work is of limited scope. Category II procedures shall not be used to change or replace Category I procedures.

9.1.7 TOPs shall be prepared in clear, precise language that can be readily understood by personnel involved in the operation.

9.1.8 Unique symbols shall be used on all bar charts, integration, and element schedules to differentiate between operations having a major control area, a local control area, and no control area. A legend shall be provided on each page.

9.2 ALL TOPS

All TOPs shall contain:

9.2.1 Identification of the hazard level on the cover for paper TOPs or immediately upon opening of an electronic TOP that defines the TOP as “hazardous” or “nonhazardous.”

9.2.2 A brief description of the purpose or objective of the task, operation, or procedure.

9.2.3 Identification of the operating location and/or departing/arriving areas.

9.2.4 Identification of specific hazards that personnel will be exposed to during the operation.

9.2.5 Operations Maintenance Requirements and Specifications Document (OMRSD), Hazard Analyses, and/or Payload Hazard Reports that specify procedural controls for specific hazardous conditions. These procedural controls shall be uniquely identified within the TOP.

9.2.6 Safety precautions (WARNING/CAUTION notes) for any activities, hazardous or non-hazardous, where specific guidelines must be observed or actions taken to prevent or limit hazards.

a. WARNING/CAUTION notes shall be inserted prior to the step (for electronic TOPs this can be a hyperlink inserted prior to the step) and shall be reviewed immediately preceding the step that directs the activity.

NOTE: If using Maximo, all WARNING/CAUTION notes can be contained in the WAD safety plan rather than prior to the step, as long as the hyperlink to the WARNING/CAUTION note is provided immediately prior to the step as required in 9.2.6 a.

b. If using hyperlinks for WARNINGS/CAUTION note, a procedural step within the TOP shall verify that all WARNING/CAUTION notes are reviewed prior to starting a hazardous task (as defined in paragraph 9.8).

c. For multiple steps for related work within a TOP, the above requirements (9.2.6 a. and b.) shall only be implemented for the first step that requires the safety precautions.

9.2.7 Identification of tools, equipment, clothing and/or any other personal protective equipment (PPE) required for the safe performance of the operation or as required by emergency procedures associated with the operation shall be contained/specified within the WARNING note.

9.2.8 Identification of organizational elements and facilities required to support the operation.

9.2.9 A list of applicable safety documents and references that are specifically called out within the TOP required to support the operation. The list shall contain the document identifying number, latest issue (LI), and title.

9.2.10 Safety rules and requirements that are required for the safe conduct of the operation.

9.2.11 Identification of the personnel certifications required for the safe performance of the operation.

9.2.12 Emergency instructions when operations directed in the TOP activate a system or equipment capable of causing personnel injury or equipment damage if not expeditiously shutdown or safed, should a malfunction occur. When a TOP is in progress, the emergency instruction in the TOP shall take precedence over the Emergency Procedures Document (EPD). Reference KNPR 8715.2 for facility EPD requirements. Emergency instructions shall:

a. Contain specific actions necessary to cope with emergency conditions.

b. Address hazards unique to the operation and shall provide for rapid safing to protect personnel and equipment.

c. Contain all the steps required to accomplish the shutdown or safing, or shall be readily available as part of the work package.

d. Be available to the test team at all times and be included as a separate operation that is uniquely identifiable (e.g., Unique title for electronic TOPs, distinctive border, or cut corners for printed TOPs).

9.2.13 The following data when involving the pressurization of vessels within GSE or facilities:

a. Maximum Allowable Working Pressure (MAWP).

b. Relief valve set pressure (if installed).

c. Burst disc pressure/temperature rating (if installed).

d. For initial (first-time) pressurization, a WARNING stating the MAWP immediately before the step that calls for pressurization. For subsequent pressurizations this may be in the form of a statement.

NOTE: A sketch or diagram which shows the configuration of the system to be pressurized and which includes maximum allowable working pressures, relief valve set pressures, and burst disc pressure/temperature ratings may be used to meet the requirements listed in (a), (b), and (c) above.

9.3 HAZARDOUS TOPS

Hazardous TOPs, as defined in section 9.8 herein, shall contain, in addition to the above:

9.3.1 Identification of all conditions that cause the TOP to be classified as hazardous.

9.3.2 A procedural step verifying the performance of a pretest briefing for integrated TOPs that require a major control area.

9.3.3 The following items shall immediately precede the step(s) that direct the hazardous task/sequence:

a. A procedural step requiring the performance of a pre-task briefing.

b. A procedural step with task leader verification that personnel participating in the hazardous operation are certified and ready to proceed.

c. A procedural step to identify/specify each control area for hazardous operations. The instructions shall include placement of signs, barriers (i.e. ropes, chains, tape), warning lights, and directions for all non-essential personnel to clear the specified control area, allowing sufficient time for them to do so before the start of the hazardous step(s).

d. A list identifying all the essential personnel required to perform the hazardous operation. The list shall identify the individuals by call sign/ functional title, number of personnel, and the organization or contractor employing the individual.

e. A procedural step providing for public address announcements, or other positive means, to be made to alert personnel of the dangers and information associated with the hazardous operation.

f. A procedural step verifying that a pre-route survey has been accomplished before transporting Ground Support Equipment (GSE) and flight hardware where length, height, or width may cause interference problems/hazards.

g. A procedural step verifying that a pre-operational inspection for operations having a major control area and/or an operational safety inspection for all hazardous operations has been performed. Any discrepancies that constrain or have the potential to impact the operation shall be documented and dispositioned or resolved, prior to the commencement of any hazardous step(s).

h. A procedural step requiring Safety concurrence prior to starting the hazardous step(s), and prior to opening the area for controlled work at the conclusion of the hazardous step(s).

i. A WARNING note, or a Note, specifying the start of a hazardous operation immediately preceding the first hazardous step, and a Note specifying completion of the hazardous operation immediately following the last hazardous step.

j. A step verifying the safed and armed circuits are safed and the Pyro Initiator Controller (PIC) capacitors are discharged prior to the disconnection of live explosives.

9.4 SUBTASK SAFETY CONTROLS

Integrated/controlling TOPs shall manage the specific safety controls contained in subtask TOPs/documents.

9.5 JOB CARDS

Safety requirements for Job Cards shall be identical to safety requirements for Category I TOPs.

9.6 OPERATIONS PLANNING SHEETS

The responsible safety and health professional(s) and, if required, the appropriate NASA KSC S&MA Division representative shall approve Operations Planning Sheets that include hazardous operations (as defined in section 9.3 of this chapter) prior to implementation of the TOP.

9.7 PLACARD PROCEDURES

9.7.1 The use of placards shall be limited to non-hazardous repetitive simple tasks.

9.7.2 Placards shall be used only for GSE and facility items. They shall not be used for equipment when interfacing with flight hardware, unless authorized by a TOP.

9.7.3 Placards shall define any prerequisites, contacts, or pre-operations that must be performed or made prior to implementation.

9.7.4 Placards shall be attached to equipment or positioned near equipment to provide assembly or operating instructions.

9.7.5 Installation of placards shall be authorized using a TOP initiated by the organization using the placard and an exact copy of the placard shall be attached to the authorizing TOP.

9.8 HAZARDOUS CLASSIFICATION OF TOPS

A TOP is classified as hazardous to ensure that an operation which has potential to result in loss of life, serious injury to personnel or damage to systems, equipment or facilities is performed in a step-by-step fashion and contains all appropriate hazard controls. TOPs shall be classified by the originating organization as hazardous if the activity controls or involves, but not limited to, operations that:

9.8.1 Require personnel to be present in an enclosed or dangerous area (tanks, manholes, etc.) in which the environment deviates from a normal atmosphere.

9.8.2 Involve the handling, receipt, storage, transportation, installation, removal, checkout, or closeout of explosives including solid propellants. For any operation or checkout of an explosive system, following explosive item installation/connection and prior to power on/off simulated or direct explosive system checks or tests, the condition or status of the explosives (connected, safed, or disconnected) must be stated and verification required within the TOP.

9.8.3 Involve liquid propellant loading, unloading or flow, venting, sampling, connecting or disconnecting, moving or storing of loaded storage units, or opening of contaminated systems.

9.8.4 Involve cryogenic loading, unloading or flow, venting, sampling, connecting or disconnecting, moving or storing of loaded storage units, or repairing of a system containing cryogenics.

9.8.5 Involves the handling or transfer of hazardous fluids, hazardous gases, combustible/corrosive liquids, or other materials hazards when the given quantity of the gas or liquids's vapor, when mixed or unmixed with air, is hazardous to personnel or equipment due to flammability, toxicity, or extremes of temperature.

9.8.6 Involve moving GSE or flight hardware where length, height, width, or weight may cause interference or hazards.

9.8.7 Involve crane-hoisting operations. The procedure for crane-hoisting shall be classified hazardous unless the cognizant program/project or NASA KSC S&MA Division determines that the size or weight of the equipment to be hoisted is such that it would not be considered a hazardous operation.

9.8.8 Involve forklift operations for loading, unloading, and transporting of hazardous materials.

9.8.9 Involve the use of ionizing or non-ionizing radiation sources that have hazard controls specified in the approved Radiation Use Authorization for that source as issued by the KSC Radiation Protection Program.

9.8.10 Involve an electrical hazard that may cause injury or death.

9.8.11 Call up hazardous step(s) of subtask TOPs. The controlling TOP shall be classified as hazardous.

9.8.12 Involve the pressurization of systems or components and include at least one of the following cases:

a. Flight system pressure vessels controlled by fracture mechanics with:

(1) Any pressurization that exceeds any previously recorded pressurization in the pressure vessel operational time/ cycle log.

(2) Any pressurization above the MAWP.

(3) Any pressurization above 25 percent of the MAWP when the vessel contains hazardous fluids.

b. Flight system pressure vessels not controlled by fracture mechanics with:

(1) Any pressurization above 25 percent of MAWP that exceeds any previously recorded pressurization in the pressure vessel operational time/ cycle record log.

(2) Any pressurization above MAWP.

(3) Any pressurization above 25 percent of MAWP when the vessel contains hazardous fluids.

9.8.13 Involve the pressurization of ground-based pressure vessels/systems and include at least one of the following cases:

a. Any pressurization above the MAWP/Design Pressure.

b. First time pressurization to rated pressure of any new vessel/system or the modified portion of an existing vessel/system. This excludes pressurization after removal or replacement of a component with a like item that has been pressure tested prior to installation. This also excludes pressurization of flex hoses up to rated operating pressure, provided hose restraints required by section 13.12.10 of this KNPR are in place.

c. In-place calibration at more than 80 percent of full scale for pressure gauges with scale range over 200 pounds per square inch gauge (psig) unless the gauge has a solid front case with pressure relief back.

d. Involve procedures that manually control pressurization of systems where MAWP/Design Pressure can be reached. The TOP shall contain a CAUTION/WARNING note stating the maximum allowable pressure.

9.9 TOP CHANGES AND REVISIONS

9.9.1 Interim changes (reference definition in Appendix A) to existing Category I and II TOPs shall be in accordance with the following:

a. Insufficient time exists to make a formal change to a previously released TOP.

b. An approved deviation authorizing an interim change is obtained prior to implementation.

c. Each change shall specify whether it adds or modifies hazardous step(s).

d. Safety approval is required for interim changes that add or modify hazardous step(s), including out-of-order processing.

e. All approved deviations or other documentation authorizing permanent changes to a TOP during its use shall be incorporated, or addressed, as part of the next printed change or revision.

9.9.2 An approved deviation is required for changes to any section of a TOP. All deviation requests shall be processed using an approved deviation process, and shall be approved prior to implementation. For emergency or time-critical situations, operations may continue with the deviation processed after the fact, provided concurrences are recorded on the net and/or documented within the TOP. Deviations shall not be required for non-technical or clerical errors.

The following apply to changes that allow for steps/sequences to be performed out-of-order:

a. Out-of-order processing for hazardous steps

(1) Out-of-order changes to hazardous steps require an approved deviation. For emergency or time-critical (real-time) situations, operations may continue with the deviation processed after the fact, provided concurrences are recorded on the net and/or documented within the TOP. Actual order shall be documented within the TOP.

(2) Pre-planned out-of-order changes to hazardous steps documented within the TOP may be performed without a deviation. Actual order shall be documented within the TOP.

b. Out-of-order processing for non-hazardous steps

(1) Out-of-order changes to non-hazardous steps require an approved deviation.

(2) For emergency or time-critical (real-time) situations, out-of-order changes to non-hazardous steps may be performed without a deviation after necessary concurrence is obtained and documented within the TOP.

(3) Pre-planned out-of-order changes to non-hazardous steps documented within the TOP may be performed without a deviation.

c. Pre- and post operations tasks may be performed in any order without a deviation provided it is preplanned and documented.

9.9.3 All TOPs/changes/deviations involving the flight termination system shall be forwarded to the KSC Range Safety Manager for coordination with the appropriate signatories per NPR 8715.5, Range Safety Program.

9.9.4 All TOPs/changes/deviations involving hazardous operations for NASA Launch Services Program (LSP) at Vandenberg Air Force Base (VAFB) or at the Cape Canaveral Air Force Station (CCAFS), shall be forwarded to the S&MA Launch Services Division.

9.9.5 All TOPs/changes/deviations involving hazardous operations for NASA payloads (KSC or CCAFS) shall be forwarded to the S&MA ISS/Payload Processing Division.

9.10 PROCESSING OF TOPS

All organizations operating in areas under KSC jurisdiction shall ensure all TOPs they originate are developed, classified (hazardous or non-hazardous), and processed as follows:

9.10.1 CATEGORY I TOPS

a. Prior to use, final version of any new, changed, or revised Category I hazardous TOP shall be reviewed and approved (by signature) by the appropriate S&MA professional(s) for compliance with the requirements herein.

b. New Category I hazardous TOPs shall be released at least seven days prior to scheduled use.

c. Changed or revised Category I hazardous TOPs shall be released at least five days prior to scheduled use and three days prior to scheduled use for page changes.

9.10.2 CATEGORY II TOPS

a. Prior to use, Category II hazardous TOPs shall be reviewed and approved (by signature) by the appropriate safety and health professional(s) for compliance with the requirements herein.

b. Category II hazardous TOPs shall be released at least two days before the procedure is performed, except in the case of real-time TOPs.

9.10.3 Nonhazardous TOPs are not required to be approved by safety if the responsible safety organization has an audit/sampling plan to ensure the safety requirements are met. The sampling plan shall be developed and documented by each program/project and audited by the appropriate NASA KSC S&MA Division.

9.10.4 Prior to use, all repetitive TOPs shall be reviewed and updated, if needed, for compliance with current requirements if it has been 3 years since its last publication.

Shuttle-Specific Requirements for 9.10.4 are contained in Chapter 18.

CHAPTER 10: MISHAPS AND CLOSE CALLS (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS)

10.1 GENERAL REQUIREMENTS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

All mishaps and close calls shall be reported to the responsible supervisor and the organizational (NASA or contractor) safety office and shall be investigated to determine the root cause(s), to develop and implement corrective actions in order to prevent recurrence, and to document and share lessons learned. In addition, all mishaps and close calls shall be electronically entered into the NASA Incident Reporting Information System (IRIS) database. The requirements stated herein implement NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Report, Investigating, and Recordkeeping. The KSC mishap and close call processes are documented in program-specific Launch Contingency Plans; and KSC-PLN-2807, KSC Mishap Preparedness and Contingency Plan.

10.2 DEFINITION OF MISHAPS AND CLOSE CALLS

10.2.1 MISHAPS

A mishap is an undesired and unexpected event that results in injury requiring more than first aid, occupational illness to personnel, and/or damage to property of at least $1000. Mishaps also include injuries or occupational illnesses resulting from repetitive stresses or exposures over a prolonged period of time. Mishaps resulting in damage to aircraft, space hardware, or ground support equipment that meet these criteria are included, as are test failures in which the damage was unexpected or unplanned. For purposes of investigation and reporting, mishaps are categorized as follows:

a. Type A Mishap

A mishap resulting in one or more of the following:

(1) An occupational injury or illness resulting in a fatality, a permanent total disability, or the hospitalization for inpatient care of 3 or more people within 30 workdays of the mishap;

(2) A total direct cost of mission failure and property damage of $1 million or more;

(3) A crewed aircraft hull loss;

(4) An occurrence of an unexpected aircraft departure from controlled flight (except high performance jet/test aircraft such as F-15, F-16, F/A-18, T-38, and T-34, when engaged in flight test activities).

b. Type B Mishap

A mishap that caused an occupational injury or illness that resulted in a permanent partial disability, the hospitalization for inpatient care of 1-2 people within 30 workdays of the mishap, or a total direct cost of mission failure and property damage of at least $250,000 but less than $1,000,000.

c. Type C Mishap

A mishap resulting in a nonfatal occupational injury or illness that caused any days away from work, restricted duty, or transfer to another job beyond the day or shift on which it occurred, or a total direct cost of mission failure and property damage of at least $25,000 but less than $250,000.

d. Type D Mishap

A mishap that caused any nonfatal OSHA recordable occupational injury and/or illness that does not meet the definition of a Type C mishap, or a total direct cost of mission failure and property damage of at least $1,000 but less than $25,000. Permanent occupational hearing loss in excess of 25 decibels in either ear is classified as an OSHA reportable event.

10.2.2 CLOSE CALLS

An occurrence or a condition of employee concern in which there is no injury or only minor injury requiring first aid and no significant equipment/property damage/mission failure (less than $1000), but which possesses a potential to cause a mishap or negative mission impact.

10.3 CLASSIFYING MISHAPS AND CLOSE CALLS

10.3.1 INITIAL ASSESSMENT

For purposes of initial assessment of mishaps and close calls, it is recognized that severity of the event may not be known. Therefore, a worst-case estimate of injury/illness and/or damage or its potential shall be made and updated as needed.

10.3.2 MISHAPS

Mishaps are classified as Type A, B, C, or D in accordance with the definitions in section 10.2.1. All mishaps shall be entered into the NASA IRIS database and information updated every 30 days until the investigation and the corrective actions are complete and closed by the responsible organization.

NOTE: For assistance with the NASA IRIS database or its use, contact the Institutional S&MA Division.

10.3.3 CLOSE CALLS

The definition of a close call is contained in section 10.2.2. For close calls, an assessment of the worst case potential mishap severity and probability of occurrence shall be performed. The mere existence of a hazard does not constitute a close call. In order to meet the definition of a close call, there must be an undesired and unexpected event that has potential for causing a mishap or negative mission impact, even though neither occurred. For example, a sidewalk that is buckled and uneven is classified as a hazard by its mere existence. If someone were to trip or fall, and escape injury or only require first aid, the event is classified as a close call if the event had significant potential to have been any type of mishap. All close calls shall be entered into the NASA IRIS database.

NOTE: For assistance with the NASA IRIS database or its use, contact the Institutional S&MA Division.

10.3.4 EXPOSURE TO HAZARDOUS SUBSTANCE

Personnel exposure, or suspected exposure, to a hazardous substance exceeding allowable limits (quantity level or exposure time) shall be reported immediately to the Occupational Health Facility (OHF) or, if not located at KSC, to a licensed medical physician. All exposures shall go through the OHF or licensed medical physician (if not located at KSC) for medical evaluation and treatment. Confirmed exposures exceeding allowable limits shall be reported and documented as a mishap or close call.

10.3.5 MUSCULOSKELETAL DISORDERS (MSD)

Lost time cases due to a MSD or repeated trauma injury or illness shall be classified as a mishap. For these cases, the date of diagnosis by a licensed physician or the first official lost time day, whichever occurs first, is the reported date that shall be entered into the NASA IRIS database.

10.3.6 OCCUPATIONAL ILLNESS

For cases of occupational illness due to long term exposure to hazards, such as abestosis, silicosis or hearing loss, the date of diagnosis by a licensed physician or the first official lost time day, whichever occurs first, is the date that shall be entered into the NASA IRIS database.

10.3.7 INJURIES INCURRED AS A RESULT OF A RECREATIONAL ACTIVITY

Recreational activitiy injuries shall be classified as NASA mishaps if the employee is on duty and is required to participate for job certification, training or by labor agreement. Each program/project or directorate organization sponsoring such recreational activity shall determine which activities employees can perform. Recreational activities shall be designed to minimize the potential for personal injury. Injuries resulting from off-duty use of KSC exercise facilities are not classified as NASA mishaps. On-duty, nonsponsored recreational activities are prohibited.

10.3.8 NATURAL PHENOMENON AND WEATHER-RELATED EVENTS

Damage resulting from natural phenomena or acts of nature (e.g., flooding, hurricanes, tornados, lightning strikes, wild fires), without human intervention, shall not be classified as a NASA mishap by the organization owning/controlling the damaged or lost property. An assessment of all damages incurred shall be performed and cost of repairs and/or replacement shall be tracked and entered into the NASA IRIS database. Natural phenomenon damage resulting from or made worse by failure of personnel to follow established procedures or standard practices, such as damage caused by animals as a result of personnel failing to properly secure and protect facilities and equipment, is not considered damage from natural phenomena, but is still classified as a NASA mishap or close call.

10.3.9 HIGH VISIBILITY MISHAPS AND CLOSE CALLS

Mishaps or close calls that may draw media attention, cause embarassment to NASA, or other events deemed important by NASA management are considered “high visibility” mishaps or close calls and may warrant a full NASA mishap investigation board.

10.3.10 MISHAPS AND CLOSE CALLS INVOLVING PROPERTY DAMAGE

The responsible manager, with review and concurrence by the NASA S&MA, shall calculate the direct cost of a mishap or close call by adding all the actual costs (or the estimate of the cost) (the greater value of actual or fair market value) of damaged property, destroyed property, or mission failure, actual cost of repair or replacement, labor (actual value of replacement or repair hours for internal and external/contracted labor), cost of the lost commodity (e.g., the cost of the fluid that was lost from a ruptured pressure vessel), as well as resultant costs such as environmental decontamination, property cleanup, and restoration. In cases where replacement parts are available from salvaged or excess equipment at little or no cost to NASA, the direct cost of the mishap or close call shall include the actual costs of replacement parts (if they were purchased new) plus labor calculated as if the salvage/excess parts were unavailable. In cases where insurance compensation, contractor compensation, or other compensation is available or provided, the direct cost of the mishap or close call shall include the direct cost (or estimate of the cost) as if this compensation were not available or provided.

10.4 REPORTING MISHAPS AND CLOSE CALLS

10.4.1 GENERAL REQUIREMENTS (CIVIL SERVICE AND CONTRACTOR)

a. Initial Reporting

Initial reporting requirements for mishaps and close calls are based on the preliminary, worst-case assessment of actual or potential severity and visibility.

b. NASA IRIS Database

All mishaps and close calls shall be entered into the NASA IRIS database within 24 hours of the event. Within 24 hours, NASA S&MA shall ensure that all NASA mishaps and close calls are recorded in IRIS and include the following information: Center submitting report; author of report; author's phone number and mail code; date report submitted; time report submitted; incident date; incident time; incident general location; exact location (if known); responsible organization; organization's point of contact; point of contact's phone number and mail code; mission affected; program impact (if known); number and type of injuries or fatalities (if known); type of damage to equipment, flight hardware, flight software, or facilities; estimate of direct cost of damage; and a brief description of the mishap or close call. IRIS cases shall be continuously updated as new information becomes available and, at a minimum, updated at least every 30 days until it is closed. For mishaps or close calls involving injury, the occupational health representative or other medical person shall provide the appropriate medical information regarding the person(s) injured and the nature of the injury(s) to the appropriate NASA KSC S&MA Division for inclusion in IRIS.

10.4.2 TYPE A, TYPE B, OR OTHER HIGHLY VISIBLE MISHAPS AND CLOSE CALLS (CIVIL SERVICE AND CONTRACTOR)

a. In order to facilitate the timely investigation and other notification requirements of NPR 8621.1, the responsible Civil Service or Contractor program/project or directorate organization shall immediately (within one hour) provide initial notification by telephone or in person to NASA S&MA, the Contracting Officer, and Contracting Officer Technical Representative (COTR). Initial notification shall include the time, the location, a description of the event, the organization(s) involved in the event, and a preliminary worst case estimate of the injuries/illness and/or the direct cost estimate of the damage resulting from the event.

NOTE: The NASA Safety and Mission Assurance Directorate will provide additional Center-wide and NASA Headquarters notifications.

b. Mishap notification must be acknowledged verbally, by e-mailed, or by fax. Information to be reported includes the Center name, location of incident, time of incident, number of fatalities (if known), number of hospitalized employees (if known), type of injury (if known), type of damage (if known), contact person, contact person's phone number, and a brief description of the mishap. In addition, within 24 hours, the S&MA Directorate shall follow up the initial phone notification to NASA Headquarters by sending an electronic notification that includes the following information: Center submitting report; author of report; author's phone number and mail code; date report submitted; time report submitted; incident date; incident time; incident general location; exact location (if known); responsible organization; organization's point of contact; point of contact's phone number and mail code; mission affected; program impact (if known); number and type of injuries or fatalities (if known); type of damage to equipment, flight hardware, flight software, or facilities; estimate of direct cost of damage; and a brief description of the mishap or close call.

c. Within 8 hours of a work-related mishap involving death of a Federal employee, or the hospitalization for inpatient care of 3 or more employees (provided at least 1 is a Federal employee) within 30 workdays after the mishap, the S&MA Directorate shall notify OSHA and provide the following information: the establishment name, location of incident, time of incident, number of fatalities (if known), number of hospitalized employees (if known), contact person, contact person's phone number, and a brief description of the mishap. After notifying OSHA, the S&MA Directorate shall inform NASA Headquarters that an oral report has been provided to OSHA. Contractors are responsible for reporting directly to OSHA when the mishap involves contractor personnel only.

d. For Type A, B or highly visible mishaps and close calls, a formal Mishap Investigation Board (MIB) (Contractor and/or Civil Service) shall be formed per section 10.5.1.

10.4.3 TYPE C OR D MISHAPS AND CLOSE CALLS

a. Contractor

Shuttle-Specific Requirements for section 10.4.3.a are contained in Chapter 18.

(1) The responsible contractor organization shall, within four hours of the event (or by 7:30 AM the next workday for mishaps occurring during shifts other than first shift), submit an initial report (e-mail or fax) to S&MA.

(2) In addition, all mishaps and close calls shall be electronically entered into the NASA Incident Reporting Information System (IRIS) database while complying with section 10.4.1.b.

(3) The initial report shall contain a description, the time, the location, and the organizations involved in the event, a preliminary worst case estimate of the injuries and/or cost estimate of the damage resulting from the event.

b. Civil Service

(1) Civil Service Mishaps Involving Injury or Illness (and which may also include property damage)

For mishaps involving more serious injury or illness involving direct emergency transport to off-site medical facilities, the emergency responders shall provide the OHF initial medical information documented on a KSC Form 6-2. For nonlife threatening injury or illness, the employee shall notify their supervisor and report to the OHF. The OHF shall record the medical evaluation on a KSC Form 6-2, and forward a copy to the Institutional S&MA Division and to the employee's supervisor (yellow copy). Upon receipt, the employee's supervisor shall fill out Section III of the KSC Form 6-2 and forward it to the Institutional S&MA Division within 72 hours of the mishap. The Institutional S&MA Division shall enter the information into the NASA IRIS database, and update as appropriate.

(2) Civil Service Mishaps or Close Calls Involving Property Damage Only

For mishaps or close calls involving damaged property only, the responsible Civil Service organization shall provide initial notification to S&MA and forwarded to the appropriate S&MA division and the Institutional S&MA Division, Institutional Safety Branch within 4 hours of the mishap or close call (or by 7:30 AM the next workday for mishaps occurring during shifts other than first shift). The appropriate NASA KSC S&MA Division shall ensure that the responsible civil service organization enters the data into the NASA IRIS database, and update as appropriate.

10.4.4 REPORTING DAYS AWAY FROM WORK (CIVIL SERVICE AND CONTRACTOR)

a. Civil Service and Contractors

Days away from work shall be entered into the NASA IRIS database by the responsible contractor organization (for contractor days away from work) or the Institutional S&MA Division (for Civil Service days away from work). Days away from work shall be counted for the calendar days away from work for 180 days duration. Reporting of days away from work beyond 180 total days away due to a single injury or illness is not required. A day away from work is defined as a full work day, and results from a nonfatal traumatic injury, or a nonfatal nontraumatic illness, that causes one or more days away from work beyond the day or shift on which it occurred. Only days away from work directed or approved by a licensed physician shall be recorded as days away. In calculating total days away from work, the total number of calender days off prescribed by the physician shall be counted, even if the employee would not normally work on some of those days (e.g., weekends, holidays or scheduled days off). For injuries or illnesses that become long-term or permanent disability cases, the mishap report status shall be updated in the NASA IRIS database by the responsible contractor organization or the Institutional S&MA Division to reflect the new mishap classification.

b. For Civil Service Only

When an injury or illness becomes a “time away from work” case, the Institutional S&MA Division Chief or Lead Engineer shall provide notification per NPR 8621.1.

10.4.5 OTHER NASA CENTERS PERFORMING WORK AT KSC

For work performed at KSC that is exclusively under the control of another or other NASA Center(s) (i.e., without the participation of KSC employees or contractors), initial and follow-up mishap/close call reporting will include notification of the host KSC program/project and S&MA Directorate. This requirement is in addition to their own NASA Center mishap/close call reporting and follow-on investigation, corrective action, and lessons learned requirements.

10.5 INVESTIGATION

10.5.1 MISHAP INVESTIGATION BOARDS (MIBS)

a. NASA MIBs

NASA Mishap Investigation Boards shall be formed for all Type A or B mishaps. Mishap Boards may also be formed for other mishaps or close calls as deemed necessary by the Center Director or program/project or organizational Director. Mishap Board investigations shall be accomplished in accordance with the requirements of NPR 8621.1.

b. Contractor MIBs

For NASA mishaps resulting from NASA contractor operations, the NASA Board Appointing Official, with the concurrence of the S&MA Director, may delay the formation of a separate NASA Mishap Investigation Board (or activity) pending the review and acceptance of the contractor report. In this case, a letter signed by the NASA Board Appointing Official shall be sent to the contractor notifying them of NASA’s intent to delay formation of a separate NASA Mishap Investigation Board. NASA also retains the option of providing a Government representative on Contractor-managed MIBs.

10.5.2 NON-BOARD MISHAP AND CLOSE CALL INVESTIGATIONS

All mishaps and close calls shall be investigated to identify the root cause(s) and other contributing cause(s). Within 30 working days of the mishap or close call, the results of the investigation shall be documented in the NASA IRIS database.

a. Civil Service Non-board Mishap and Close Call Investigations

For mishaps or close calls with damage to property exclusively under the control of NASA Civil Service personnel, the appropriate NASA KSC S&MA Division shall ensure that the NASA program/project conducts the investigation and enters the data into IRIS. When injury or illness to civil service personnel is involved, the Institutional S&MA Division, in conjunction with the NASA program/project or NASA KSC S&MA Division, shall conduct the investigation. Civil Service injury and illness investigation results shall be documented in Section III of KSC Form 6-2 and submitted to the Institutional S&MA Division for entry into the NASA IRIS database. The program/project or NASA KSC S&MA Division shall maintain involvement and oversight in the investigation and analysis, and provide consultation on an as needed basis.

b. Contractor Non-board Mishap and Close Call Investigations

Contractor organizations are responsible for investigating their own nonboard mishaps and entering the results of the investigation directly into the NASA IRIS database. Both the appropriate program/project and the appropriate NASA KSC S&MA Division shall maintain insight into the investigation of contractor mishaps, track progress as documented in the NASA IRIS database and perform independent assessments of the investigation results and the effectiveness of the identified corrective action.

10.6 MISHAP REPORTS

10.6.1 MISHAP INVESTIGATION BOARD (MIB) REPORTS

a. The mishap investigation report shall contain a description of the structured analytical techniques used to identify causal factors, detailed documentation of mishap data, discussion of root cause(s), and significant observations, findings and recommendations. The report shall also include a proposed Corrective Action Plan (CAP) to be used as a framework for further development and implementation. Witness statements shall be kept separate from the main portion of the report so that they can be easily separated and withheld from release and distribution of the report. NPR 8621.1 contains detailed information on report requirements and format. Within 75 workdays of the mishap or close call, the MIB shall submit the completed and signed mishap report to the appointing official. Once the report is approved, the MIB Chair shall ensure that the NASA IRIS database is updated with the report and proposed corrective action plan and distribute the final report in accordance with NPR 8621.1. The Institutional S&MA Division is the official repository for all MIB reports and associated documentation. Witness statements and medical records shall be sealed and retained by the S&MA Directorate in a locked file, and are not part of the distributed MIB report.

b. Contractor reports shall undergo a formal review by NASA, and, once accepted, a formal letter of acceptance from the NASA Board Appointing Official will be provided to the Contractor.

10.6.2 NON-BOARD MISHAP INVESTIGATION BOARD REPORTS

A mishap report documenting investigation results including identification of root cause(s), significant observations, findings, and recommendations shall be entered into the NASA IRIS database within 30 days of the event.

10.7 CORRECTIVE ACTIONS

a. Corrective action(s) shall be determined and implemented in order to prevent recurrence of similar events.

b. Immediately after the mishap report has been authorized for public release, the appointing official shall direct the responsible organization to develop a CAP for those recommendations approved by the endorsing officials.

c. Within 15 workdays from being tasked, the responsible organization shall develop and submit the CAP to the appointing official.

d. The CAP shall contain a matrix or other means of matching corrective actions to all findings and recommendations.

e. The CAP shall provide corrective action(s) for the root cause(s) identified, the proximate and intermediate causes, contributing factors, and for all other failed controls or barriers to the mishap or close call.

f. The CAP shall provide a description of the corrective action(s), and identify (to the lowest level possible) the organization(s) responsible for implementation and the organization(s) responsible for ensuring completion the action item(s).

g. The responsible organization shall monitor corrective action activities for mishaps and close calls and determine if they are carried out according to plan.

10.8 LESSONS LEARNED

a. All mishaps and close calls shall be evaluated for any lessons learned.

b. When the evaluation results in lessons learned, then the lessons learned shall be submitted to the NASA Lessons Learned Information System (LLIS) in order to share this information and prevent recurrence.

NOTE: The LLIS is available to all NASA and NASA contractor personnel at http://llis.nasa.gov/.

10.9 METRICS AND TREND ANALYSIS

10.9.1 SAFETY STATISTICS RECORD (SSR)

a. A Safety Statistics Record, KSC Form 6-22V2 NS, shall be completed monthly by all KSC contractor, program/project, and directorate organizations and submitted to the Institutional S&MA Division for use in developing Center-wide safety metrics.

b. If adjustments, corrections or additions to a previous fiscal year's statistical data occur, an updated year-end SSR for the affected fiscal year shall be submitted.

10.9.2 TREND ANALYSIS

All KSC program/project or directorate organizations shall perform regular analysis of safety-related mishap and metric data in order to identify trends requiring corrective or preventive actions.

10.10 MISHAPS INVOLVING PAYLOAD CUSTOMERS, RESIDENT OFFICE PERSONNEL AND OFFICIAL VISITORS

For mishaps exclusively affecting non-KSC Civil Service or Contractor personnel or property (i.e., personnel who are conducting official business on KSC but who are not NASA KSC Civil Servants or Contractors), KSC will provide initial response, medical services, and control of the mishap scene. In this case, the investigation and reporting process will be determined by the appropriate Memorandum of Understanding (MOU) or Customer Agreement, or the organization's Center or corporate safety office. These mishaps will not be counted as NASA

KSC mishaps unless otherwise stated by a formal agreement. The appropriate NASA KSC program/project and S&MA Directorate shall be provided insight into the investigation and be provided courtesy copies of the final mishap report.

CHAPTER 11: SAFETY PROGRAM (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS)

11.1 SAFETY ENFORCEMENT

Each contractor's safety program shall contain provisions for compliance with and enforcement of safety requirements. A means of auditing and enforcing these requirements shall be developed and maintained.

11.2 SAFETY PROGRAM DOCUMENTATION

Facility Inspection Summary - Program/project or Institutional S&MA Division shall identify potential hazards at least annually. The operating organizations shall keep the following information:

a. Facility name and building number

b. Date inspected

c. Hazards identified from the inspection

d. Status of hazards - Open/Closed

CHAPTER 12: KSC SUPPLEMENT TO NFPA 70, NATIONAL ELECTRIC CODE (NEC)

12.1 GROUNDING AND BONDING

All sources of static electricity discharges shall be grounded when such discharge would create an unsafe situation. Tank cars, storage tanks, connecting pipes, hose lines, and nozzles shall be bonded together prior to the loading or unloading of flammable materials. Where propellants are stored or handled, facilities shall be provided for personnel to dissipate static charges from their person.

12.1.1 PERSONNEL GROUNDING

Personnel grounding devices (e.g., legstats, wristats, conductive footwear) shall be worn by all personnel handling Category A electro-explosive devices (EED) when the Faraday caps are removed, or installing Category B items on/in units that will be Category A when the installation is complete, or when working within five (5) feet of exposed solid grain. When using legstats, personnel must stand on a conductive surface and use legstats in pairs to ensure one foot remains in contact with the ground at all times. Personnel required to wear these devices shall ensure resistance checks are performed using a conductive shoe tester prior to operations. The resistance measured from facility ground to the wearer must be between 10,000 ohms and 1 megohm. Reverification of grounding will be necessary if personnel remove their conductive shoes, legstats, wristats, or leave the immediate area where the operation is taking place. The grounding devices shall be removed upon leaving the ordnance operation area. Personnel will exercise caution to avoid all electrical sources when wearing personal grounding devices.

12.1.2 GROUNDING OF FLIGHT HARDWARE

These requirements are program-specific and shall be developed by the program and documented elsewhere, if applicable.

Shuttle-Specific Requirements for this section are contained in Chapter 18.

a. The flight hardware containing hazardous commodities shall be electrically grounded at all times.

b. **Reserved**

c. **Reserved**

d. **Reserved**

12.1.3 GROUNDING OF TOOLS, EQUIPMENT, AND MATERIALS

a. Pneumatic (air motor) tools used on hardware containing EEDs, within ten feet of open grain, or in petroleum/oil/lubricant areas shall be fitted with a conductive air supply hose or be connected to facility ground. Conductive air supply hoses shall be included in a scheduled preventive maintenance program that shall test and verify continuity.

b. The Solid Rocket Motor (SRM) transporter shall be grounded to facility ground at all times when moving in or out from under a segment. When moving a loaded segment, the transporter shall be grounded prior to entering (or until after exiting) a building. The transporter shall not

enter a building at the Rotation, Processing, and Surge Facility (RPSF) without being grounded. Segment to pallet to transporter ground shall be maintained during moves.

c. All material in contact with open grain shall be grounded.

d. For horizontal SRM segment grain inspection the first pad shall be grounded prior to installation. Subsequent pads shall be butted/ overlapped to ensure electrical continuity of pads.

e. Conductive plastic sheeting (velostat) shall be placed on railcar surface at entrance to the bore. Sheeting shall be grounded to common ground with railcar prior to installation.

12.1.4 GROUNDING DURING HOISTING OF FLIGHT HARDWARE

When explosives and/or flammable fluids are involved, electrical grounding shall be required as follows:

a. Ground crane hook to facility ground (same potential as the load) before connecting to the load.

b. Use bonding strap from load to hook when satisfactory contact (continuity) is not obtained.

c. The ground may be disconnected after the load is lifted clear of its supporting structure, but shall be reconnected to facility ground as soon as possible while the load is still suspended.

d. The final ground /detachment shall be at least ten feet away from any open grain/explosives.

e. Voltage checks on the crane hooks shall be performed prior to lifting flight hardware containing explosives. During the voltage checks, neither of the voltages (AC nor DC) may exceed 100-mV Root-Mean-Square (RMS) measured across a 1-ohm resistor. The voltage checks shall be performed while operating the crane; all crane motions shall be checked. Crane hook voltage checks shall not be required for lifting of other hazardous commodities providing the crane hook and load are properly grounded.

f. **Reserved**

Shuttle-Specific Requirements for item f. are contained in Chapter 18.

12.2 THREE-PHASE POWER CONNECTIONS

a. Three-phase power sequencing shall be verified in each KSC facility prior to connection, including after facility modification or outages.

b. The phasing of the power source shall be verified prior to each closure of the payload canister transporter shore power contactor switch. The phasing of the payload canister transporter systems and subsystems shall be verified upon first use or component replacement.

12.3 ELECTRICAL EXTENSION DEVICES

Electrical extension devices include extension cords, Relocatable Power Taps (RPTs), and other devices designed to extend electrical wiring from a permanent receptacle to a piece of

electrical equipment. Extension devices are widely used for supplying electrical power and have been a primary cause of many fires. Every effort must be made to avoid using extension devices. Moving of furniture, relocation of equipment, or installation of additional permanently wired electrical receptacles may help to eliminate the need for extension devices.

a. An installation or equipment shall only be considered acceptable when:

(1) It is accepted, certified, listed, labeled, or otherwise determined to be safe by a nationally recognized testing laboratory and used in accordance with manufacture's instructions; or

(2) With respect to an installation or equipment of a kind that no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, it is inspected or tested by another Federal agency or by a State, municipal, or other local authority responsible for enforcing occupational safety provisions of the National Electrical Code (NEC) and found in compliance with the provisions of the NEC as applied in 1910 Sub Part S; or,

(3) With respect to custom-made equipment or related installations that are designed, fabricated for, and intended for use by a particular customer, it is determined to be safe for its intended use by its manufacturer on the basis of test data which the employer keeps and makes available for inspection by the authority having jurisdiction.

b. Extension devices shall not be used as a substitute for permanent wiring.

c. Electrical extension devices will comply with 29CFR 1910 Subpart S.

d. All listed and labeled electrical extension devices shall be installed and used in accordance with any instructions included in the manufacture's listing and labeling.

e. Extension devices shall be UL-Listed.

f. Extension cords shall be three-wire with adequate current capacity rating. The use of two-wire or high-gauge extension cords (16 gauge or higher) shall be prohibited.

g. All extension devices must be the three wire grounded type and attachment plugs shall be "Dead Front" construction and meet the NEC and OSHA Electrical requirements. (See Definition)

h. Damaged extension devices shall be removed from use immediately and discarded.

i. Electrical extension devices shall not be used in combination (i.e., "piggybacked") where one extension device is plugged into another.

NOTE: The use of a single ground fault circuit interrupter (GFCI) pigtail is excluded from this requirement.

j. All uses of electrical extension devices shall be evaluated based on intended use, environment in which it is to be used, capacity of the service circuit, capacity of the device and cord/cable, and the physical condition of the extension device.

k. The use of electrical extension devices to provide power to meet legitimate operational needs (e.g., use of electrical hand tools, heat lamps, lighting, etc.) for temporary use that is

restricted to completion of a temporary job shall be permissable. These usages shall require evaluation by a competent persons (see definition) regarding the method and equipment used to ensure the device and electrical service is adequate for the demand.

l. All extension cords [with the exception of Relocatable Power Taps (RPT) (i.e., power strips as described below] shall be unplugged when not in use.

m. Relocatable Power Taps (RPTs)

(1) RPTs (i.e., power strips) with transient voltage surge suppression (TVSS) capability shall be permissible to protect electronic equipment such as computers, copiers, printers, fax machines, analytical instruments, and other critical electronic components from transient voltage surges.

NOTE: There is no time constraint regarding how long RPTs/surge protection devices may be used continuously in this capacity. These devices should be turned off or disconnected when not in use.

(2) The use of RPTs shall be permissible as long as the RPT is not permanently installed/secured to building structures, tables, work benches, cabinets, or similar structures.

NOTE: An RPT would be considered “permanently secured” if tools are required to install or remove.

(3) RPTs shall not be rewired in order to attached a longer cord. This will invalidate the UL listing and will prohibited the RPT from being used.

(4) RPTs shall not be used on construction sites.

n. Uninterruptible Power Supplies (UPS)

(1) UPS shall be used in accordance with the manufacturer’s instructions for use with electronic computer/data supply processing equipment.

(2) A maintenance schedule shall be established when a UPS systems are placed into service.

o. Ground Fault Circuit Interupter

(1) Extension devices exposed or potentially exposed to wet environments shall be approved for use in wet environments, equipped with a GFCI, and be connected to a permanent electrical outlet.

(2) The use of plugging extension cords into GFCI pigtails shall not be considered “piggy backing” or “daisy chaining.”

(3) When using extension cords in combination with GFCI pigtails, the maximum rated load applied shall not exceed the rating of the GFCI pigtail.

p. Extension devices used in potentially hazardous or explosive atmospheres shall meet the National Electric Code (NEC) standards for the appropriate class and division and shall not be modified by the user.

q. Equipment power cords, extension cords, and other electrical cabling shall be used in a manner that does not create a tripping hazard. If such placement is unavoidable, a protective cover or equivalent shall be placed over the cable and marked in such a manner as to alert personnel to the tripping hazard (e.g., black/yellow safety tape, brightly colored cones, etc.)

r. Extension cords run through doorways, windows, or similar openings shall be protected from damage.

s. Extension cords shall not be run through holes in walls, ceilings, or floors, concealed behind walls, ceilings, or floors or attached to building surfaces.

t. In areas where vehicles might run over the extension device, a protective cover/bridging device with brightly colored cones designating the hazard shall be used to reduce the possibility of damage to the extension device.

u. Electrical Appliances

(1) Appliances shall be plugged directly into a permanently mounted receptacle that is part of the facilities fixed wiring; appliances shall not be plugged into electrical extension devices or cubicle wall outlets.

(2) Electrical appliances which have been modified or that are nonstandard in any way shall not be used.

(3) All electrical appliances shall be unplugged when not in use except when the appliance is controlled by an internal power switch.

(4) Only UL listed or FM approved coffee makers, refrigerators, crock pots, toasters, and microwaves shall be permitted for general office food preparation, provided the electrical system is capable of supporting the load needed for these items.

(5) Toaster ovens shall not be used or present on the Center.

CHAPTER 13: NASA KSC REQUIREMENTS FOR GROUND-BASED VESSELS AND PRESSURIZED SYSTEMS (PVS)

13.1 PURPOSE

The purpose of this Chapter is to assign responsibilities and to ensure the structural integrity of PVS through implementation of the minimum requirements for ground-based PVS in accordance with this document, NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S), NASA General Safety Program Requirements, applicable Federal Regulations, and national consensus codes and standards (NCS).

13.2 SCOPE

This Chapter defines organizational responsibilities for all ground based equipment designed for, or operating at, positive or negative gauge pressure, defines items excluded from certification requirements, contains specific criteria for inspection, analysis, documentation, testing, nondestructive examinations, marking and labeling of pressure vessels and pressurized systems, and provides reporting data input requirements.

13.3 DEFINITIONS

Pressure Vessel/Systems (PVS)-related definitions are included in Appendix A.

13.4 POLICY

It is KSC policy that all ground-based Pressure Vessels and Pressurized Systems (PVS) which are not excluded per section 13.17 of this Chapter shall be certified/recertified in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Divisions 1 and 2; ASME B31.3 Code for Pressure Piping; and ANSI/NB-23 National Board Inspection Code. Additionally, all pressure vessels and pressurized systems shall comply with KSC design standards KSC-STD-Z-0005 through KSC-STD-Z-0009. All PVS shall be safe to operate and be subject to Inservice Inspection (ISI) and periodic recertification to maintain personnel and equipment safety. The following criterion applies:

13.4.1 All new PVS shall be designed, fabricated, installed, operated, maintained, certified, and recertified in accordance with applicable codes, standards, and guides. For existing PVS which do not conform to these codes, standards, and guides, supplemental analyses, tests, examinations and risk assessments shall be performed to ensure that the safety of personnel, equipment, and facilities is not compromised.

13.4.2 Periodic inspection and maintenance activities shall be specified and documented throughout the usage history of the PVS. Inspection procedures shall be developed on the basis of established codes and standards or as the result of engineering evaluation.

13.4.3 In instances where policies set forth in this chapter are in conflict with KSC pressure systems design criteria and specifications (e.g., KSC-STD-Z-0005), the more stringent requirement shall prevail.

13.4.4 Operation of Commercial Off the Shelf (COTS) systems will be within the manufacture's placard limitations.

13.5 RESPONSIBILITIES

13.5.1 HEADS OF PRIMARY ORGANIZATIONS

Heads of program/project or directorate organizations having Design, Operation and Maintenance (O&M), or sustaining engineering responsibility, are responsible for ensuring that:

a. Design and modification of pressurized systems for use at KSC, or where KSC has design, O&M, or sustaining engineering responsibility are in accordance with current national consensus codes, standards, and guidelines.

b. Necessary documentation to support the certification program is received for all new pressure vessels, pressurized systems, and all systems being modified, and that such documentation is transmitted to the cognizant O&M organizations and to the KSC Pressure Systems Manager (PSM) via the Document Release Authority (DRA). The document shall also be available through the KSC Electronic Documentation System (KEDS).

c. Field surveys are performed to verify PVS are properly categorized and included or excluded in the PVS certification program, as appropriate.

d. An inventory database is updated and maintained for pressure vessels and systems. This includes all PVS that are inactive and active, and those that are exempt from the PVS Certification Program. For systems excluded from the PVS Certification Program, documentation should be maintained indicating the rationale for exclusion from certification.

e. A data management system for maintaining files containing the certification/re-certification and ISI documentation required to certify each vessel or system.

f. All PVS are marked or labeled for traceability in the certification program.

g. Review of existing documentation is performed to determine suitability to support certification, and missing documentation is obtained or developed.

h. A 20-year ISI plan is developed and implemented.

i. A certification report describing all of the steps involved, along with the rationale for certifying pressure vessels and systems for continued service is provided.

j. Training requirements for personnel working on pressure vessels and systems are established.

k. An individual is assigned to represent the program/project or directorate organization in all matters relating to the PVS certification program and is identified to the PSM per a letter assigning the individual to the Pressure Vessels/Systems Committee.

NOTE: The above responsibilities do not apply to the Director of International Space Station/Payload Processing for payload-associated Ground Support Equipment (GSE) supplied by other NASA centers and government agencies. This equipment is covered by Chapter 20 (STS/ISS payloads) or Eastern Western Range (EWR) 127-1 (1997)/ AFSPCMAN 91-710 V3 (ELV Payload GSE).

13.5.2 KSC PRESSURE SYSTEMS MANAGER (PSM)

The PSM is responsible for:

a. Assuring that necessary documentation to support the certification program is maintained on all systems owned or operated by KSC or its contractors. For systems excluded from the PVS Certification Program, documentation should be maintained indicating the rationale for exclusion from certification.

b. Reviewing and approving PVS certification criteria for special cases not covered in this chapter: reviewing certification implementation schedules, defining required documentation, analysis, inspection, testing, nondestructive examination, and reporting requirements for pressure vessels and pressurized systems.

c. Evaluating proposed waivers, deviations, and variances involving PVS, covered by the certification program.

d. Evaluating exclusion criteria and approving exclusions other than those listed in section 13.17.

e. Reviewing disposition (i.e., de-rate, re-rate, repair, alterations, decommission) of all pressure vessels or systems that do not meet inspection or testing requirements.

f. Reviewing, as necessary, hazardous and non-hazardous inspection and test procedures utilized by the certification program, to assure adequacy of safety considerations.

g. Reviewing and approving supplemental analysis, tests, procedures, and examinations, as necessary.

h. Maintaining a baseline inventory/status of all PVS for which KSC has design or operational responsibility. This includes vessels/systems that are exempt from certification and the rationale for exclusion.

i. Reviewing, evaluating, and have readily available all PVS certification and inservice inspection (ISI) reports.

13.6 PRESSURE VESSELS AND PRESSURIZED SYSTEMS (PVS) PROGRAM REQUIREMENTS

13.6.1 GENERAL REQUIREMENTS

a. The PSM has the authority to interpret this standard. (This is not to be interpreted as authority to change or waive the requirements of this document)

b. Ground-based PVS listed in section 13.17 shall be exempt from the certification requirements of this KNPR.

c. PVS shall meet the requirements of State and Local Boiler and Pressure Vessel Statutes unless exclusive Federal laws and regulations apply (e.g., 29 CFR 1910). In the event of a

conflict between this document and applicable statutes or regulations, the statutes or regulations govern.

d. All PVS shall be certified, recertified, and documented in accordance with the requirements of NPD 8710.5, NASA-STD-8719.17, and this KNPR. The Maximum Allowable Working Pressure (MAWP), Maximum Operating Pressure (MOP), temperature range, and other service conditions shall be documented for each PVS in the certification report.

e. Compliance with the requirements of this document shall be documented and approved by the PSM in accordance with section 13.14, Certification/Recertification Requirements. PVS are designated as “Certified” when the PSM has reviewed and signed the certification report.

f. A periodic inspection plan shall be developed and performed for all PVS in accordance with section 13.9 or Figure 13-8 of this KNPR.

g. The original service life or remaining safe life of each PVS shall be documented at the time of certification or re-certification based on relevant failure modes, cyclic service history, rates of degradation, damage mechanisms, or other appropriate factors.

(1) All conditions that cause changes in the current estimate of remaining life shall be assessed and documented, with appropriate modification to the inspection and recertification plans of record, in accordance with section 13.11.6 of this document.

(2) Potential damage mechanisms shall be identified and evaluated, including but not limited to fatigue, creep, and corrosion.

h. Initial certification shall be given only after all known safety-related discrepancies have been corrected. Non-safety related discrepancies shall be dispositioned and corrected in conjunction with regularly scheduled maintenance.

i. PVS shall be pressurized only after initial certification is complete, with the exception of pressurization that may be required for initial integrity testing of the PVS.

j. Systems requiring a pressure regulator and/or a pressure relief device or both shall not be operated unless such components are in place and operating properly.

k. When systems of different pressure ratings are connected, a relief device shall protect each section of the system. In those cases where the maximum regulator inlet pressure exceeds the MAWP or design pressure (as designated by the design drawing) of the section downstream of the regulator, the relief device shall be set no higher than this pressure rating and be sized to prevent the pressure from rising more than 10 percent above this pressure rating.

l. PVS that do not meet applicable NCS, guides, and regulations shall only be certified and allowed to operate if a risk and hazard assessment has been performed, the owner acceptance of residual risk has been documented, and the Center approval has been formally documented by means of a variance in accordance with section 13.16 of this document.

m. Inactive vessels shall comply with section 13.13, Inactive, Unsafe, and Decommissioned Vessels and Systems.

n. Vessels and systems on standby/contingency, either with or without pressure, should be treated as if they are in continuous service, and the certification of such PVS shall be maintained to conform to expected service conditions.

o. A change in the service of a PVS shall require evaluation for applicability of the original Code for the new service, possible application of a new Code appropriate to the new service, and possible reevaluation in accordance with the applicable NCS.

p. PVS shall be exposed only to those fluids that have been demonstrated to be compatible with the vessel or system materials.

q. A vessel or system that has been de-rated shall be re-rated to the original or new operational parameters only after appropriate testing, examination, repair, alteration, modification, documentation, and engineering analysis.

r. Program/project or directorate organizations that process spacecraft, missiles or launch vehicle systems with one or more Graphite/Epoxy (Gr/Ep) or Kevlar/Epoxy Composite Overwrapped Pressure Vessels (COPVs) shall be required to submit data that demonstrates the requirements in section 13.18 have been met.

s. Pressure systems shall always be depressurized before disconnection, repairs, or replacements are attempted.

t. PVS used to transport fluids and gases under pressure shall comply with Department of Transportation (DOT) 49 CFR 100 - 185 or ASME Section XII regulations, as applicable. Non-DOT vessels may be transported with a blanket purge not to exceed 25 psi or 1/5 MOP (which ever is less) for relocation; after relocation the pressure vessels shall be recertified.

u. Relief valve, pressure relieving device, exhausts, and other vents shall incorporate appropriate means of reacting to thrust loads, including balanced thrust (“zero thrust”) vent tees and structural supports as appropriate.

13.6.2 DESIGN, OPERATION, AND MAINTENANCE REQUIREMENTS

a. Operate all PVS within the certification parameters.

b. The owner shall maintain change and modification records of PVS.

NOTE: This may be used to identify problem components or PVS trends.

c. The owner shall report to the PSM any PVS incidents within eight hours of occurrence and shall perform corrective actions as required by the PSM.

d. The owner shall have qualified personnel operating the system.

e. The owner shall collect operational data as required to support certification/ recertification of PVS and provide the data to the PSM as required to facilitate certification/recertification.

NOTE: Some areas of concern are cyclic operation, corrosion, erosion, and creep.

f. The owner shall operate and maintain boilers in accordance with recommendations of the boiler manufacturer, including water quality. In some cases, due to operational, environmental, or other parameters, maintenance procedures in addition to the manufacturer's recommendations may be necessary.

g. The owner shall maintain PVS and their components in accordance with the manufacturer's recommendations or with a suitable maintenance plan to ensure continued compliance with the certification/recertification. In some cases, due to operational, environmental, or other parameters, maintenance procedures in addition to the manufacturer's recommendations may be necessary.

h. The owner shall not operate PVS unless qualified,except for inspection, examination, and testing as required by the NCS or the inspection plan. Maximum operating pressure under these conditions shall be determined by the cognizant design organization.

13.7 DOCUMENTATION REQUIREMENTS

The Contractor program/project or directorate organization shall prepare and maintain certification files for each vessel or systems under its jurisdiction. If the required original documentation is not available, it shall be re-created to the maximum extent possible. The following documentation shall be required and shall be released in the appropriate documentation centers (KEDS) or Technical Documentation Center or Engineering Documentation Center (TDC/EDC):

13.7.1 PRESSURE VESSELS

a. Manufacturer's drawings: The drawings shall be either certified shop fabrication drawings or as-built drawings.

b. In addition to certified shop fabrication drawings or as-built drawings manufacture's drawing, the drawings or certification/re-certification report shall also contain the following:

c. Manufacturer's name and address.

d. Date of manufacture (see vessel nameplate).

e. Dimensions and details of construction.

f. Design and operating conditions, including service fluid, operating temperature, and MAWP.

g. Material thickness (head, shell, etc.).

h. Material corrosion allowance.

i. Identification of materials, including types of alloys, tensile properties, and impact properties.

j. Efficiency of weld joints.

k. Nondestructive Examination (NDE) performed.

l. Types of pressure tests performed.

m. Design calculations - Design calculations for pressure vessels shall include MAWP, temperature, wind, vibration, and any other applicable loading.

n. Manufacturer's data report(s) - (ASME Forms U-1, U-1A, U-2, U-2A, U-3, U-4, A-1, A-2, A-3 as applicable.)

o. Inspection, examination, and test records.

p. Facsimile of nameplate stamping.

13.7.2 PRESSURE SYSTEMS

a. End-to-end system drawings, including schematics, which show (as a minimum) system operating pressures, safety device set pressures, and line sizes and wall thickness of piping or tubing. Part numbers traceable to the manufacturer shall identify all pressurized components. For existing systems where components cannot be positively identifiable, such components shall only remain in service, provided a review of fabrication and installation drawings, maintenance records, manufacturer's data, etc., and verifies proper components are installed.

b. KSC component specification drawing, component maintenance drawing, or equivalent, or vendor data for each unique pressurized component in the system suitable for verifying pressure rating, materials of construction, flow parameters, operating characteristics, and relief device capacity to maintain system pressure within ASME Code allowable limits.

c. Approved operating or preventive maintenance procedures that describe requirements for periodic system maintenance and testing, relief device and pressure gage setting and calibration criteria, and flex hose inspection and test criteria.

13.7.3 REPAIRED, ALTERED, OR MODIFIED SYSTEMS AND/OR VESSELS

a. Alterations or repairs to vessels and system modifications shall be thoroughly documented in the appropriate system certification file, and released into KEDS.

b. Vessel alteration or repair documentation shall include calculations, drawings, specifications, NDE reports, and other pertinent documentation, as applicable by this document and the National Board Inspection Code, NBIC-23.

c. Any vessel or system that is altered, repaired or modified shall be recertified. A revised certification report shall be issued that describes the alterations, repairs, or modifications.

13.8 TESTING REQUIREMENTS

13.8.1 GENERAL

a. All new, repaired, or modified systems or portions thereof, shall be pressure and leak tested prior to activation. Testing of pressure systems shall be in accordance with applicable NCS and equipment technical manuals.

b. Leaks shall not be repaired when a system is under pressure or the test fluid has not been drained.

c. Test record for each pressure vessel shall include the manufacturer's data (e.g., design specification, applicable code for design, test/inspection criteria, operating instructions, location of any dimensional check points, and installation information).

13.8.2 NON-FLIGHT PRESSURE VESSEL

New pressure vessels shall be pressure tested by the manufacturer in accordance with the applicable code. For ASME Code vessels, this test shall be one time only. All repairs, alterations and retest of ASME Code vessels shall be in accordance with American National Standards Institute (ANSI)/NB-23. Vessels designed per 49 Code of Federal Regulations (CFR) shall be retested/requalified in accordance with 49 CFR requirements. Where 49 CFR regulations do not specify retest, a retest procedure shall be developed.

13.8.3 FLIGHT VEHICLE VESSELS AND SYSTEMS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

International Space Station Requirements for this section are contained in Chapter 19 .

Pressure vessels and systems that have been pressurized to operating pressure as complete systems prior to delivery to KSC shall require further testing as part of the receiving inspection/ acceptance activity. Retest shall be performed only as specified in approved Technical Operating Procedure (TOP).

a. Flight Vehicle Fracture Critical Vessels and Systems

(1) Flight hardware pressure vessels that are controlled as fracture critical shall be tested/pressurized to levels specified in the appropriate Fracture Mechanics Plan and JSC 08934, "Shuttle Operational Data Book," Volume I, "Shuttle Systems Performance and Constraints Data."

(2) Pressure vessels and systems shall be processed through turnaround flow at temperature adjusted operating pressures, only if the operating pressures are sufficiently below the threshold pressures to avoid sub-critical flaw growth. The MAWP shall be specified in the applicable operating procedure.

(3) Fracture critical controlled vessels/systems shall be pressurized to operating pressures, using specified liquids/gases, without remote controls, only if the vessels/systems have been previously pressurized to operating pressure levels.

(4) A logbook shall be maintained on each Fracture Mechanics controlled pressure vessel/system processed at KSC. The log shall identify how many times the vessel/system has been pressurized, the pressure levels, liquids/gases used, duration of the pressure cycles, and any other pertinent data. The log shall also identify the total number of cycles for which the vessel/system was designed.

(5) A logbook shall be maintained for each PVS processed at KSC. The log shall identify how many times the vessel/system has been pressurized, the pressurization levels, fluids used, duration of the pressure cycles, and any other pertinent data. The log shall also identify the design criteria used in fabricating the vessel/system.

b. Flight Vehicle Non-Fracture Critical Vessels and Systems

(1) PVS shall not be pressurized above 50 percent of design burst pressure, adjusted for temperature.

(2) PVS shall be processed through turnaround flow at pressure levels not to exceed 50 percent of design burst pressure, adjusted for temperature, if warranted by operational considerations.

(3) PVS that have not been tested as a system prior to delivery to KSC shall require personnel evacuation and remote controls for the initial (first-time) pressurization and for any subsequent pressurization that will exceed the highest level of pressure reached during previous testing as a system.

(4) PVS shall be pressurized using fluids specified in JSC 08934, “Shuttle Operational Data Book,” Volume I, “Shuttle Systems Performance and Constraints Data.” Pressurization levels specified herein shall not exceed those specified in JSC 08934, Volume I.

13.8.4 For flight vehicle systems utilizing both fracture critical and non-fracture critical pressure vessels, pressurization at KSC shall be performed at pressure levels that do not exceed that allowed for the weakest link in the system. The lowest MAWP or design pressure (as designated by the design drawing) in the system shall be used as the basis for the pressure to be applied.

13.8.5 Any pressurization of systems or components above 25 percent of design burst will require a minimum 200-foot control area when the system or component contains hazardous fluids.

13.9 INSERVICE INSPECTION (ISI) AND INSPECTION REQUIREMENTS

a. The operating organization shall develop a 20-year ISI and test plan consistent with intervals recommended in the applicable NCS and this standard.

b. The operating organization shall perform an external visual examination (VE) or “walk-down” of vessels and systems. For vessels at space vehicle launch pads or other locations that are subject to severe environmental conditions, including exposure to solid rocket exhaust products, shock, and vibration from the launch environment, the external visual examination interval shall not exceed two years. For other vessels not exposed to such extreme conditions, the external visual examination may be extended to no more than five years. This “walk-down” is to determine the overall fitness for service, identify any deficiencies that may have compromised the PVS or any configuration changes, etc. or more frequently if indicated by the ISI.

c. DOT 49 CFR containers used as stationary vessels shall be inspected as defined in DOT 49 CFR regulation. In the event 49 CFR does not specify periodic visual inspection, inspection intervals for DOT 49 CFR vessels shall not exceed 1 year.

d. The ISI plan shall be developed based on the evaluation of the documentation, field inspection results, NDE results, and the engineering evaluation.

e. When a 20-year ISI plan has been prepared by a previous operating organization, the current operating organization shall be responsible for implementing and updating the ISI plan.

f. The ISI data sheet shall be presented in either a tabular or matrix format in the certification report. A sample ISI Form is shown in Figure 13-8.

g. The ISI plan shall provide development rationale in the certification report.

h. It shall be permissible to conduct the ISI in conjunction with routine system maintenance, where appropriate.

i. Inspection intervals for all relevant damage mechanisms shall be specified in the inspection plan consistent with intervals recommended in the applicable NCS and this standard.

j. The NDE inspection frequency for fatigue-limited PVS shall be not more than one half the Code allowable cyclic fatigue life, which is established either by postulating a minimum detectable flaw size using appropriate NDE method(s) to determine remaining life cycles up to reaching critical flaw size or by using the cumulative cyclic usage factor and Stress Number (S/N) diagram approach of ASME Boiler and Pressure Vessel Code, Section VIII, Div. 2, or other applicable NCS.

k. Inservice inspections shall be performed to obtain sufficient data to ensure that unanticipated forms or rates of degradation, service changes, or other factors have not changed the remaining life.

l. Personnel performing Inservice inspections and walk downs shall be appropriately qualified as applicable in accordance with the appropriate training.

m. Personnel performing NDE inspections and tests shall be appropriately qualified and certified [American Society for Nondestructive Testing (ASNT) or equivalent] as applicable in accordance with the appropriate NCS.

n. Baseline thickness shall be verified for all PVS subject to wall thinning as the limiting damage mechanism prior to initial operation or certification. For pressure vessels, measurements shall be taken on the head and wall considering the service fluid, operating environment, and projected service life. In no case shall the verification interval exceed 20 years.

NOTE: If questionable areas are found during the Visual Examination, further examination by NDE techniques shall be performed using techniques that do not compromise vessel or system integrity.

o. Inservice corrosion rate thickness inspections shall be determined by the PVS integrity assessment.

p. PVS whose service life is limited by fatigue or brittle fracture shall have fatigue inspections performed no later than when the PVS has experienced one-half of the specified number of permissible load cycles.

q. Inspection intervals shall be reviewed and adjusted throughout the life of a PVS to incorporate safety related Code changes, unanticipated rates of degradation, change in service fluid, operating pressure or temperature, or other relevant factors.

r. Records of inspection shall be maintained for the life of the pressure vessel, and for 1 year after the vessel is decommissioned, and disposed of in accordance with KNPR 4000.1, Supply and Equipment System Manual. After vessel disposal, the records will be archived per NPR 1441.1.

s. Vessels designed for permanent installation shall be re-inspected anytime they are moved to a different location.

t. The inner vessel of cryogenic (jacketed) vessels and other insulated storage vessels are exempt from the visual examination requirements, provided the pressure retaining boundary is protected from corrosion and leakage is not indicated. Additional engineering analysis based on the credible failure mechanism shall be performed to justify the inner vessel exemption from the visual examination (leak before burst, fatigue, etc).

u. Maintain verification that pressure relief devices (PRDs) i.e. relief valves, pressure indicating devices (gages), are in a periodic inspection or recall program. Frequency of inspection or recall is to be based on design and safety standards, codes, and severity of service.

v. Verify system operating pressures, relief device settings, line sizes, and wall thickness, and component pressure ratings are in accordance with approved documentation.

w. Verify that all components and piping and tubing are properly identified. Also verify from vendor drawings or data sheets that all components have been hydrostatically or pneumatically tested.

x. All system and vessel examination intervals specified above are the maximum allowed. When service and environmental conditions, age, and additional concerns arise during analysis and evaluation, a more frequent examination interval may be established. This could result in a shorter recertification interval than would be developed for a similar PVS with no identified concerns.

y. All changes in service fluids, operating pressure or temperature, all repair records, and conditions found during inspections shall be included in the inspection record. The inspection record must show as a minimum, MAWP, the last date of inspection, and hydrostatic/pneumatic test pressure, and test date(s).

13.10 MARKING AND IDENTIFICATION REQUIREMENTS

Marking and labeling requirements shall conform to the applicable design specifications, codes, standards, and fabrication and installation drawings. ASME Code terminology shall continue to be used until metric units are incorporated into the ASME Code. Vessels and components shall be identified by unique identifiers (find numbers) that are traceable to the mechanical schematic drawing (refer to GP-435, Vol. 1, sections 2.5.2 and 6.6.1).

13.10.1 GROUND-BASED OR GROUND SUPPORT EQUIPMENT (GSE) PRESSURE VESSELS

a. Manufacturer’s Nameplate - Manufacturer nameplates vary with regards to type, size, location and contents but generally contain the following: MAWP or Design Pressure (D.P.), Temperature Range, Capacity, Material, Media, Model Number or Serial Number and other

Information. For ASME stamped vessels, the National Board Number shall be included if the vessel was registered with the National Board. Nameplates must be accessible and legible.

b. The MAWP and Name of Service Fluid - Must be displayed on the vessel in a conspicuous location. Where multiple vessels are grouped together to store the same fluid at the same pressure, only the most conspicuous vessel in the group need be labeled. The marking shall be legible at a distance of 16 meters (50 feet).

c. Maximum Operating Pressure (MOP) - MOP designation use is optional. Utilization is generally reserved for those applications where the maximum operating pressure used with a given pressure vessel is lower than the vessel's capability or MAWP. When used, the MOP shall be displayed on the vessel in a conspicuous location. Where multiple vessels are grouped together to store the same fluid at the same pressure, only the most conspicuous vessel in the group need be labeled. The marking, which may be somewhat larger than that for the MAWP, shall be legible at a distance of 16 meters (50 feet).

d. Find Number (Axxxxxx) - The KSC-unique, alphanumeric identifier designated by stencil or corrosion-resistant, metal tag. May be grouped together on conspicuous signage in cases where vessels are banked together.

e. KSC PVS Certification Program Nameplate - Each certified pressure vessel shall have a corrosion-resistant plate, tag or stenciled sign permanently affixed as near as possible to the original manufacturer's name-plate, bearing the following information as a minimum:

> "KSC PVS CERTIFICATION PROGRAM, CERTIFIED
> MAWP xxxx psig," and "CERTIFICATION DATE
> (Month and Year)."

13.10.2 PANELS

a. RELIEF VALVES

Each relief valve shall be labeled or tagged to include the following:

(1) Set pressure in psig

(2) Date (month/year) valve was set or calibrated

(3) Find Number

(4) Next due date (month/year)

(5) Manufacturer's nameplate

NOTE: The pressure shown shall be the nominal pressure, exclusive of any tolerance, specified by appropriate engineering directive. Also, each relief valve will have a Find Number on the panel front (plate) next to the relief valve schematic symbol or the panel back (ink-stamp or tag).

b. PRESSURE GAGES

Each pressure gage that is periodically recalibrated shall have a calibration sticker affixed to the gage dial or cover/lens to include the following:

(1) Calibration date (month/year)

(2) Next due date (month year)

(3) Unique ID Number

Also, each pressure gage will have a Find Number on the panel front (plate) next to the pressure gage schematic symbol or the panel back (ink-stamp or tag).

c. TRANSDUCERS

Each transducer that is periodically recalibrated shall have a calibration sticker affixed to the body of the instrument or to an identification tag which will include the following:

(1) Calibration date (month/year)

(2) Next due date (month/year)

(3) Unique ID Number

Also, each transducer will have a Find Number on panel front (plate) next to the transducer schematic symbol or the panel back (ink-stamp or tag).

d. PANEL TUBING

Identification tag is required on each tube assembly letter with:

(1) Tube size

(2) Test Pressure

(3) Test Date

(4) Other miscellaneous information required by controlling system design specification.

The identification shall consist of a metal band secured around the tube or a tag secured by safety wire. For long runs of pipe, a second tag may be affixed.

e. MISCELLANEOUS COMPONENTS

Miscellaneous components (hand valves, check valves, regulators, filters, etc.) shall, as a minimum, be marked or identified with a Find Number. This marking will consist of a Find Number on panel front (plate)/back (ink-stamping or tag).

f. PANEL FACE MARKING

Each panel front (face) shall be marked with a one-line schematic representing commodity flow, panel inlets and outlets, schematic symbols, respective component Find Numbers, etc. Also, each panel front will have signage indicating such descriptive information as panel title, drawing number, program model number, etc as required by respective design specification.

13.10.3 INTERCONNECTING PIPING, TUBING, AND IN-LINE COMPONENTS

Interconnecting piping and tubing shall be marked to indicate commodity, direction of flow, and nominal operating pressure in accordance with respective design specifications. In-line components shall, as a minimum, be marked or identified with a Find Number. If these components are pressure gages or transducers, the marking requirements of section 13.10.2 apply.

13.10.4 FLEX HOSES

a. All flex hose assemblies in use shall have corrosion-resistant metal tag(s) attached that bears the following information as a minimum:

(1) Date (month and year) of Fabrication

(2) Hydrostatic Test Date (month and year)

(3) Current, Periodic Visual Inspection and Next Due Date (month and year)

(4) Manufacturer's Name, Part Number and/or KSC Part Number

(5) Rated Working Pressure

(6) Serial Number (S/N)

(7) Service Media (Only for dedicated fluid hoses in support of any oxygen, hydrocarbon or hypergolic liquid system.)

(8) For Type I hoses, a Find Number

b. All new or refurbished flex hose assemblies in inventory, under the control of a Logistics organization, shall have corrosion-resistant metal tag(s) attached that bears the following information as a minimum:

(1) Date (month and year) of Fabrication

(2) Hydrostatic Test Date (month and year)

(3) Manufacturer's Name, Part Number and/or KSC Part Number

(4) Rated Working Pressure

(5) Serial Number (S/N)

NOTE: Commercial off-the-shelf equipment which contains flex hoses, and is approved by Underwriter's Laboratory (UL), National Institute for Occupational Safety and Health (NIOSH), or other safety certifying organizations, shall be exempt from these requirements.

13.10.5 MARKING REQUIREMENTS – PORTABLE AND MOBILE PRESSURE SYSTEMS

KSC owned portable and mobile pressure vessels and systems shall be marked in accordance with KSC Drawing 81K04331, "Specification for Marking of Propellant Portable Containers," or in accordance with KSC Drawing 81K00643, "Specification for Marking of Mobile GSE." Other portable and mobile pressure systems shall be marked in accordance with 49 CFR requirements for hazardous materials.

13.10.6 NON-CODE PRESSURE VESSELS AND PRESSURE SYSTEMS

Code pressure vessels that have been re-designated as non-code shall be clearly and visibly marked to indicate the non-code status, and the lettering shall be legible up to a distance of 16 meters (50 feet).

13.11 ENGINEERING ANALYSIS

The program/project or directorate organization shall perform an engineering analysis at recertification to determine the disposition of the system or vessel(s). Possible choices for disposition include:

13.11.1 Certifying the system or vessel(s) for continued operation.

13.11.2 Certifying the system or vessel(s) for continued operation with specific restrictions imposed.

13.11.3 Re-rating or de-rating the system or vessel(s) for operation at a new pressure or temperature.

13.11.4 Replacing components or portions of the system, after which it may be certified for continued operation.

13.11.5 Removing the system or vessel(s) from service.

13.11.6 PVS INTEGRITY ASSESSMENT, REMAINING LIFE

13.11.6.1 PVS INTEGRITY ASSESSMENT

a. Integrity assessment of each PVS shall be performed and documented at the time of certification or recertification.

b. Integrity assessment shall be consistent with the methodologies identified in the appropriate post-construction NCS.

c. The PVS integrity assessment shall include an inspection plan that addresses credible damage mechanisms for the specific PVS.

d. Verification of integrity of each in-service PVS shall be documented at each periodic inspection interval as specified in the inspection plan in compliance with the appropriate NCS.

e. If at any time a PVS is not fit for the intended service, the PVS shall be immediately removed from service and the certification of the PVS shall be revoked.

NOTE: Integrity verification is achieved by meeting the requirements of this document and appropriate reference documents such as ANSI/NB-23. The period of re-inspection for each PVS is to be based on maintaining a continuous state of compliance with these requirements.

13.11.6.2 REMAINING LIFE ASSESSMENT REQUIREMENTS

a. The original service life or remaining safe life of each PVS shall be documented at the time of certification or recertification through a detailed integrity assessment based on nondestructive examination (NDE) and inspection results, relevant damage mechanisms, cyclic service history, rates of degradation, and other appropriate factors.

b. The engineering assessment for remaining life shall be consistent with methodologies of appropriate post-construction NCS.

c. The rate of service related or environmentally induced wall thinning of PVS shall be documented by means of periodic thickness inspection, with appropriate adjustments made to the estimated remaining life, inspection plan, and recertification plan.

d. When PVS service life is limited by fatigue considerations, NCS-based fatigue or fracture life assessment shall form the basis for specified cyclic life.

e. When NCS fatigue analysis is performed on PVS that are not fully compliant with the NCS from which the technique is derived (e.g., when ASME Sect. VIII, Div. 2, fatigue analysis is performed on an ASME Sect. VIII, Div. 1, or non-Code vessel), an appropriate additional FS shall be applied to the allowable cyclic life based on the risk and hazard assessment.

NOTE: The fatigue life assessment methodology of ASME Section VIII, Div. 2, may be used to estimate fatigue life of Div. 1 vessels or non-Code vessels provided the allowable stress values from Div. 1 are substituted for Sm and appropriate consideration is given to the additional requirements imposed on Div 2 material, fabrication and inspection. Greater FS on cyclic life must be incorporated as uncertainty and unknowns increase. Similarly, the fracture assessment methodology of Div. 3 may be used to assess non-Div. 3 vessels provided additional consideration is given to uncertainties in stress intensity factors and fracture toughness for material that was not fully documented at the time of fabrication in accordance with Div. 3 requirements, which is typically the case for old PVS.

f. Cyclic life usage shall be obtained from history files or logs or conservatively estimated and documented at the time of each periodic cyclic service inspection, with appropriate adjustments made to the estimated remaining cyclic life in the recertification plan.

g. Unless specifically documented in the original design, the certified remaining life of any PVS shall not exceed 40 years, and the recertification period shall be in accordance with section 13.14 of this document.

h. Service life extension analysis shall include, but is not limited to, consideration of the following:

(1) Relevant characteristics of the PVS as determined by the application of appropriate NDE and/or testing.

(2) The fidelity of the NDE methods employed to locate relevant flaws.

(3) Brittle fracture failure mode when actual service temperature may be less than the MDMT of the PVS material using post-1988 ASME Boiler & Pressure Vessel or Piping Code rules for fracture toughness (e.g., UCS-66 rules in Section VIII, Div. 1).

(4) If leak before break failure mode forms the basis of life extension, leak detection requirements shall be implemented and documented in the PVS risk assessment

13.12 DESIGN, REPAIRS, ALTERATIONS, OR MODIFICATIONS

13.12.1 GENERAL DESIGN REQUIREMENTS

a. The PVS manufacturing or alteration shall be in strict accordance with the quality assurance manual of the manufacturing organization, applicable NCS and KSC design standards (KSC-STD-Z-000X).

b. ASME Code stamped items shall only be repaired or altered by National Board (NB-23) certified organizations (for example “R” and “VR” stamp holders) in strict conformance with their approved quality manual

c. The PSM shall review and approve new designs, alteration, modifications, repairs, and design analysis prior to start of PVS construction.

d. All welding shall be:

(1) Performed in accordance with procedures qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, including all essential variables for the joint in question.

(2) Performed by welders qualified and current in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, on such weld procedures.

(3) Post weld heat treatment shall be performed as required and in accordance with the ASME Code.

(4) Alterations or repairs to vessels in lethal fluid service shall require all new butt welds to be radiographed in accordance with the requirements of ASME Code, Section VIII, Division 1, Paragraph UW-2 (a).

(5) Except as provided in paragraph 13.12.4.3.a(2), impact and other testing shall be performed as required and in accordance with the ASME Code.

(6) Inspections shall be performed by inspectors trained and certified in use of the techniques being applied, in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section V.

13.12.2 DESIGN AND CONSTRUCTION REQUIREMENTS FOR NEW PVS

All new ground-based conventional (i.e., non-flight) PVS shall be designed, fabricated, assembled, erected, inspected, examined, and tested in accordance with the appropriate national consensus standards, codes, and regulations.

13.12.3 PRESSURE VESSELS FOR TRANSPORT OF PRESSURIZED FLUIDS

Pressure vessels used to transport fluids under pressure shall comply with the DOT regulations of 49 CFR 100-185 or ASME Section XII as applicable.

13.12.4 PRESSURE VESSELS NOT FOR TRANSPORT OF PRESSURZED FLUIDS

13.12.4.1 New pressure vessels, including heat exchangers, shall be ASME Section VIII code stamped as specified within the scope of the Division being used and registered with the National Board.

13.12.4.2 Vacuum vessels shall be ASME Section VIII code stamped and registered with the National Board except as provided in sections 13.12.4.3 and 13.12.4.4 of this KNPR.

13.12.4.3 For new vacuum vessels, or alterations/repairs to existing vacuum vessels, operating in high vacuum service (internal pressure less than 10-3 torr) or in other cases involving only external atmospheric pressure (i.e., no external pressure greater than 14.7 psig) where specific operational needs make ASME Section VIII or NB-23 code stamping unfeasible, all of the requirements specified elsewhere in this document shall apply with the following exceptions (this paragraph is not to be construed to accept the purchase or use of non-code stamped vacuum vessels where there is not a specific overriding need):

a. No ASME “U” Stamp (“code stamp”) or National Board Inspection Code (NBIC) “R” Stamp is required, however all documentation requirements of this document shall be met, except:

(1) The ASME or NBIC Data Report shall be processed in all respects as for a code stamped vessel, but it shall not be submitted to the National Board, and the Certificate of Shop Inspection shall be signed either by a National Board commissioned inspector or by the PSM.

(2) For industry standard components such as potted connectors and “Conflat” flanges used in strict accordance with the manufacturer’s ratings and recommendations, material records and analysis are not required provided sufficient information regarding material is available to perform properly any welding or brazing processes required.

NOTE: This does not exclude from the ASME Code analysis requirement those industry standard components that are rated by their manufacturers only for external pressure and that require relief protection above a PRD setting of 2 psig (or less, if so specified by the manufacturer). If relief protection is required, bolting or other fasteners shall be analyzed in accordance with the ASME Code or other means acceptable to the PSM to determine that they have a positive pressure rating sufficient for the credible positive pressure scenarios.

b. Intermittent welds are permitted on nozzles and reinforcing pads, however an appropriate code equivalent analysis shall be performed to verify the adequacy of the weld design.

c. Nozzle reinforcement may be achieved using configurations other than those illustrated in ASME Section VIII, however adequacy of such designs shall be demonstrated by appropriate ASME Code equivalent analysis or testing.

d. The ASME Section VIII requirement for an internal pressure test (hydrostatic or pneumatic) may be replaced with a vacuum test to 1.5 times the specified pressure differential, but not to exceed an external pressure of 14.7 psig. This exception shall not be used in those cases where proof test is used in lieu of analysis if an overpressure of 1.5 times the maximum allowable working (differential) pressure is not attained.

e. Materials other than those specified for use in ASME Section VIII and its reference documents may be used, however their adequacy for the intended application shall be demonstrated to the satisfaction of the PSM.

f. Allowable stresses and other material properties for “non-code” materials shall be obtained following the approach and safety factors used in developing ASME Section VIII allowable stresses and other values.

g. ASME Code pressure relief capacity requirements shall be met for internal pressurization sources, but the relief device need not be “UV stamped,” provided the set pressure is less than 15 psig.

h. If a vacuum vessel requires relief protection with PRD setting above 2 psig due to the nature of the potential pressurization source, the vessel pressure shell shall be structurally qualified in accordance with the requirements of the ASME Code, Section VIII, Division. 1.

i. If relief protection of any set pressure is required for a vacuum vessel due to attached pressure sources, bolting or other fasteners shall be analyzed in accordance with the ASME Code or other means acceptable to the PSM to determine that they have a positive pressure rating sufficient for the credible positive pressure scenarios.

j. The relief protection for all vacuum vessels attached to any positive pressure source shall be reviewed and approved by the PSM.

13.12.4.4 The foregoing exceptions to the requirements of this document and of the ASME and NBIC Codes notwithstanding, and not reducing the effect of any other requirement of this document or of the ASME or NBIC Codes, specific note is made of the following requirements: Vacuum vessels shall be fabricated, repaired, or altered only by manufacturers having either an ASME “Code Stamp” (ASME “U” Authorization) or NBIC “R” Stamp, or that have been audited and determined by the PSM to have an equivalent quality assurance manual and process, including implementation.

13.12.5 BOILERS AND BOILER PIPING (ALSO SEE FIGURE 13-12)

a. Power boilers shall be ASME Section I code stamped and registered with the National Board.

b. Power boiler piping shall meet ASME B31.1, Power Piping.

c. Power boiler external piping shall be ASME code stamped.

d. Heating boilers shall be ASME Section IV code stamped and registered with the National Board.

13.12.6 NON-BOILER PIPING SYSTEMS

a. Process piping shall meet the requirements of ASME B31.3, Process Piping.

b. Other piping shall meet the requirements of the most applicable ASME B31 series Code.

13.12.7 REQUIREMENTS FOR SPECIFIC COMPONENTS - PRDs

a. PRD exhausts and other vents shall incorporate appropriate means of reacting to thrust loads, including balanced thrust ("zero thrust") vent tees and structural supports as appropriate.

b. The location, design, operating parameters, last test date, and due date for re-closable PRDs on each in-service PVS shall be documented in the PVS configuration management system.

NOTE: Redundant PRDs used only for operational pressure control below the MAWP of the PVS are not subject to this requirement, provided the system is otherwise protected in accordance with the requirements of the applicable NCS.

c. Non-reclosable PRDs shall meet the requirements of section 13.12.7.b of this document with the exception of test date and due date.

d. Overpressure protection for PVS shall be in accordance with the applicable NCS.

e. Overpressure protection devices for PVS rated less than 15 psig shall have adequate relief capacity and set pressure tolerance.

f. The accuracy of the pressure set point of pressure safety valves (PRDs) shall be periodically retested, or the PRDs shall be replaced. The following retest intervals shall be used, consistent with the guidance of NB-23, Part RB:

(1) Steam Systems – Annually

(2) Gas systems above 200 psi MAWP – annually, or if on a case-by-case basis inspections indicate the interval can be extended, but no less frequently than 3 years

(3) PRDs in combination with rupture disks – 5 years

(4) Category M, corrosive, flammable, or toxic fluid systems – 2 years (Note: This paragraph is not directly from NB-23.)

(5) All others – in accordance with Center procedures, but no more than 5 years.

g. Rupture disks need not be replaced periodically provided their vent spaces are inspected and confirmed unrestricted (e.g., free of debris) at the intervals listed above for PRDs.

NOTE: Because the normal failure of rupture disc is to fail below rated burst pressure, if it has been determined that such a failure will not result in an increased risk, manufacturer's recommended replacement periods may be increased.

h. Adjustments and repairs to Code stamped PRDs shall comply with the applicable NCS.

i. Adjustments and repairs to non-Code PRDs shall comply with the applicable NCS to the extent possible.

j. Pressure regulators shall not be used to provide overpressure protection to a PVS.

k. Pressure safety relief valves shall only be used in accordance with the applicable ASME code of construction.

l. PVS with an MAWP of less than 15 psig including vacuum systems charged from internal or external gas sources shall have appropriate PRD protection. Code stamped PRDs are generally not available with ratings less than 15 psig. Therefore these low-pressure PVS may be protected with non-Code/non-conventional PRDs such as check valves with known cracking pressures or lift disks whose relieving pressure depends solely on the weight of the disk. Such non-conventional PRDs are subject to all other applicable requirements of this section, including periodic retesting.

13.12.8 SAFETY-RELATED SWITCHES AND PRESSURE INDICATING DEVICES

When pressure-indicating devices or pressure or temperature switches exist on a pressure system to provide safety and hazard information to personnel, critical operational information to operators or control systems, or to document compliance with Code test pressures, they shall be considered safety-related devices and shall meet the requirements listed below.

a. The location and last test date of all safety-related pressure-indicating devices and pressure or temperature switches shall be documented in the PVS Configuration Management Data System.

b. Safety-related pressure-indicating devices shall meet an appropriate NCS, such as ASME B40.100, UL-404, or MIL-G-18997.

c. The accuracy of all safety-related pressure indicators shall be periodically verified by means of a Center-approved procedure at an interval no less frequent than that required for PRDs on the same system.

d. The minimum acceptable accuracy across the system design pressure range for each safety-related pressure indicator shall be in accordance with ASME B40.100 and the design specification.

e. If a catastrophic failure of a gauge can cause personnel injury the pressure gauge shall be equipped with a relief back case.

13.12.9 PRESSURE REGULATORS

a. Pressure regulators used to control pressure of gases supplied from compressed gas cylinders or portable tanks shall comply with OSHA regulations in 29 CFR 1910, particularly section 101, and by citation, CGA P-1 (in particular sections 3.3.8 and 3.3.9).

b. PVS downstream of pressure regulators shall either be certified for the MAWP of the pressure source, or appropriate PRDs to accommodate a full open regulator failure shall be included in the PVS installation to preclude the possibility of the downstream pressure exceeding the MAWP or placard rating of the lowest rated component, except as provided in section 13.12.9.c of this document.

c. When the PSM concurs that the use of PRDs is not feasible downstream of a regulator (such as due to venting or purity constraints), and if there are no pressure vessels downstream of the regulator, a pressure regulator certified in accordance with CGA Standard E-4 may be used in lieu of a certified PRD (since it precludes the possibility of downstream pressurization to a demonstrated high degree of reliability), provided its full-open discharge pressure does not exceed the placard rating of the lowest rated downstream element or component, and provided the regulator has been inspected and maintained in accordance with CGA E-4 and pressure tested within the past five years.

13.12.10 FLEXIBLE HOSES

a. Metallic and nonmetallic flex hoses shall be assembled, connected and disconnected in accordance with the manufacturer's specifications and recommendations and tested in accordance with the applicable NCS.

b. Rated working pressure for all flex hose assemblies shall not exceed 25 percent of the manufacturer's specified minimum burst pressure.

c. Flexible hoses shall not be used in PVS in lieu of rigid piping or tubing unless the use of rigid piping or tubing has been determined to be impractical (such as where vibration isolation, motion allowance, or component flexibility requires their use).

d. A flexible hose that is permanently installed by welding or brazing shall be included as part of the PVS inspection and testing requirements, and the retest requirement of section 13.12.10.e does not apply.

e. Flexible hoses whose rupture would cause unacceptable hazard to personnel or risk to mission shall be retested at the flexible hose MAWP no less frequently than every 5 years.

f. Flexible hoses whose rupture would cause unacceptable hazard to personnel shall have sufficient intermediate restraint at appropriate intervals along their lengths to mitigate the hazard. Adequacy of the structure to which hose end restraints are attached shall be determined by engineering.

(1) A hose containment grip (Figure 13-7) shall be installed across each intermediate union or splice on hoses over 4 feet (1.2 meters) in length.

(2) For hoses over 2 feet (0.6 meters) in length, pressurized above 150 psig (1.03 MPa):

(a) The hose shall be restrained at each end by an approved stainless resistant device (Figure 13-6) and restrained every 6 feet of length by securely attaching to the structure in a manner that in no way interferes with the hose flexibility.

(b) If the hose cannot be securely attached to the structure every 6 feet, 50lb sandbags, ingots, or other suitable weights shall be used at a minimum of 6 foot intervals to prevent the hose from whipping around in the event of a burst.

(3) Restraint requirements are not required for hoses contained by surrounding structure that can provide protection to personnel and hardware.

(4) Restraint requirements are not required for hoses outward from the end of swing arms, tail service masts, etc., to flight vehicle interfaces.

13.12.10.1 Hydrostatic Test

a. Each hose assembly shall be hydrostatically tested to a minimum 150% of the hose's design rated working pressure at the time of manufacture/ fabrication unless specified by the OMRSD design-controlled drawing, or manufacture's specification.

b. Hydrostatic retest of flex hoses is not required unless they are modified or repaired. Flex hoses shall be retested to verify the integrity of the modification or repair.

13.12.10.2 Permanently Installed Hoses

a. Permanently installed hoses used with toxic/lethal fluids, regardless of operating pressure, shall have the end fittings and intermediate splices leak tested, at a minimum, annually. The leak test shall be performed at the maximum system operating pressure using an inert gas.

b. Permanently installed flex hoses that operate at 150 psig [1.03 MPa (gage)] or higher pressure shall be visually inspected over their entire length annually, as a minimum, for damaged fittings, broken braid, kinks, flattened areas, or other evidence of degradation.

c. All permanently installed flex hoses used with toxic/lethal fluids, regardless of operating pressure, shall be externally, visually inspected over their entire length annually, as a minimum, for damaged fittings, broken braid, kinks, flattened areas, or other evidence of degradation.

d. All nonmetallic hoses used for N_2H_4, MMH or N_2O_4 service shall be internally, visually inspected for any indication of the hose liner blistering, after one-year cumulative exposure to any of these fluids.

13.12.10.3 Temporary-Use Hoses

Temporary-use flex hose assemblies are used for transfer of cryogens, gases, hypergols, hazardous waste, and toxic/corrosive fluids in applications where the hoses are routinely connected/disconnected, such as in fluid transfer operations or in test setups.

a. Temporary use hoses used with toxic/lethal fluids, regardless of operating pressure, shall have the end fittings and intermediate splices leak tested, as a minimum, annually, at the design rated operating pressure of the hose using an inert gas.

b. All temporary-use flex hoses used with toxic/lethal fluids, regardless of operating pressure, shall be inspected over their entire length prior to use.

c. All other temporary-use flex hoses that operate at 150 psig [1.03 MPa (gage)] or higher pressure shall be externally, visually inspected over their entire length prior to use.

d. All nonmetallic hoses used for N_2H_4, MMH, or N_2O_4 service shall be internally, visually inspected for any indication of hose liner blistering after one-year cumulative exposure to any of these fluids.

13.12.11 VIEW PORTS IN PVS (INCLUDING SIGHT GLASSES AND LIQUID LEVEL INDICATORS)

a. View ports shall be treated as hazardous, and hazard mitigation steps shall be employed to ensure the safety of personnel from brittle failures.

b. For materials in the brittle range, the Code equivalent FS on breaking strength for view ports shall be 10, or as recommended by the manufacturer subject to approval by the PSM.

c. A view port shall be initially pressure tested in accordance with the applicable NCS for the PVS in which it is installed.

d. Fluid compatibility shall be considered during view port testing.

e. The initial pressure test shall be performed with the view port installed in the PVS or in a fixture duplicating the installed loads.

f. View ports shall have an engineering assessment performed (including view port cycle life and ambient noise effects) to determine the appropriate inspection period.

g. Retesting shall be performed if required by the engineering assessment in section 13.12.11.f of this document.

h. View ports or windows on PVS shall be inspected visually annually for cracks, scratches, or other imperfections. An engineering assessment shall be performed on the imperfections to disposition the findings.

13.12.12 DOT CONTAINERS USED AS STATIONARY EQUIPMENT

a. DOT containers used as stationary equipment shall be certified as either DOT cylinders or as non-Code vessels.

NOTE: This document does not address the road worthiness of the trailer.

b. DOT specification cylinders that are used in non-DOT service, such as in refillable fixed installations, shall be certified as non-Code vessels with risk assessment, acceptance, and approval via the variance process.

c. The DOT containers used in non-DOT service shall be certified based on the original DOT requalification intervals for the specific cylinder specification (reference Table 1 in 49 CFR 180.209(a) and 49 CFR 180.405)

NOTE: An uncertainty for consideration during certification is that not all DOT specifications are based upon ASME, ASTM, or other standard material specifications. Because of this, minimum

assured material strength, toughness, and fracture properties are usually not known, although individual cylinder tensile strength can sometimes be inferred if the original DOT design thickness is known. Thus, for any grouping of cylinders, there is generally no assurance of commonality in material properties from one cylinder to the next. It is therefore difficult to perform conservative fatigue and fracture analysis for remaining life calculations. For these reasons, and because they have lower material strength FS (see section 13.12.12.d below), DOT cylinders cannot generally be considered ASME equivalent.

d. If a DOT container is used as stationary equipment, and the owner has elected to certify the DOT container as non-Code PVS, it shall be certified (recertified) as described below.

(1) ASME Equivalent Derating – The original cylinder working pressure shall be de-rated for NASA use, to increase the material FS to be FS =4 (or other appropriate FS applicable to the time and material of construction). The extent of derating shall be based on equivalent stress ratio between DOT and ASME or other suitable engineering analysis.

Example: For 3AA containers, the MAWP is 62% of the service rating stamped on a cylinder, calculated as follows. The test pressure maximum hoop stress is 67% of ultimate for 3AA cylinders (reference 49 CFR 178.37(f)(2)). The test pressure is also 5/3 the service rating (reference 49 CFR 178.37(i)(4)), which means that the stamped service pressure results in hoop stress of (3/5)(.67) = 0.4 times the ultimate stress (i.e., 2.5 normal safety factor on ultimate strength). In order for the hoop stress not to exceed 0.25 times the ultimate stress (FS = 4), the service pressure must not exceed 62% of the rated new service pressure (MAWP) [(0.62)(0.4)=0.25]. Deratings for other containers are determined by applying similar data from 49 CFR 178, Subpart C.

(2) Consideration shall be given to the service temperature and the potential change in material properties.

13.12.13 VESSELS ORIGINALLY NOT DESIGNED FOR, BUT BEING USED FOR MOBILE APPLICATIONS

This paragraph applies to PVS that were not originally designed to meet DOT requirements and are used to transport material under pressure.

a. This type of PVS shall not be used to transport material on public thoroughfares or water ways.

b. An engineering evaluation shall be performed to document that the fixed vessel design meets the static and dynamic load requirements associated with transport and use as a mobile vessel.

c. This type of PVS shall be evaluated as “non-Code PVS” per section 13.12.16 of this document.

13.12.14 INTEGRITY ASSESSMENT OF EXISTING CODE PVS

a. Existing Code PVS shall be documented as meeting the requirements of the original construction Code by means of record collection and physical measurements and condition assessment. Original Code information, if available shall be released into the PVS configuration management system.

b. Existing Code stamped vessels that do not meet original ASME Code requirements shall either be repaired in an ASME Code-compliant manner (see section 13.12.14.d of this document) and brought into conformance, re-rated to a lower pressure, recertified as non-Code PVS in accordance with section 13.12.16 of this document, or removed from service.

c. Code PVS shall only be altered or repaired in accordance with the requirements of the applicable NCS.

d. ASME Code stamped items shall only be repaired or altered by National Board (NB-23) certified organizations (for example “R” and “VR” stamp holders) in strict conformance with their approved quality manual.

NOTE: Government or contractor organizations that do not have an “R” or “VR” stamp do not meet the requirement.

e. Re-rating of ASME Code vessels, if required, shall be in accordance with applicable NCS.

f. Code PVS for which current Code requirements have changed from the original fabrication Code shall be reassessed and re-rated as necessary to assure an acceptable risk level.

NOTE: For example, the 1988 changes to fracture toughness rules for prevention of brittle fracture could significantly increase the assessed risk of continued operation at the original design limits. Thus, a 4 inch thick vessel fabricated from A-212 Grade B (Firebox) material is now known to have an allowable minimum design material temperature (MDMT) of 118 degrees F.

The vessel nameplate likely shows an MDMT of –20 degrees F. If the vessel normally receives ambient compressed gas at 60 degrees F, the vessel would require risk reassessment and likely additional hazard mitigation to assure continued safe operation.

g. The PSM has the authority to determine when or which Code requirements changes require reassessment of particular PVS.

h. Code PVS that have been re-designated as non-Code shall be clearly and visibly marked to indicate the non-Code status.

i. For existing PVS that have not undergone a full initial integrity assessment in accordance with section 13.12 of this document, operation shall only be permitted following approval of a technical variance waiver in accordance with section 13.16. The following paragraphs provide guidance on typical evaluations to be performed for waiver documentation through an abbreviated integrity and risk assessment review in order to obtain a reasonable level of confidence that the system to be placed in operation does not involve an excessive level of risk.

(1) Evaluate major energy and toxic material sources supplying and/or affecting the system.

(2) Perform typical and worst case wall thickness calculations, including both stress and stability.

(3) Perform typical nozzle reinforcement calculations.

(4) Perform analysis of typical high stress areas such as nozzles, supports, or other significant discontinuities.

(5) Verify material thickness and other aspects of configuration to ensure applicability of analysis.

(6) Make conservative assumptions as to material characteristics if actual material is not known.

(7) Consider heat treatment state for materials and operations where this may be a factor.

(8) Perform visual inspections of overall PVS condition, including such items as system configuration, critical weld configuration, condition and quality, corrosion, erosion, or other system deterioration.

(9) Perform volumetric inspections of critical welds or welds most likely to experience degradation, with quantity and location subject to the approval of the PSM.

(10) Evaluate pressure relief capacity versus needs.

(11) Identify most likely failure modes, including fatigue, and most likely locations for those failures to occur.

(12) Consider service history with regard to relevant failure modes, including cyclic service history, and most likely locations for accumulated service related damage.

(13) Evaluate and document the risk for the PVS.

(14) Develop a plan and schedule for the full inspection and recertification of the PVS, based on a ranking of risks and associated analyses, inspections, and mitigations, with schedule determined so as to minimize the overall risk.

j. If a Risk/Hazard Assessment has not been determined in accordance with section 13.16, System Safety and Risk Assessment Requirements, of this document for existing PVS by Sept 30, 2011, the PVS shall be removed from service.

13.12.15 TECHNICAL VARIANCE REQUIREMENTS FOR NEW NON-CODE PVS

NOTE: This section does not endorse the purchase of new non-Code PVS, but offers guidance for those rare cases where new PVS are essential to mission success but cannot reasonably meet all of the requirements of the appropriate NCS.

a. Technical variance approval and risk acceptance shall be obtained prior to initial operation of the non-Code PVS.

b. New non-Code PVS shall be certified in accordance with section 13.14 of this document.

c. To the extent possible, Code design and construction techniques shall be utilized on non-Code PVS, in particular through the use of:

(1) Code material; i.e., material whose specifications and grades are approved for use by the Code that would otherwise apply to construction.

(2) Components, (i.e., valves, fittings, elbows, etc.) that are certified to standards approved for use by the Code that would otherwise apply.

(3) Code-certified welding processes, personnel, and "U" authorized shops that meet all applicable ASME quality assurance and certification requirements for Code construction.

NOTE: NASA fabrication shops that do not possess an ASME "U" authorization, regardless of individual personal training, qualifications, and certifications, shall not be considered equivalent to Code certified shops and hence shall only perform non-Code welding.

(4) Assurance of material design factors of safety (FS) of no less than a Code PVS.

13.12.16 EXISTING NON-CODE PVS (LEGACY)

a. Non-Code PVS shall be documented and evaluated to the extent possible as meeting the requirements of the most applicable NCS.

b. Non-Code PVS shall only be altered or repaired in accordance with the requirements of the most applicable NCS to the extent possible. See section 13.12.4.3 for alterations to existing vacuum vessels.

Example: A non-Code stamped PVS that has a parallel in ASME Code construction shall be repaired or altered by National Board (NB-23) certified organizations in strict conformance with their approved quality manual except for Code stamping.

c. Assessment of non-Code PVS that have a parallel in an NCS shall include assessing new changes in Code requirements that have updates from the edition used for original evaluation. The PSM has the authority to determine when or which Code requirements changes require reassessment of particular PVS.

d. The design and operational limits of existing non-Code PVS shall be determined based on the Factor of Safety (FS) in a manner consistent with the most applicable NCS from the time of construction.

NOTE: For ASME Section VIII, Div. 1 vessels, design tensile stress FS = 3.5 on ultimate stress since issuance of the 7/1999 Addenda to the 1998 Code, 4.0 from 8/1951 Addenda to the 1950 Code through the 7/1999 Addenda to the 1998 Code, and 5.0 prior to 8/1951 (except for a brief period during World War II based on Code Case 968).

e. All existing non-Code PVS shall have a risk assessment performed and be processed in accordance with NPD 8710.5, and this document.

f. When the risk associated with operation of any PVS is unacceptable, the risk shall be mitigated in accordance with the risk reduction protocol in paragraph 1.7.1 of NPR 8715.3, NASA General Safety Program Requirements, or the PVS shall be removed from service.

g. Code PVS that have been re-designated as non-Code shall be clearly and visibly marked to indicate the non-Code status.

h. DOT specification vessels in permanent or semi-permanent installations that do not strictly comply with 49 CFR 100-185 shall be designated and certified as non-Code PVS. See section 13.12.12 for additional specific requirements for DOT vessels.

i. The provisions of sections 13.12.14.i and 13.12.14.j apply to existing non-Code PVS that must be placed in service prior to certification or recertification in accordance with section 13.14 of this document.

13.13 INACTIVE, UNSAFE AND DECOMMISSIONED VESSELS AND SYSTEMS

13.13.1 INACTIVE VESSELS OR SYSTEMS

For each inactive vessel/system, the following information shall be submitted to the PSM within 90 days after removal from service:

a. Facility location (number and name) obtained from KSC-GP-14-2.

b. Service fluid.

c. Pressure Vessel/System drawing Identification (ID) number.

d. Manufacturer's name and date of manufacture.

e. Vessel's Serial Numbers (S/N).

f. MAWP or design pressure.

g. Facility O&M organization.

h. Vessel capacity.

i. Code stamping.

j. Certification date.

k. Certification report number.

l. Associated system baseline number.

m. Normal operating pressure, temperature, and pressure cycle.

n. A copy of this information shall be maintained in the respective vessel or system documentation file.

o. Inactive vessels and systems shall be stenciled or otherwise labeled

"**INACTIVE-VERIFY CERTIFICATION BEFORE REUSE**"

p. Prior to inactive PVS being returned to service, all maintenance shall be performed and all appropriate inspections completed.

13.13.2 STORAGE REQUIREMENTS FOR INACTIVE VESSELS OR SYSTEMS

a. When PVS are put into storage they shall be protected against exposure to adverse environments which could cause corrosion or other forms of material degradation.

b. PVS shall be protected against mechanical damages resulting from scratches, dents, mechanical impacts, etc.

c. Induced stresses due to storage fixture constraints shall be minimized by suitable storage fixture design.

d. PVS should be drained; inerted and a blanket purge should be maintained on the system.

e. An engineering review of minimum maintenance required for the system components will be conducted, to include periodic inspections to ensure all storage conditions have been met.

13.13.3 UNSAFE OR DECOMMISSIONED VESSELS OR SYSTEMS

a. When a vessel/system is determined to be unsafe for continued use, it shall be removed from service.

b. If the PVS is repairable, it should be repaired per the appropriate NCS.

c. If the PVS cannot be repaired, it shall be decommissioned and disposed of in accordance with KNPR 4000.1, Supply and Equipment System Manual.

d. Each unsafe vessel/system shall be physically disabled and shall be stenciled:

"**NOT USABLE - FOR DISPOSAL ONLY.**"

e. If the PVS cannot be repaired, and cannot be physically moved, it shall be abandoned in place and each vessel/system shall be stenciled:

"**NOT USABLE – ABANDONED IN PLACE**"

f. A report shall be submitted to the PSM describing the disposal procedure. The procedure should address:

(1) Disposal method (excessed in accordance with KNPR 4000.1, Supply and Equipment System Manual, appropriately marked, and method of physically disabling the pressure vessel).

(2) Method for flushing and disposing of any vessel or system toxic or hazardous substance.

(3) Vessel manufacturer's nameplate data, system baseline number, drawing number, or other identifying nomenclature.

13.14 CERTIFICATION/RECERTIFICATION REQUIREMENTS

13.14.1 PVS shall be certified before entering service.

13.14.2 All certification and recertification reports shall be published in the KSC Engineering Documentation System (KEDS).

a. PVS may be activated after a suitable initial operating safety assessment has been performed and documented.

b. Prior to certification or recertification a comprehensive integrity assessment shall be performed in accordance with sections 13.11.6.1 and/or 13.12.14 of this document.

c. Prior to certification or recertification initial service life and remaining life shall be determined in accordance with section 13.11.6 of this document.

d. Prior to certification or recertification an inservice inspection plan shall be developed or updated in accordance with section 13.9 of this document and all appropriate inspections completed.

e. Prior to certification or recertification a risk assessment shall be performed or updated in accordance with the requirements of section 13.16 of this document.

f. Prior to certification or recertification all components that require periodic inspection or testing shall be current as required in section 13.12 of this document.

g. Inactive vessels or systems being placed in service shall be recertified when any of the following conditions exist:

(1) The vessel or system is to be used at a higher or lower temperature, or at a higher pressure, than specified in the original design.

(2) The vessel or system shows visible indication of deterioration from corrosion or improper handling.

(3) The vessel or system has not been certified per the requirements of this chapter.

(4) There is a change in service conditions that would require that a new inspection interval be developed.

(5) The vessel or system has been altered, repaired, modified, or reconfigured to the extent that any previous certification is invalidated.

13.14.3 CERTIFICATION:

The following information, as a minimum, shall be required in the certification report:

a. System Description: Identification of the major components and a brief description of the operation and configuration of the system. Photographs and drawings may be used as required. System endpoints or boundaries shall be clearly defined.

b. Documentation Summary: Description of the documentation available, identifying nomenclature, its location, accuracy, and identification of significant discrepancies.

c. Design Verification Results: Description of the system and vessel design verification effort, identifying applicable codes and standards, input data, and significant findings. Copies of the design verification results shall be retained in the PVS certification file.

d. Engineering Work Packages: Description of documentation issued for inspection and tests and description of any repairs and modifications required for PVS certification.

e. Inspection and Test Results: Summary of the tests and nondestructive examinations performed, including visual inspections. Unacceptable results should be described in detail. Copies of all NDE test reports shall be retained in the PVS certification file

f. Engineering Analysis: Summary of all significant engineering analysis performed, including results of calculations, analysis of inspection results, and special engineering analysis performed (remaining life, Risk Assessment Codes (RAC), etc). Copies of the engineering analysis shall be retained in the PVS certification file.

g. Certification Summary: Complete summary of the Pressure Vessels/Systems certification effort and final disposition of the system and components.

h. ISI Requirements: The 20-year ISI plan, including inspections and tests to be performed, and the frequency, for the system and individual components. ISI guidelines are established with the intervals recommended in the applicable NCS and this document. A discussion of the purpose and extent of inspections identified shall also be provided.

i. Certification Certificate: Certificate, which indicates that system and vessel(s) comply with this Chapter, except for non-safety- related discrepancies identified in the certification report. PVS shall not be considered certified until all safety related hardware discrepancies are corrected.

13.14.4 RECERTIFICATION

Recertification is the procedure by which previously certified vessels or systems are recertified for use at a designated pressure through appropriate tests, inspections, examinations, and documentation. See Figure 13-9 describes the logical recertification procedure for ISI equipment.

a. PVS shall be recertified on or before one-half the documented initial service life or one half the recertified remaining life (e.g. for a 40 year life vessel initially certified on April 1, 1997, the recertification must be completed on or before April 1, 2017).

b. Recertification shall be performed when the PVS service changes (e.g., commodity, design parameters, location, and orientation).

c. Recertification shall be performed if any repair, alterations, or modifications, change of location, etc. are made to the PVS.

d. Recertification shall be performed as directed by the PSM in the case of NCS changes that reduce the estimated remaining life or increase the known risk of continued operation. (An example of this is the incorporation of fracture toughness requirements for MDMT in UCS-66 in 1988.) (Refer to sections 13.12.14.f and 13.12.14.g of this document.

e. Recertification shall be performed if any unanticipated service degradation is identified that reduces estimated service life, changes probability of failure or failure modes, or changes the risk assessment.

f. Disregard of maintenance or inspection shall be cause for revocation of the certification at the discretion of the PSM.

g. Recertification Tests, Inspections and Examinations or Nondestructive Evaluation (NDE) will consist of, but not limited to the following:

External Visual Examination (VE) of vessel(s) and system component(s) surfaces for subsequent documentation and correction of the following general conditions:

(1) Corrosion

(2) Cracking

(3) Bulges or Blisters

(4) Leakage

(5) Excessive Vibration

(6) Abnormal Noise

(7) Overheating

(8) Vacuum Jacket Line Frost

(9) Loose Fasteners, Supports, or Misc. Parts

h. VE requirement may be modified or waived if vessel/system component Preventive Maintenance (PM) is current and there are no long-standing open discrepant conditions from previous PM VE examinations.

Ultrasonic Thickness (UT) measurements of vessel head, wall or nozzles for material thickness determination and subsequent engineering evaluation. UT requirements may be modified or waived in the case of multiple vessel clusters of banks where a random sample percentage of the vessels in a given group will be selected for UT measurement and subsequent evaluation. Whenever possible, UT measurements shall be performed at the same location, except where it is not practicable to do so.

13.14.5 OVERDUE COMPONENTS CERTIFICATION STATUS

a. If specific component tests specified in section 13.12.7 of this document are not completed within the prescribed interval, the PVS certification shall be revoked.

b. A variance is required to extend the period of an overdue item past the interval prescribed in section 13.12.7 of this document.

13.15 PRESSURE VESSELS/SYSTEMS DATABASE

The KSC Pressure Systems Manager shall maintain an inventory and certification status database of all ground-based PVS at KSC.

13.15.1 DATA REQUIREMENTS

a. Each program/project or directorate organization having responsibility for one or more pressure systems or vessels that are covered by this Chapter shall provide the information, as shown in Figure 13-9, Figure 13-10, and Figure 13-11 to the PSM. Other formats may be acceptable provided all information in the figures is provided.

b. Each program/project or directorate organization shall submit updated data, at least quarterly.

c. Any changes shall be easily identifiable.

13.16 SYSTEM SAFETY AND RISK ASSESSMENT REQUIREMENTS

13.16.1 TAILORED SYSTEM SAFETY REQUIREMENTS FOR PVS

a. Risks shall be identified and documented for all PVS within the scope of this document, the risk status shall be updated during the certification/recertification process, and new risks shall be identified as appropriate throughout the life of a PVS.

b. Risks shall be assessed and Risk Assessment Code (RAC) determined for all PVS in accordance with section 13.16.2 of this document.

c. The PSM has authority to specify the method and detail of risk analyses appropriate for each PVS.

d. Planning of risk mitigation activities and residual risk analysis shall be performed and documented in the initial PVS certification or subsequent recertification to reduce or eliminate risks, and residual risks greater than the thresholds identified in section 13.16.3 of this document shall be accepted to the appropriate level as specified in section 13.16.3 and NPD 8710.5.

e. The assessed risk of in-service PVS shall be no greater than RAC 3 after mitigation unless that risk is specifically approved and accepted in accordance with section 13.16.3 of this document.

f. PVS risks shall be mitigated in accordance with the risk reduction protocol in Section 1.7.1 of NPR 8715.3, NASA General Safety Program Requirements.

g. Measures that reduce the risk classification shall be documented and tracked, and will remain in effect throughout the life of each PVS.

h. The PSM has authority to modify risk mitigation requirements or de-certify and remove from service any PVS that is not safe to operate.

i. The PSM shall serve as the System Safety Manager with respect to PVS in accordance with paragraph 2.8.2 of NPR 8715.3 for PVS.

j. System safety documentation shall be as specified throughout this document and shall be maintained within the PVS configuration management system.

k. The PSM shall identify each PVS change that potentially affects the baseline risk assessment throughout the life of the PVS and take appropriate actions to analyze, plan, track, and control the risks associated with each change.

13.16.2 RAC DETERMINATION

a. The level of risk shall be evaluated based on the likelihood of mishap and on the severity of the consequence. The risk shall be categorized in accordance with Figure 13-1, Figure 13-2, and Figure 13-3.

b. The RAC is a numerical expression of comparative risk determined by an evaluation of both the potential severity of a condition and the likelihood of its occurrence causing an expected consequence. RACs are assigned a number from 1 to 7 in a risk matrix. The PSM may approve alternative risk determination methods.

RAC Determination					
	A Frequent	**B Probable**	**C Occasional**	**D Remote**	**E Improbable**
I Catastrophic	1	1	2	3	4
II Critical	1	2	3	4	5
III Moderate	2	3	4	5	6
IV Negligible	3	4	5	6	7

FIGURE 13-1: RAC DETERMINATION

c. Severity is an assessment of the worst potential consequence, defined by degree of injury or property damage, which could occur. The severity classifications are defined in Figure 13-2.

Severity Determination Table					
Class	**Class Description**	**Equipment Loss[1] ($K)**	**Downtime[1]**	**Data Integrity[1]**	**Environmental Effect[1]**
I Catastrophic	A condition that may cause death or permanently disabling injury, facility destruction on the ground, or loss of crew, major systems, or vehicle during the mission.	> $1,000	> 4 months	Data Not recovered	> 5 years or >$1M to correct
II Critical	A condition that may cause severe injury or occupational illness or major property damage to facilities, systems, equipment, or flight hardware.	$1000 to $250	4 months to 2 weeks	Repeat program	1-5 years or $250 - $1M to correct
III Moderate	A condition that may cause minor injury or occupational illness or minor property damage to facilities, systems, equipment, or flight hardware.	$250 to $25	2 weeks to 1 day	Repeat test period	< 1 yr or $25K - $250K to correct
IV Negligible	A condition that could cause the need for minor first aid treatment though would not adversely affect personal safety or health. A condition that subjects facilities, equipment, or flight hardware to more than normal wear and tear.	$25 to $1	< 1 day	Repeat test point	Minor or < $25K to correct

NOTE: The values and ranges are considered default values and ranges and may be adjusted based on actual data.

FIGURE 13-2: SEVERITY DETERMINATION TABLE

d. Probability is the likelihood that an identified hazard will result in a mishap, based on an assessment of such factors as location, exposure in terms of cycles or hours of operation, and affected population

e. Examples of calculation of the probability estimation are shown in section 13.16.2.f.(5) of this document.

Probability Determination Table			
Level	**Description**	**Qualitative**	**Definition**
A (Frequent)	Frequent	Likely to occur immediately	$X > 10^{-1}$
B (Probable)	Probable	Probably will occur in time	$10^{-1} \geq X > 10^{-2}$
C (Occasional)	Occasional	May occur in time	$10^{-2} \geq X > 10^{-3}$
D (Remote)	Remote	Unlikely to occur	$10^{-3} \geq X > 10^{-6}$
E (Improbable)	Improbable	Improbable to occur	$10^{-6} \geq X$

FIGURE 13-3: PROBABILITY DETERMINATION TABLE

f. Default Equipment Failure Probability Estimates

(1) The equipment failure probability estimates of Figure 13-4 shall be applied only to certified PVS.

(2) Without further information on a specific PVS complying with the certification requirements of this document, the default values of Figure 13-4 shall be used as the equipment failure probability in the RAC determination of this section.

(3) The PSM has authority to modify the failure probabilities, without processing a variance for specific systems covered by Figure 13-4, provided one of the following is met: (1) failure data exists that is more relevant to the particular PVS, (2) analysis is performed and documented consistent with the principals of risk management found in NPR 8000.4, Risk Management Procedural Requirements, (3) informed and conservative engineering judgment based on information relevant to the particular facts and condition of the PVS in question is exercised and documented.

(4) PVS failure probabilities shall be combined with exposure in terms of hours or cycles of operation and affected population in determining the likelihood that a failure will result in a mishap and the overall RAC.

(5) The values in Figure 13-4 represent the probability of failure, not the likelihood of consequence.

Example 1: Small bore piping system with personnel exposure 2 hours/24 hour work day, 5 day work week; PVS pressurized 24 hours/7 days a week.

State Assumptions:
Equipment Failure Probability from Figure 13-4. Item number 11:
1x10-3 (catastrophic failures)/(PV-year)

Total hours pressurized per year:
52 weeks/year *7 days/week *24 hours/day = 8736 hours.
Exposure hours per year:
52 weeks/year *5 days/week *2 hours/day = 520 hours

Exposure Fraction:
Exposure hours per year/Total hours pressurized per year
520 hours/8736 hours = 5.9x10-2

Likelihood of Consequence to Personnel (ignores risk to equipment/facility):
Equipment Failure Probability x Exposure Fraction:
1x10-3 x 5.9x10-2= 6x10-5

This value (6x10-5) would then be used to determine the probability level (i.e., A, B, C, D, or E) from Figure 13-3 by comparison of the value to the definition column and selecting the appropriate level. For this example the level would be D, “Remote”.

This level is used in the RAC matrix (Figure 13-1) with the severity determination of Table 2 to determine the RAC for the PVS.

Example 2: Small bore piping system PVS pressurized 24 hours/7 days a week with no personnel exposure (personnel are shielded or remote from hazard).

State Assumptions:
Equipment Failure Probability from Figure 13-4. Item number 11:
1x10-3 (catastrophic failures)/(PV-year)

Total hours pressurized per year:
52 weeks/year *7 days/week *24 hours/day = 8736 hours.
Exposure hours per year:
52 weeks/year *5 days/week * 0 hours/day = 0 hours

Exposure Fraction:
Exposure hours per year/Total hours pressurized per year
0 hours/8736 hours = 0

Likelihood of Consequence to Personnel (ignores risk to equipment/facility):
Equipment Failure Probability x Exposure Fraction:
1x10-3 * 0 = 0
Probability Level: E, “Improbable”

g. For PVS whose design life is limited by fatigue or brittle fracture failure mode, and whose life has been extended through the application of NDE, in order to consider the potential for NDE to

miss existing crack-like flaws the probability of failure shall be increased by a minimum of one level from Figure 13-4 (i.e., an original level E (10-6) becomes a level D (10-3 to 10-6).

h. Severity Class assessment shall include consideration of the worst credible consequence due to residual risk for all failure modes.

i. Where Figure 13-4 requires that a specific failure assessment be performed, that assessment shall consider the particular facts and condition of the PVS in question and be based on either: (1) analysis consistent with the principles of risk management found in NPR 8000.4, Risk Management Procedural Requirements, or (2) informed and conservative engineering judgment that is approved and documented by the PSM.

j. Failure probabilities of PVS not included in Figure 13-4 (e.g., plastic pipe systems) shall be specified by the PSM based on one of the following: (1) qualitative or quantitative data relevant to the PVS in question, (2) analyses performed consistent with the principles of risk management found in NPR 8000.4, Risk Management Procedural Requirements, or (3) informed and conservative engineering judgment that is documented.

FIGURE 13-4: TENTATIVE CATASTROPHIC PVS FAILURE RATES PER YEAR (MEDIAN VALUES) FOR CERTIFIED PVS

Item	PVS Component Type	Equipment Failure Probabilities				
		$>10^{-1}$	10^{-1} to $> 10^{-2}$	10^{-2} to $>10^{-3}$	10^{-3} to $> 10^{-6}$	$\geq 10^{-6}$
	Steel Pressure Vessels:	(catastrophic failures) / (PV-yr)				
1	Code vessels fabricated to 1988 ASME or later and pre-1988 Code vessels operating above the post-1988 MDMT that comply with the certification requirements of this document					10^{-6}
2	Code vessels fabricated to pre-1988 ASME and operating lower than post-1988 MDMT with validated fracture life assessment				$>10^{-6}$	
3	Code vessels derated due to safety requirements, Code equivalent FS retained				$>10^{-6}$	
4	Code vessels with FS less than original Code (e.g., due to degradation or fluid service changes)	$>10^{-6}$, Case-by-Case Assessment required				
5	DOT container in static service, maintained under 49 CFR 180 with acceptable VT inspection					10^{-6}
6	Inactive DOT container more than 20 years beyond last 49 CFR 180 stamped retest date				$>10^{-6}$	

Item	PVS Component Type	Equipment Failure Probabilities				
		$>10^{-1}$	10^{-1} to $>10^{-2}$	10^{-2} to $>10^{-3}$	10^{-3} to $>10^{-6}$	$\geq 10^{-6}$
	Steel Pressure Vessels:	(catastrophic failures) / (PV-yr)				
7	DOT container not maintained per 49 CFR 180. See notes for this item re: dual categories	FS ≤4 – Case–by-Case assessment required			$>10^{-6}$ (FS≥4)	
8	Non-Code vessels fabricated as equivalent to ASME (operation colder than vs. meets post 1988 rules)	>E-3 (colder than post 1988 MDMT) – case-by-case assessment required			$>10^{-6}$ (meets post-1988)	
9	Non-Code vessels/non-Code equivalent – *	$>10^{-6}$, Case–by-Case assessment required				
	Steel Piping System:	(catastrophic failures / Piping System-yr)				
10	Small bore [nominal pipe size (NPS) 4" and under] piping system (no double containment, sensors/alarms, etc.) – **Small system** (less than 75 ft. of pipe)				10^{-3}	
11	Small bore (NPS 4" and under) piping system (no double containment, sensors/alarms, etc.) – Large system (more than 75 ft. of pipe)			$>10^{-3}$		
12	Large bore piping system (> NPS 4', non-intergranular stress corrosion cracking (IGSCC)) – Small system (less than 75 ft. of pipe)				10^{-4} (10^{-5} see Note 1)	
13	Large bore piping system (> NPS 4', non-IGSCC) – Large system (more than 75 ft. of pipe) with failure modes that include thermal fatigue, fluid dynamic loads, or erosion/corrosion wall thinning as described in 6.2.11.2			$>10^{-3}$	10-4 (see Note 1)	
14	Degraded or non-Code piping systems	Case-by-Case assessment required				

NOTE 1: Adjusted if NASA-STD-8719.17, paragraph 6.2.11.3, failures do not apply.

NOTE 2: Failure mode is assumed to be catastrophic rupture of the pressure boundary with leak before rupture, which is the dominant failure mode of the data in the listed references.

NOTE 3: Failure rates are considered constant throughout the service life. Such a “no-aging” constraint requires that inspections be performed and leaks are corrected.

13.16.3 VARIANCE

a. A variance shall be used to address case-by-case variations from requirements of this document.

b. KSC PVS variances will be processed in accordance with KNPR 8715.3, Section 1.6, Safety Variance Processing.

c. For KSC PVS, Section 13.16, System Safety and Risk Assessment Requirements will be used to determine the risk (probability of failure, and consequence) and Risk Assessment Code.

d. The rationale and acceptance of variances must be objectively reviewed, evaluated, and documented.

NOTE: NASA does not have approval authority for variances to Federal, State, or local regulations (e.g., OSHA, Cal OSHA), nor to consensus standards that are required by Federal regulations [e.g., ANSI, American Conference of Governmental Industrial Hygienists (ACGIH)] that apply to NASA. Any variance of a Federal, State, or local regulation must be reviewed by NASA Headquarters Office of Safety and Mission Assurance prior to submittal to the appropriate Federal/State/local agency for approval.

e. Copies of all KSC PVS variances shall be sent to NASA Headquarters Office of Safety and Mission Assurance. Technical variance approval must meet the requirements (as a minimum) of Figure 13-5, Technical Variance Approval Process.

Technical Variance Approval Process		
	RAC 1 & 2	**RAC 3+**
Headquarters notification	**X**	**X**
Center Director Approval	**X**	
Safety and Mission Assurance Director Approval	**X**	**X**
PSM	**X**	**X**
Program Manager/Owner	**X**	**X**

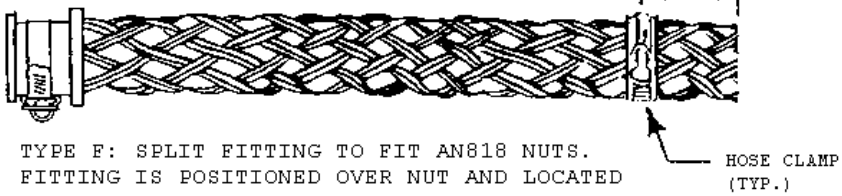
FIGURE 13-5: TECHNICAL VARIANCE APPROVAL PROCESS

TYPE E: DOUBLE EYE GRIP - USED WHERE FASTENING IS MADE WITH EYE BOLTS OR SIMILAR ANCHOR TERMINATIONS.

TYPE A: SINGLE EYE GRIP - USED WHERE FASTENING MUST BE MADE FROM FROM ONE ANCHOR POINT.

TYPE U: UNIVERSAL BALE GRIP - USED TO FASTEN AROUND A STRUCTURE OR CLOSED EYE.

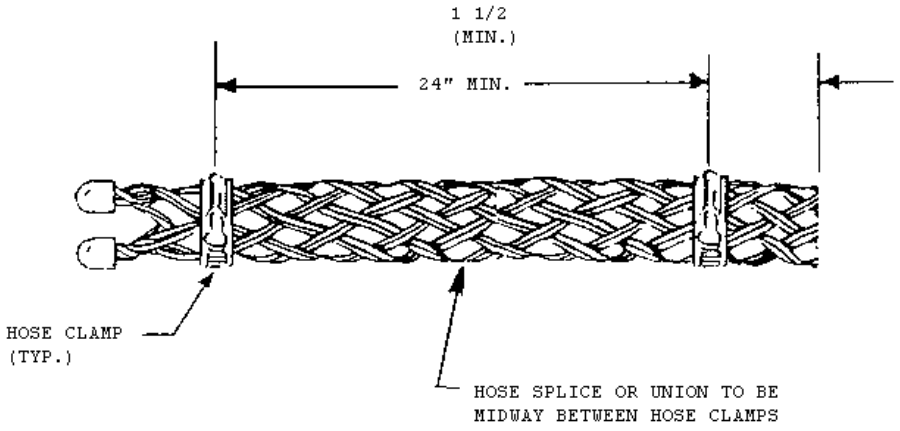
TYPE Y: THREADED BOLT 5/16-18 X 1-1/2 INCH LONG - USED TO FASTEN THROUGH HOLES IN PLATE.



TYPE F: SPLIT FITTING TO FIT AN818 NUTS. FITTING IS POSITIONED OVER NUT AND LOCATED WITH INTERNAL FLANGE. A HOSE CLAMP IS FURNISHED AND REQUIRED TO CORRECTLY POSITION FITTING.

NOTES:
1. SAFETY APPROVED FOR ALL HOSES SIZES AND PRESSURE RATINGS.
2. RESTRAINTS WITH BRONZE COMPONENTS SHALL NOT BE USED WITHIN 25 FEET OF HYPERGOLS OR AMMONIA.

FIGURE 13-6: Type E, A, U, Y AND F HOSE CONTAINMENT GRIPS



TYPE T: CONTAINMENT GRIP INSTALLED ACROSS HOSE SPLICE OR UNION JOINING HOSES TOGHETHER.

NOTES:
1. SAFETY APPROVED FOR ALL HOSE SIZE AND PRESSURE RATINGS.
2. RESTRAINTS WITH COMPONENTS SHALL NOT BE USED WITHIN 25 FEET OF HYPERGOLS OR AMMONIA.

FIGURE 13-7: TYPE T HOSE CONTAINMENT GRIP

(SAMPLE)

INSERVICE INSPECTION (ISI) DATA SHEET

System _____ Baseline No. _____

Certification Report No. _____ Release Date ___/___/___

	ISI Requirements Test Method Required at Time Intervals (Years)					
	Initial	1	2	5	10	20
Vessels						
Vessel Supports						
Piping System & Components						
Piping Supports						
Relief Valves						
Pressure Gages						
Flexible Hoses						

INSPECTION AND TEST METHODS

AET	- Acoustic Emission Test	C	- Calibration
UT-THK	- Ultrasonic Thickness Meas.	PT	- Liquid Dye Penetrant Exam.
VE	- External Visual Exam.	MT	- Magnetic Particle Exam.
VI	- Internal Visual Exam.	RS	- Recall System
UT-VOL	- Ultrasonic Volumetric Test	RT	- Radiography
HPT	- Hydrostatic Pressure Test	R	- Recertification Required.
PPT	- Pneumatic Pressure Test		

FIGURE 13-8: INSERVICE INSPECTION REQUIREMENTS

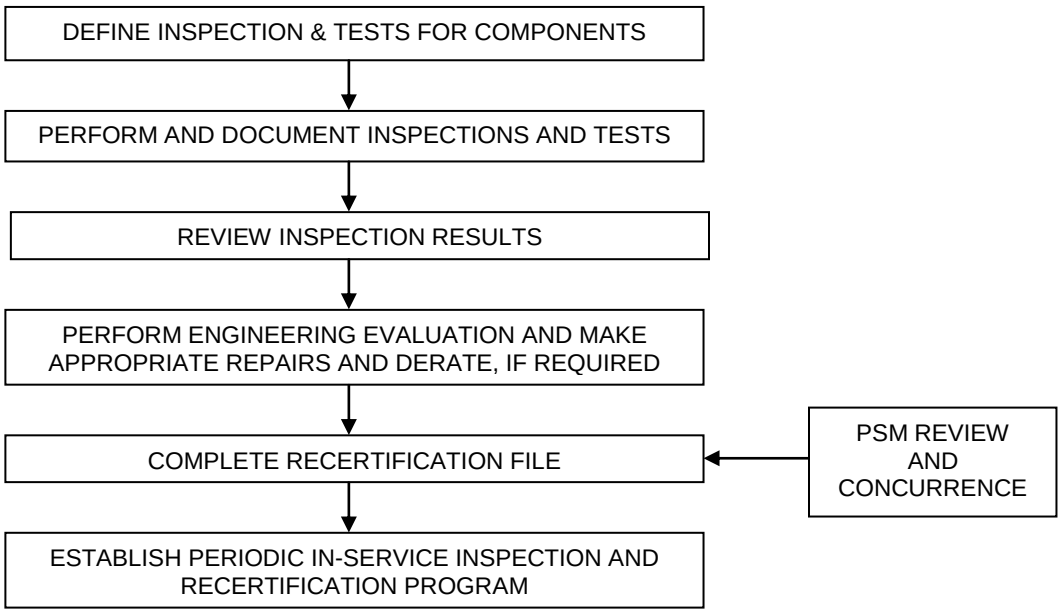


FIGURE 13-9: RECERTIFICATION PROCEDURE FOR INSERVICE EQUIPMENT

(S A M P L E)

S Y S T E M D A T A S H E E T

Cert. Report No. _____ Rev.___ Rev. Date ___/___/___ Needs Rev? (Y/N) ___
System Description
_____

Location
_____

No. of Identical Systems in this Cert. _____ Facility Number(s) _____

Baseline No. (B/L) _____ Station Set (SS) No. _____

PMN (s) _____ , _____ , _____,

_____ , _____ , _____

Orig. Cert. Report Date ___/___/___ System Status - Active/Inactive (A/I) _____

System Certified Date ___/___/___ Certifying Organization _____

Cert. Expiration Date ___/___/___ O & M Organization _____

Service Fluid (s) _____ ISI Requirements Defined? (Y/N) _____

System Design Pressure _____(MPa or lb/in^2 gage)

SMS Drawing Number(s) _____ , _____, _____,

_____ , _____, _____

Number of Vessels in System _____ Number of Relief Devices in System _____

Number of Gages in System _____ Number of Flex. Hoses in System _____

Last Walkdown No. _____ Last Walkdown Date ___/___/___

COMMENTS:
_____
_____
_____

Figure 13-10: System Data Requirements

(SAMPLE)

V E S S E L D A T A S H E E T

System Cert. Report No. _____ Date _____

Vessel Find No. _____ PMN _____
(or other unique designator)

Vessel Description _____

_____

KSC Instl. Dwg. No. _____ Mfgr. Name _____

Mfgr. Dwg. No. _____ Mfgr. S/N
_____

ASME Code Stamp - Yes/No (Y/N) _____ Code Section/Division _____

Year Built _____ Vessel Fluid Media _____

Vessel Status-Active/Inactive/Scrapped/Excessed (A/I/S/X) _____

Vessel Water Volume _____(m^3 or ft^3)

Certified Vessel MAWP _____(MPa or lb/in^2 gage) at _____(^oC or ^oF)

Original MAWP _____(MPa or lb/in^2 gage) at _____(^oC or ^oF)

Min. Design Metal Temp. _____ (^oC or ^oF) at _____(MPa or lb/in^2 gage)

COMMENTS:
_____
_____
_____

Figure 13-11: Vessel Data Requirements

OTHER REFERENCES

The following table is provided for guidance as to applicable codes, standards, and laws. Actual applicability is to be determined by the PSM.

FIGURE 13-12: APPLICATION OF NATIONAL CONSENSUS CODES, STANDARDS, AND LAWS TO PVS[12]

PVS	Designed, Fabricated, Inspected, Tested, and Installed	Operated and Maintained	Repair, Alteration, Inservice Inspection
Unfired Pressure Vessel	ASME B&PVC Section VIII,		American Petroleum Institute (API) 510 , 572, 579, 580, 581 ANSI/NBIC NB-23
Process Piping	ASME B31.3		API 570, 576, 574, 579, 580, 581 ANSI/NBIC NB-23
Power Boiler	ASME B&PVC Section I	ASME B&PV Section VII	ANSI/NBIC NB-23,
Heating Boiler	ASME B&PVC Section IV	ASME B&PV Section VI	ANSI/NBIC NB-23
Power Piping	ASME B31.1		ANSI/NBIC NB-23
DOT Cylinders and Cargo Tanks	49 CFR, 29 CFR 1910.101 CGA C-6, C-8, P-1, S-1.1, S-1.2	49 CFR CGA C-6, C-8, P-1, S-1.1, S-1.2	49 CFR, 29 CFR 1910.101 CGA C-6, C-8, P-1, S-1.1, S-1.2
Low Pressure Fixed Storage	29 CFR 1910.106, API 620		API 510, 572, 579, 580, 581 STI – SP001
Liquid Oxygen Systems	NFPA 50, 53 , 55, ASTM G88, ASTM MNL 36, and 29 CFR *1910.104*	ASTM MNL 36, and 29 CFR *1910.104*	ASTM MNL 36, and 29 CFR 1910.104
Gaseous Oxygen Systems	NFPA 50, 53, 55, ASTM G88, ASTM MNL 36, and 29 CFR *1910.104*	ASTM MNL 36, and 29 CFR *1910.104*	ASTM MNL 36, and 29 CFR 1910.104
Liquid Hydrogen Systems	CGA G-5.4, NFPA 50B, 55, ANSI/AIAA G-095-2004, and 29 CFR 1910.103., NASA/TM-2003-212059, ISO TC 197/SC N	NFPA 50B, 55, NASA NSS 1740.16, ANSI/AIAA G-095-2004	
Refrigeration Piping	ASME B31.5		

[1] 29 CFR 1910.6 contains a list of all referenced standards and the paragraph of application
[2] 49 CFR 171.7 contains a list of all material incorporated by reference and the paragraph of application

PVS	Designed, Fabricated, Inspected, Tested, and Installed	Operated and Maintained	Repair, Alteration, Inservice Inspection
Gaseous Hydrogen Systems	CGA G-5.4, NFPA 50A, 55, ANSI/AIAA G-095-2004, and 29 CFR 1910.103, NASA/TM-2003-212059, ISO TC 197/SC N	NFPA 55 (50B), ANSI/AIAA G-095-2004 NASA/TM-2003-212059, ISO TC 197/SC N	
Acetylene Cylinders	29 CFR 1910.102 (CGA G-1) & 1910.253	29 CFR 1910.102 (CGA G-1) & 1910.253	
Compressed Air Receivers	29 CFR 1910.169, ASME B&PVC VIII	29 CFR 1910.169	29 CFR 1910.169
Flammable Liquids	29 CFR 1910.106, 49 CFR 171-180, NFPA 30		
Liquefied Petroleum Gases	29 CRF 1910.110, 110(b)(10) – Safety Devices, DOT 49 CFR 178, ASME B&PV VII, NFPA 58	29 CRF 1910.110, NFPA-58	
Anhydrous Ammonia	29 CFR 1910.111, ASME B&PV VIII, DOT	29 CFR 1910-111	
Oxygen Welding	29 CRF 1910.253, ANSI B57.1 (CGA V-1), NFPA-51	29 CFR 1910.253, NFPA-51	
DOT Cylinders	49 CFR 100-180, 29 CFR 1910.101, (CGA S-1.1, S-1.2, S-1.3)	29 CFR 1910.101, (CGA P-1, S-1.1, S-1.2)	29 CFR 1910.101, (CGA C-6, C-8) and ANSI/NB-23
Tanks (fixed)	29 CFR 1910.106 (API-12A, -12B, -12D, -12F, -620, -650, -2000), ASME B&PVC VIII, UL-58, -80, -142), AWWA D-100., Unified Facilities Guide Specifications (UFGS) 13209.N		API 510, 572, 579, 580, 581, 653
Building Services and Piping	ASME B31.9		
Risk Based Inspection			API 580, API 581, API -570, API -510

13.17 ITEMS EXCLUDED FROM CERTIFICATION

The following PVS do not require certification in accordance with this KNPR, and are excluded from the requirements of this document provided they are covered under appropriate inspection and maintenance programs. Each Center's PSM has the authority to require inclusion of any excluded system at that Center due to the hazards presented by its use in a particular application. Excluded systems are subject to the requirements of OSHA, the applicable NCS, and NASA safety requirements. Operation of Commercial Off the Shelf (COTS) systems shall be within the manufacturers' limitations.

13.17.1 Water systems under 150 psig for which surge is not a design consideration or has been mitigated.

13.17.2 Fire Protection:

a. Water deluge systems not to exceed 250 psig for which there is no hazard to personnel in the event of failure.

b. Fire protection water systems for facilities

c. Fire extinguishers covered by: 29 CFR Part 1910, Subpart L, "Fire Protection," including portable extinguishers, standpipe and hose systems, automatic sprinkler systems, fixed dry chemical extinguishing systems, carbon dioxide extinguishing systems, and halogenated extinguishing agent systems.

13.17.3 Exclusion limits for natural gas and Liquefied Propane (LP):

a. Public utility-owned natural gas supply and distribution systems.

b. LP gas storage and distribution systems utilizing 49 CFR storage vessels and used for utility/domestic applications. ASME Code stamped vessels shall not be exempt.

13.17.4 Control, instrument, and shop air or inert gas piping systems with Maximum Allowable Working Pressure (MAWP) not to exceed 150 psig and line sizes not to exceed Nominal Pipe Size (NPS) 3/8. Relief valves and compressed air receiver vessels are not included in this exclusion. This exclusion does not apply to higher pressure or larger size PVS that supply the lower pressure PVS.

13.17.5 Fuel storage PVS supplied with licensed motorized vehicles and meeting applicable Department of Transportation (DOT) regulatory requirements.

13.17.6 Glove boxes.

13.17.7 Commercial Off the Shelf (COTS) PVS

a. Hot water systems for buildings.

b. Prepackaged pressurized water and steam cleaning systems maintained and operated in strict accordance with the manufacturer's recommendations. This does not include custom fabricated/assembled systems.

c. Prepackaged refrigerators, freezers, and Heating, Ventilating, and Air Conditioning

d. Prepackaged hydraulic systems

e. Welding equipment.

f. Laboratory equipment. However, equipment that could be pressurized above its MAWP for any reason by the fluid delivery system shall have appropriate overpressure protection installed and the fluid delivery system shall be certified by the PSM in accordance with this document. This exclusion does not apply to laboratory designed and assembled systems.

An example is a mass spectrometer with a manufacturer's placard rating of 25 psig that receives gas from a 2000 psig DOT cylinder via a pressure regulator and plastic tubing. The mass spectrometer and DOT cylinder (see section 13.17.12) are not subject to certification in accordance with this document although they must be safely operated in accordance with manufacturer's recommendations, and there must be a certified pressure relief device (PRD) (see section 13.6.1) downstream of the cylinder's pressure regulator (see section 13.8), and the plastic tubing must be adequately rated and restrained (see section 13.12). The required PRD may be internal to the mass spectrometer, however such an internal PRD is subject to the requirements of section 13.6.1. Consequently, a separate external (accessible) PRD is usually added to meet the requirements of this document.

13.17.8 Vacuum Systems:

a. Vacuum systems with volumes not greater than 100 cubic feet. However, all vacuum systems that could inadvertently be pressurized above atmospheric pressure by internal or external sources (e.g., as a result of valve leakage on a test gas line or a pressure regulator or mass flow controller failure) shall have appropriate overpressure protection [see section 13.12.7, particularly 13.12.7(l)], and the fluid delivery system is included within the scope of this document.

b. Vacuum piping above ground not greater than NPS 6 which is adequately supported and restrained and buried vacuum piping of any diameter. This exclusion does not apply to piping which is connected to a positive pressure source that requires relief protection above a PRD setting of 2 psig. The relief protection of all vacuum piping systems attached to positive pressure sources shall be reviewed and approved by the PSM.

13.17.9 Temporary non-NASA owned construction or maintenance related PVS, provided there is negligible operational risk or hazard to personnel under any foreseeable failure and the operating contractor is contractually obligated to meet, and demonstrates compliance with, all applicable Federal, State and local safety regulations.

13.17.10 Atmospheric storage tanks that only are subjected to hydrostatic pressure and that comply with the applicable American Petroleum Institute (API) or Underwriter Laboratories Incorporated (UL) standards.

13.17.11 Self-contained pressure eye wash systems, provided overpressure protection devices are periodically tested or replaced in accordance with manufacturers' recommendations.

13.17.12 DOT specification containers that are periodically retested and re-qualified strictly in accordance with 49 CFR 180, provided that the owner's OSHA inspection requirements of 29 CFR 1910.101 are met. This exclusion does not apply, however, to other attached components or laboratory equipment or other systems using or being charged from these containers. The exclusion does include:

a. Self-contained Air Breathing Equipment or other Breathing Equipment Apparatus: Covered by 29 CFR Section 1910.134

b. Compressed Gas Cylinders: covered by 49 CFR, Subtitle C, and 49 CFR Part 178

c. Mobile Equipment for Gases and Liquids: covered by 49 CFR, Subtitle B, Chapter 1, Subchapter C.

13.17.13 Flight weight PVS used for their intended flight related purpose aboard air or space craft even when that craft is on the ground. This exclusion does not apply to flight weight PVS that have been converted for ground use outside of their flight related function.

13.17.14 HYDRAULIC SYSTEMS

a. Most hydraulic systems designed in accordance with national consensus standards are excluded.

b. However, nonflight hydraulic systems that support launch vehicle functions, fixed and mobile launch tower operations, or hydraulic systems that support the transportation of launch vehicles or their payloads, or other hydraulic systems used for processing flight hardware, are not excluded and must be certified in accordance with the requirements of this Chapter.

13.17.15 ASSESSED HAZARD EXCLUSION

The PSM shall have the authority to exclude other PVS from the Center's certification program if a risk and hazard assessment that is performed in accordance with NPR 8715.3, NASA General Safety Program Requirements and section 13.16 of this document demonstrates that all of the following conditions are met:

a. There is negligible operational risk or hazard to personnel under any foreseeable failure.

b. A technical variance is approved to document the scope, conditions, and operational scenario of the exclusion.

c. All other applicable NASA safety requirements are met.

d. All other applicable regulatory safety requirements are met.

13.17.16 TEST ARTICLES AND TEST SPECIFIC PVS EXCLUSIONS

a. Test article PVS that have been formally reviewed and accepted in accordance with the requirements of NPR 8715.3, NASA General Safety Program Requirements, are excluded.

b. Temporary test specific PVS (e.g., special test equipment (STE)) are excluded if risk assessment has been performed in accordance with NPR 8715.3, NASA General Safety

Program Requirements, there is no risk to personnel, and risk to the facility has been accepted by the Center. Equipment is not considered to fall into this category if it consists of components used repeatedly for testing different test articles or configurations.

c. Payload-Associated GSE: This GSE, which is used to process or service payloads, is provided by other NASA centers or Government Agencies other than KSC and does not become a permanent part of any KSC ground system.

13.18 SAFETY REQUIREMENTS FOR DESIGN, TEST, AND GROUND PROCESSING OF FLIGHT COMPOSITE OVERWRAPPED PRESSURE VESSELS (COPVS) AT THE KENNEDY SPACE CENTER (KSC), CAPE CANAVERAL AIR FORCE STATION (CCAFS), AND THE VANDENBERG AIR FORCE BASE (VAFB)

Shuttle-Specific Requirements for this section are contained in Chapter 18.

NOTE: The interim requirements letter between NASA KSC and the Air Force dated November 23, 1993, remains in effect for COPVs processed at KSC, CCAFS, VAFB, and Dryden under the requirements of AFSPCMAN 91-710.

13.18.1 GRAPHITE/EPOXY (Gr/Ep)COMPOSITE OVERWRAPPED PRESSURE VESSELS (COPVs)

a. The design, qualification, and acceptance testing of Gr/Ep COPVs shall comply with the requirements of ANSI/American Institute of Aeronautics and Astronautics (AIAA) S-081A-2006, “Space Systems-Composite Overwrapped Pressure Vessels (COPVs).”

b. Gr/Ep COPVs shall employ proven processes and procedures for manufacture and inspection. The fabrication process shall provide for initial, in-process, and final inspections of the liner and overwrap to support the safe operation and mission success of the vessels as required by ANSI/AIAA S-081A-2006.

c. Prior to the first pressurization of Gr/Ep COPVs at the KSC, CCAFS, VAFB or Dryden, 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 for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A (see ANSI/AIAA S-081A-2006, Paragraph 5.5.3). If this inspection is not possible at the launch site (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.

d. After completing the visual inspection, and determining that there is no evidence of critical damage to the Gr/Ep COPV, the vessel shall be pressure tested to 1.1 times the ground maximum operating pressure. The pressure shall be held a minimum of ten (10) minutes. This pressurization shall be conducted remotely or a blast shield shall be used to protect personnel.

e. If Gr/Ep COPVs are to be pressurized at the KSC, CCAFS, VAFB, or Dryden to pressures greater than one third 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 ten (10) minutes after pressurization is completed.

f. 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.

g. 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.

h. 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 NASA Safety organization.

i. Users shall develop Emergency Response Plans (ERPs) that include contingency safing and backout plans for Gr/Ep COPVs containing hazardous fluids or in proximity to hazardous commodities. The ERPs shall consider 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 prior to the start of ground operations by the applicable NASA Safety organization.

13.18.2 KEVLAR COMPOSITE OVERWRAPPED PRESSURE VESSELS (COPVs)

a. All new Kevlar COPVs shall comply with the design, qualification, and acceptance testing requirements of ANSI/AIAA S-081A-2006.

b. Kevlar COPVs shall employ proven processes and procedures for manufacture and inspection. The fabrication process shall provide for initial, in-process, and final inspections of the liner and overwrap to support the safe operation and mission success of the vessels as required by ANSI/AIAA S-081A-2006. .

c. Prior to the first pressurization of Kevlar COPVs at the KSC, CCAFS, VAFB or Dryden, 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 for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A (see ANSI/AIAA S-081A-2006, Paragraph 5.5.3). If this inspection is not possible at the launch site (i.e. the Kevlar COPV is not accessible), then it shall be conducted the last time the Kevlar COPV is accessible for inspection.

d. After completing the visual inspection, and determining that there is no evidence of critical damage to the Kevlar COPV, the vessel shall be pressure tested to 1.1 times the ground maximum operating pressure. The pressure shall be held a minimum of ten (10) minutes. This pressurization shall be conducted remotely or a blast shield shall be used to protect personnel.

e. If the Kevlar COPVs are to be pressurized at the KSC, CCAFS, VAFB, or Dryden to pressures greater than one-third the Kevlar COPV design burst pressure, the pressurization shall be conducted 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 ten (10) minutes after pressurization is completed.

f. Personnel limits for each operation on or near the Kevlar COPV/Spacecraft shall be established to minimize personnel exposure to the pressurized tank when at pressures greater than one third design burst pressure.

g. The transport of pressurized Kevlar 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.

h. The Mechanical Damage Control Plan (MDCP) for the Kevlar COPVs shall be provided by the design agency for review by the applicable NASA Safety organization.

i. Users shall develop Emergency Response Plans (ERPs) that include contingency safing and backout plans for Kevlar COPVs containing hazardous fluids or in proximity to hazardous commodities. The ERPs shall consider 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 prior to the start of ground operations by the applicable NASA Safety organization.

CHAPTER 14: KSC SUPPLEMENT TO NSS 1740.12, NASA SAFETY STANDARD FOR EXPLOSIVES, PROPELLANTS, AND PYROTECHNICS

14.1 HUMIDITY REQUIREMENTS

Relative Humidity (RH) in the operational area shall be determined and recorded prior to the start and every 4 hours during operations involving open grain, open flammable/ combustible fluid systems, and Category A Electroexplosive Devices (EEDs) [when the Faraday cap is removed or firing circuits to EEDs are exposed].

14.1.1 AT OR BELOW 50 PERCENT RH

a. Bonding and grounding of nonconductive materials and personnel shall be verified in accordance with Chapter 12.

b. During open flammable/combustible fluid system and open grain operations including Solid Rocket Booster (SRB) processing, electrostatic scanning, not to exceed 1-hour intervals, shall be performed during the operation and at any time additional personnel that are not grounded, equipment, or hardware are introduced into the immediate area, the RH goes lower, or the handling of nonconductive materials is required. All operations will cease if scan levels are above 350 volts.

14.1.2 AT OR BELOW 30 PERCENT RH

a. Operations involving open grain (except SRB segments) and open flammable/combustible fluid systems shall not be permitted.

b. All operations where the pyrotechnic devices are to be electrically disconnected, reconnected, or exposed for testing shall not be permitted.

Shuttle-Specific Requirements for this section are contained in Chapter 18.

c. Electrostatic scanning shall be performed on all personnel, tools, and equipment within five-foot radius of EED exposed circuits. All EED operations will cease if scan levels are above 350 volts. Electrostatic scanning will be performed prior to each disconnection and at 10 minute intervals.

14.1.3 BETWEEN 30 PERCENT AND 10 PERCENT RH

SRB segment processing between 30 percent and 10 percent RH shall use the following requirements:

a. Electrostatic scanning shall be accomplished at 10-minute intervals if the propellant is exposed and 30-minute intervals if the propellant is covered.

b. Operations shall not continue on segments with propellant exposed if a potential of 350 volts or greater is measured on the segment case, propellant, or equipment and personnel who are within 5 feet of open grain.

c. When the segment has the end rings with shipping covers installed, the following shall apply:

(1) Operations shall stop when electrostatic scan readings are measured above one kV. Processing shall not continue until the electrostatic scan indicates less than 1 kV.

(2) When electrostatic scan readings on the case (propellant covered) are measured above 4 kV, Safety shall be notified and all personnel shall be evacuated at least 500 feet (radius) from the processing area. Reentry into the operations area shall only be by personnel designated to perform electrostatic scans.

14.1.4 SRB Segment processing shall not be permitted below 10 percent RH.

14.2 EXPLOSIVES REQUIREMENTS

14.2.1 GENERAL REQUIREMENTS

The following general requirements shall be applicable to all activities involving explosives:

a. EEDs shall be classified as Category A or Category B.

b. Restrictions for Category A EEDs shall be developed and incorporated into appropriate Technical Operating Procedures (TOPs).

c. All explosive materials used at KSC shall be delivered, stored, installed, inspected, and tested only in approved areas/facilities.

d. Explosives shall be under the control of the explosive storage area supervisor until delivery to the requesting organization.

e. All electrical connectors on equipment entering the Solid Rocket Motor (SRM) bore shall be sealed and potted.

f. Only Factory Mutual (FM), Underwriters Laboratory (UL), or Bureau of Mines-approved, explosion-proof flashlights/lanterns shall be permitted in explosives controlled areas.

14.2.2 EXPLOSIVES TEST EQUIPMENT (ETE)

a. The appropriate NASA KSC S&MA division shall approve ETE. The submitting organization shall provide the following data:

(1) Model number

(2) Mechanical/electrical engineering drawings and specifications

(3) System safety analysis

b. A valid calibration seal shall be maintained on all approved ETE.

c. ETE approved by the 30th or 45th Space Wing (SW) for use in a joint Air Force/NASA jurisdiction facility does not require a separate NASA approval.

d. Section 14.4 contains the list of currently approved ETE.

14.2.3 TRANSPORTATION AND HANDLING

a. Safety chains or other types of especially designed breakaway control safety features shall be required between towing vehicle and trailer(s) when pintle or lunette fasteners are used.

b. Explosives delivered to the operation site shall be only that required for the task.

c. Explosives shall remain in the shipping/ transportation containers until needed.

d. Explosives delivery to a staged area for all explosives operations, including SRM segments, shall be scheduled as late as possible prior to the start of the operation.

(1) If the explosives operation is delayed prior to the scheduled start time, the explosives delivery shall be cancelled and rescheduled accordingly.

(2) If the explosives operation is delayed after explosive delivery and is expected to be delayed more than one shift, the explosives shall be returned to the storage area. Exception – SRM segments are not required to be returned to the storage area as long as the VAB ordnance operation has begun, the operational delay encountered is due to technical reasons, and the delay is not expected to be longer than 48 hours.

e. The minimum number of personnel shall accompany explosives being transported on elevators.

14.2.4 OPERATIONS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

14.2.4.1 EED devices shall not be electrically connected to systems until power on/power off stray voltage tests are performed.

14.2.4.2 The Launch Vehicle or Payload as an integrated vehicle or single element and Pyro Initiator Controller (PIC) Ground Support Equipment (GSE) shall be powered down during electrical connection/disconnection of explosive/pyrotechnic devices, except as allowed in sections 14.2.4.7 below.

14.2.4.3 Controlled switching, a Radio Frequency (RF) Control Area, and Radio Frequency (RF) silence shall be in effect during electrical connection/ disconnection or during the removal of Faraday cap/shorting plug of explosive/pyrotechnic devices.

14.2.4.4 All facility/high bay doors and openings within the Radio Frequency (RF) control area shall be closed during electrical connection/disconnection of pyrotechnic devices.

14.2.4.5 Safety concurrence shall be required prior to payload power-up testing after payload Category A final explosives connection.

14.2.4.6 RF TRANSMISSIONS

a. Cellular phones, answer back pagers (RF), portable computers, and portable hand-held KSC-controlled radio transceivers operating in the Very High Frequency (VHF) and Ultra High Frequency (UHF) ranges shall not be allowed within 25 feet of flight hardware or launch

accessory equipment containing EEDs, which includes NASA Standard Initiators (NSIs), when the shorting/Faraday caps are removed either from the explosives or firing line(s) connected to explosives. Faraday caps shall remain on EEDs at all times unless RF silence has been established. Shorting plugs shall not be acceptable unless provided with a shielding cap that is designed to provide RF protection.

b. Mobile, KSC-controlled radio transceivers shall not transmit within 50 feet of flight hardware or launch accessory equipment containing EEDs, which include NSIs, when the shorting/Faraday caps are removed and/or firing circuits are not connected.

c. Unapproved radio transceivers, Citizen Band, and amateur radios shall not transmit within 600 feet of flight hardware or launch accessory equipment containing EEDs, which include NSIs, when the shorting/Faraday caps are removed either from the explosives or firing line(s) connected to explosives.

14.2.4.7 SAFE AND ARM (S&A) DEVICES

a. Pin Removal

Two firing inhibits shall remain when removing an S&A safing pin.

b. Rotation

(1) Rotation of the Range Safety System (RSS) S&As during ground test and processing shall be performed with the Explosive Transfer Assembly (ETA) or Confined Detonating Fuse (CDF) disconnected from the S&A or at the point of terminus. All rotation testing of S&As shall be completed before the firing circuits are electrically connected, except as required after ordnance connection. Rotation testing of RSS S&As, with only the initiators electrically connected, shall be performed with a 10-foot clear minimum.

(2) If a condition exists whereby the firing circuits must be connected during the rotation test, a safety assessment shall be provided to show that inadvertent ignition of the detonators shall not occur.

(3) For rotations that require the ETA connected (one-time postordnance connection), all personnel shall clear the appropriate Blast Danger Area (BDA), and a remote rotation shall be completed. Safety shall be notified prior to rotation of all S&As. SRB ignition S&As shall not be rotated in the VAB.

(4) S&A rotation during Phase 1 or 2 lightning warnings shall be prohibited.

c. Installation/Removal

(1) Upon S&A removal, the igniter well shall be covered with an appropriate hard cover.

(2) Faraday caps shall remain on EEDs when installing or removing the S&A.

14.2.4.8 HATCH T-HANDLE EXPLOSIVES

Reserved

14.2.4.9 EXPLOSIVES INSTALLATION, CONNECTION, VERIFICATION AND SAFEGUARDS

Reserved

14.3 PROPELLANT REQUIREMENTS

14.3.1 GENERAL HYPERGOLIC PROPELLANT SYSTEMS OPERATIONS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

a. Propellant transfers shall be performed only in safety-approved areas.

b. Prior to starting, Hypergolic Vent Exhaust System (HVES) shall be operational.

c. Toxic propellant systems shall be drained and flushed or purged to nonhazardous concentration levels prior to opening unless personnel are properly protected.

d. Prior to replacement or storage of components or system repair, hypergolic or toxic system components shall be flushed and purged of all residual propellants and appropriately capped or bagged and labeled prior to movement.

e. Toxic and/or flammable vapor monitoring shall be required during break-in to any propellant system that has been contaminated by propellants and during the handling of contaminated parts. Toxic vapor monitoring shall also be required at the conclusion of any hazardous operation prior to opening of the control area to unprotected personnel.

f. Component parts and tools which have been in contact with the oxidizers/fuels shall be decontaminated or considered contaminated and as such shall be handled and transported with the same level of safety precautions applied to the oxidizers/ fuels.

g. Hypergol Servicing/Deservicing

To ensure the safety of personnel, facilities, and hardware, the program shall perform an analysis of hypergol servicing/deservicing operations, including scrubber operations and the effects of toxic releases on adjacent areas and facilities.

14.3.2 H2/O2 OPERATIONS

a. Personnel exposed to higher than normal concentrations of oxygen or hydrogen gases shall not come into proximity of ignition sources until they have been in a normal atmosphere at least 30 minutes.

b. Systems previously serviced with gaseous or liquid hydrogen shall be purged until the hydrogen content of the purged gases is less than 1 percent. Hydrogen systems shall be purged until the oxygen content of the purged gases is less than 1 percent (inert) before any hydrogen is allowed into the system.

c. Replenishment of the LH_2/LO_2 storage tanks or local hazardous operations in the storage facilities shall be performed in series.

14.3.3 AUXILIARY POWER UNIT (APU)/HYDRAULIC POWER UNIT (HPU) EXHAUST/DRAIN PLUGS REMOVAL

Shuttle-Specific Requirements for this section are contained in Chapter 18.

Toxic Vapor Checks (TVCs) shall be performed when hyper system exhaust/drain plugs are not installed.

a. **Reserved**

b. **Reserved**

14.3.4 HYPERGOLIC PROPELLANT SCRUBBER OPERATIONS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

a. Scrubber system configuration shall be verified before the power-up of the fuel and oxidizer scrubbers in storage facilities, except in emergency conditions. Restrictions shall be implemented in accordance with Chapter 4 of this KNPR. All scrubber liquor shall be sampled.

b. **Reserved**

14.3.5 HYPERGOLIC EQUIPMENT

Hypergol equipment/parts, including the associated clean gas equipment, shall be dedicated to fuel or oxidizer media systems.

Exception 1: Tube/Pipe parts and fittings remain as general use (non dedicated) subject to the following conditions:

a. The propellant contact surface(s) is to have a material comprised solely of type 304/316 SST, or Type 304L/316L SST (if welded), or engineering approval equal.

b. Verification of precision cleaning in accordance with Level 300A (minimum), Test Method 1 of KSC-C-123.

Exception 2: Parts/equipment previously dedicated/"part-marked" ("Fuel Use Only" or "Oxidizer Use Only") for use with one media may be re-identified and used with other hypergol media subject to the following conditions:

a. Verification of a. and b. from Exception #1, above.

b. All soft goods (including lining) shall be replaced with new soft goods comprised of a material compatible with the media, as specified in Material Selection List for Reactive Fluid Service KTI-5211, for which it is intended for use.

c. Remarking shall be controlled through the GSE Material Review (MR) process.

14.3.6 FLOWING/VENTING OF INERT/TOXIC GASES/VAPORS

a. TVCs shall be performed following the flow or venting of toxic fluids or gases.

b. Oxygen level checks shall be performed prior to entry into the Launch Vehicle access white room, all Launch Vehicle compartments, and any other areas if inert gases have been activated or released.

Shuttle-Specific Requirements for item b. are contained in Chapter 18.

c. Warning signs shall be posted on or in close proximity to all engines being actively purged with an inert gas. Signs need not be attached to the engine but shall be readily visible and worded to alert personnel of the hazard.

14.3.7 LAUNCH VEHICLE PROCESSING WITH HYPERGOLICS ONBOARD

These requirements are program-specific and shall be developed by the program and documented elsewhere, if applicable.

Shuttle-Specific Requirements for this section are contained in Chapter 18.

14.3.7.1 SAFETY ANALYSIS

a. When flight hardware is processed through KSC facilities with hypergolic propellants on board, the hardware owner shall be responsible to assure the safety of all individuals that could potentially be exposed to a hypergolic propellant leak and to assure that adequate controls are in place to mitigate potential damage to KSC facilities.

b. The hardware owner shall develop a safety analysis that will address, at a minimum:

(1) Leaks that can occur as a result of hardware design (e.g. thermal effects on valve seals)

(2) Potential accidental arming and/or firing of thrusters, valves, or other devices

(3) Monitoring for potential leaks

(4) The need for controlled and/or cleared areas around hardware that is filled with propellant.

14.3.7.2 **Reserved**

14.3.7.3 **Reserved**

14.3.7.4 **Reserved**

14.3.7.5 **Reserved**

14.3.7.6 **Reserved**

14.3.7.7 SRM Processing Requirements

a. General

(1) Personnel shall not enter the SRM bore when the SRM is in the vertical position until a documented safety assessment has been performed to identify/mitigate all hazardous conditions and ensure compliance with established safety and health requirements and standards.

(2) Conductive bore inspection pads shall be installed in the bore for personnel access when the SRM is in the horizontal position.

(3) Loose propellant and Ammonium Perchlorate (AP) shall be removed from nonpropellant surfaces. Any loose propellant on propellant surfaces shall be removed. AP shall be removed from the propellant surface where the inspection pads are to be installed. AP removal shall be accomplished using clean cotton cloths wetted with distilled or deionized water and gently pressing onto the surface and lifting free. Do not rub. Remove excess water.

(4) Loose propellant, solid propellant cuttings, and AP (including contaminated cloths) shall be placed in velostat plastic bags, inside a closed, grounded, metal container, for pickup and delivery to the Ordnance Storage Facility (OSF) and subsequent disposal. The designated staging area for the waste is the northwest corner of the Rotation Building and the waste shall be removed within one shift (8 hours).

(5) Conductive plastic sheeting (velostat) shall be placed on railcar surfaces at bore entrances to prevent contamination of propellant. Sheeting shall be grounded to a common ground with the segment/railcar prior to installation.

(6) Open end(s) of segment shall be covered with velostat sheeting securely anchored to prevent wind damage during outside moves.

(7) Personnel entering the bore shall wear conductive bags over socks. No shoes shall be worn in the bore.

b. End Ring Covers

End ring covers shall be reinstalled at the completion of all inspections. Forward covers shall be installed prior to break-over operations.

c. Cutting and/or Trimming

(1) Railcars and rolling stock shall be moved from the railroad tracks located between the Rotation, Processing, and Surge Facility (RPSF) main gate and Kennedy Parkway North.

(2) The segment shall remain secured to the railcar, railcar brakes set, and segment connected to facility ground. The forward segment shall be orientated with the forward dome end-facing west during grain trimming.

(3) Doors on the West end of the Rotation Building shall remain closed during the trimming of propellant.

(4) Public Affairs (PA) tour buses shall be rerouted during the operation.

(5) Only tools and equipment designated for cutting/trimming of grain shall be used.

(6) Upon completion of grain trimming, the segment end shall be securely covered and the segment moved into the Rotation Building.

14.3.7.8 RPSF OPERATIONS

The H77-0412 Impact Covers (Protective Pies) shall be installed as soon as the two point lifting beam is removed from the aft and center segments following breakover. Modified, small diameter, covers may be used during inspection and/or repair of vertical segment when access is limited to the clevis area.

14.3.7.9 OPEN GRAIN INSPECTION OF BOOSTER SEPARATION MOTORS (BSMs)/ROCKET MOTORS AT THE OSF

Orientation of BSMs for inspections shall be toward the exterior (south) wall to minimize property and equipment damage and/or personal injury.

14.3.7.10 SRB IGNITER

The igniter shall not remain at the operational site but shall be installed or taken to the OSF.

14.3.7.11 SRM SEGMENT TRANSFERS

a. A segment shall not remain parked outside the VAB/RPSF any longer than required to perform electrostatic scan unless a written discrepancy condition exists.

b. Two segments may be permitted in the VAB transfer aisle only during SRM stacking operations and with Safety concurrence, providing that:

(1) Segments are spaced a minimum of 240 feet apart.

(2) Neither segment is a forward segment.

(3) Any segment attached to a crane must be soft mated or hard down on pallet.

c. The segmented storage (impact) cover shall be in place under the weather cover on the forward end of the segment prior to leaving the building.

d. After moving a segment between buildings, an electrostatic scan of the pallet shall be required only when humidity levels drop below 30 percent.

e. Operations shall be stopped for electrostatic readings greater than 1 kV.

14.3.7.12 SRB HOIST AND STACK ON MOBILE LAUNCH PLATFORM (MLP)

The SRM impact covers shall be in place on the forward end of the segment when in the VAB. The only exception is when the segment is in the high bay during scheduled operations, with the following precautions:

a. The covers may be removed provided the entire high bay, in which the work is being performed, is cleared except for personnel man-loaded by OMI performing the tasks.

b. Personnel shall not work above the open grain area or do unrelated work within 10 feet of the open grain operation.

14.3.7.13 HANDLING AND TRANSFER OF HYDRAZINE (N2H4)/MONOMETHYL HYDRAZINE (MMH)/NITROGEN TETROXIDE (N2O4)

a. Hydrazine/MMH/nitrogen tetroxide vessels, contaminated tools and GSE, and Propellant Handlers Ensemble (PHE)-suited personnel shall ingress/egress test cells by an exterior door (not through inhabited areas).

b. Fuel and oxidizer vessels shall not be transported together or placed within 25 feet of each other.

c. Storage of fuels or oxidizers shall not be permitted in test cells or on hypergolic service pads. Placement may precede the start of operations, as directed by the TOP. Only Department of Transportation (DOT) compliant containers specifically marked for anhydrous hydrazine, methyl hydrazine, or nitrogen tetroxide shall be used to collect hypergol fuel or oxidizer (including wastes).

d. A limit of four solid waste containers (two in use, two awaiting sample results), and eight liquid waste containers (four in use, four awaiting sample results) shall be allowed to be staged at the hypergolic sump sites. Containers that exceed this limit shall be removed within 3 working days from completion of the operation that generated this waste.

e. Containers shall not be filled to more than one-half capacity marked accordingly.

f. These requirements shall also apply to tanker operations.

14.4 LIST OF KSC APPROVED EXPLOSIVES TEST EQUIPMENT

Manufacturer	Model	
Alinco	101-5A1	*
	101-5BFG	*
	101-5BPGG	*
	101-5CFG	*
AMPTEC Explosive Safety Igniter Tester	620 ES	*
ETI (DuPont) Blasters Multimeter	101	
	101A	
Fluke	11	
	77	
	87	
	8050	
	8012A	
	8024B	
	8060A	
	8600A	
Hewlett Packard	3457A	
	3466A	
	4328A	
Hypertronics Megaohmeter	HM6B	
Keithley	580	
	8600A	
Simpson Digital Multimeter	467	
Space Electronics Igniter Circuit Tester	101-5AF	*
	101-5AL	*
	101-5HJ	*
	101-5HJ/HJR	*
	101-5HP	*
	101-5RZ-3	*
Stray Voltage Checker	C72-1127-03	
Valhalla Digital Igniter Tester	4165	*
	4313AB	*
	4314A	*
	4314AN	*
	4314AF	*
	4314B	*
	4314KB	*
	Alpha 4314 KRC	*
	4650A	*

* These meters are approved for NSI Bridgewire Measurements only.

CHAPTER 15: KSC SUPPLEMENT TO NASA-STD-8719.9, NASA SAFETY STANDARD FOR LIFTING DEVICES AND EQUIPMENT

15.1 GENERAL

a. This chapter supplements procedures and requirements found in NASA-STD-8719.9, NASA Standard for Lifting Devices and Equipment, for lifting operations at Kennedy Space Center.

b. An initial review of KSC lifting equipment was performed in 1990 to assess design compliance with NASA-STD-8719.9. Non-compliances were approved by the applicable Level III Risk Review Board. Contact the KSC Lifting Devices and Equipment Manager (LDEM) for further information.

15.2 RESPONSIBILITIES

a. The LDEM shall be the single point of contact for the KSC Lifting Program.

b. The LDEM and the Lifting Devices and Equipment Committee shall ensure the requirements and procedures contained in this supplement are understood and applied in lifting operations at KSC.

c. All personnel involved in lifting operations at KSC shall adhere to the requirements and procedures contained in this supplement. Change recommendations, safety variances, and questions about requirements shall be coordinated through the KSC LDEM.

15.3 HOISTING AND HANDLING

Shuttle-Specific Requirements for this section are contained in Chapter 18.

15.3.1 LIFTING / SUSPENSION OF LOADS

a. Loads shall not be lifted, suspended, or transported over flight hardware or one-of-a-kind Ground Support Equipment (GSE), whose loss would have serious programmatic impact, unless the lift is essential to perform a Technical Operating Procedure (TOP) controlled task.

b. Loads shall not be lifted, lowered, or left suspended any longer than necessary to accomplish the task. In the event a problem occurs during a lifting operation that prevents completion of the operation, the load will be safed, to include returning the load to the pre-lift position if necessary. Approved procedures will be used to resolve the problem before the operation resumes.

c. Flight hardware lifting, stacking or mating operations in progress during launch countdown shall be static or soft-mated (as defined in the procedure) by L-1 hour. Static conditions for Solid Rocket Motor (SRM) segments shall either be within five feet of the transfer aisle floor, or if not soft-mated (as defined in the procedure), the segments shall not engage the clevis or Field Joint Assembly Fixture (FJAF). The forward assembly shall remain static above and shall not engage the forward segment. Static condition for flight hardware, if not soft-mated (as defined in the procedure), shall be in the transfer aisle.

15.3.2 CRITICAL LIFTS

a. Lifting and movement of flight hardware packaged per its applicable shipment specification shall not be considered a critical lift. The LDEM and affected organizations may designate the handling of specific packaged flight hardware as critical if circumstances dictate.

b. Lifting and movement of flight bulk parts (e.g., fasteners) and raw materials shall not be considered a critical lift except for those items with hazards where loss of containment would result in immediate physical harm to operators or other personnel involved in the operation.

c. A critical lift for a powered industrial truck would be to directly lift unpackaged flight hardware or any other lift designated critical by the LDEM and affected organizations.

d. Transport and lifting of in-process manufacturing products not yet certified or designated as flight hardware shall not be considered a critical lift.

15.3.3 LOAD TESTING

15.3.3.1 Lifting equipment load tests shall not be performed above flight hardware or critical GSE or when failure of the lifting equipment could damage flight hardware or critical GSE unless a risk assessment has been performed with concurrence by the LDEM and appropriate management.

15.3.3.2 Solid Rocket Booster (SRB) Engine Service Platform (ESP) winch load tests should be performed before SRB stacking begins; however, these load tests may be performed at other times based on the following restriction.

a. Reserved

b. When the SRBs are stacked or partially stacked, SRB ESP winch load tests may be performed only if the SRB ESP is in position and supported by the cobra heads.

15.3.3.3 CRANES USED FOR LOAD TESTING

a. The KSC list of cranes permitted to be used for load testing other lifting devices is posted at the following website:

http://ksc-lde.ndc.nasa.gov

b. Primary organizations responsible for design, procurement, operations or maintenance of lifting equipment shall submit requests for changes to the LDEM, with rationale, to the list of cranes used for load testing. The LDEM will approve/disapprove changes to the list. Requests for changes to the list shall state what load testing will be performed and should include the following:

(1) Design standard(s),

(2) Design safety factor(s),

(3) Test history,

(4) Operations history,

(5) Maintenance history, and

(6) Other acceptance rationale to perform the load testing.

15.3.3.4 NON-LOAD TEST SLINGS

a. The KSC List of Non-Load Test Slings (i.e., slings not requiring periodic load tests) is posted at the following website:

http://ksc-lde.ndc.nasa.gov

b. Program / project or directorate organizations responsible for design, procurement, operations or maintenance of lifting equipment slings shall submit requests for changes to the LDEM, with rationale, to the List of Non-Load Test Slings. The LDEM will approve/disapprove changes to the list. Requests for additions to the list shall state why the periodic load test will not be performed and should include the following:

(1) Design standard(s),

(2) Design safety factor(s),

(3) Rated load versus actual load,

(4) Test history,

(5) Operations history,

(6) Planned future use,

(7) Material / construction properties,

(8) Storage provisions,

(9) Maintenance performed, and

(10) Other information that is acceptance rationale not to perform the periodic load test.

15.3.3.5 For slings (reference NASA-STD-8719.9, Section 10, Slings and Rigging), the periodic load test factor shall be a minimum of 1.0, however may be tested up to a maximum periodic load test factor of 1.25 at the discretion of the responsible engineer.

15.3.4 TRANSIT OF CRANES

a. Prior to any crane move, the route of travel shall be planned and checked to ensure that adequate clearances exist along the selected route and that the route is adequate for the loads being transported.

b. All cranes shall maintain adequate clearance from walls, overhead trestles, columns, and other structures.

15.3.5 GROUNDING DURING HOISTING OF FLIGHT HARDWARE

Electrical grounding shall be required, when explosives and/or flammable fluids are involved, per the requirements of Chapter 12 of this KNPR.

15.4 SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL (SLOAA)

15.4.1 GENERAL

This procedure implements the "National Aeronautics and Space Administration Alternate Safety Standard for Suspended Load Operations" at KSC. This standard has been approved by the Occupational Safety and Health Administration (OSHA) as an alternate to 29 Code of Federal Regulations (CFR) 1910.179(n)(3)(vi), 29CFR 1910.180(h)(3)(vi), and 29 CFR 1910.180(h)(4)(ii).

15.4.2 ANALYSIS / APPROVAL REPORT

In accordance with the requirements specified in NASA-STD-8719.9, Appendix A, paragraph A.4, a NASA SLOAA report shall be generated by the operating organization for any suspended load operation involving employee exposure. Employee exposure means having any part of the body beneath the load such that if the crane and/or hoist system (including rigging) were to fail and the load were to drop, the employee could be injured or killed if he or she were in the envelope of the falling load. An accepted, permanent residual risk is where the suspended load operation with employee exposure cannot be procedurally eliminated nor corrected by engineering means. SLOAA reports are posted at the following web site:

http://ksc-lde.ndc.nasa.gov

a. The KSC LDEM shall assign a tracking number and review the SLOAA report.

(1) Those crane and hoist systems without Single Failure Points (SFPs), whose failure would result in dropping the load, require NASA S&MA approval.

(2) Those crane and hoist systems with SFPs, whose failure would result in dropping the load, require NASA Headquarters Office of Safety and Mission Assurance (OSMA) review and concurrence.

b. The operating organization shall prepare a SLOAA report for each suspended load operation to include all supporting data. An Approval Sheet for Suspended Load Operations (KSC Form 20-200 NS is available at http://kscforms.ksc.nasa.gov/findex.cfm) shall be used for all KSC approval signatures including concurrence by the LDEM. The responsible program/project NASA KSC S&MA Division Chief shall sign the last page of the SLOAA.

CHAPTER 16: SYSTEM SAFETY AND RELIABILITY ENGINEERING REQUIREMENTS

16.1 GENERAL

Shuttle-Specific Requirements for this section are contained in Chapter 18.

The system safety and reliability engineering requirements delineated herein are intended for systems and operations directly supporting the performance of KSC's mission. Formal, documented system safety and reliability analyses are required for equipment (i.e., facility systems, Ground Support Equipment [GSE]) that supports the KSC institutional infrastructure and is directly involved in flight hardware processing.

a. Ground systems used at KSC, for which KSC does not have sustaining engineering responsibility, shall meet the applicable system safety and reliability analysis requirements of the NASA Center or Program having sustaining engineering responsibility. KSC shall have the right to review all engineering documentation to ensure that risks to KSC personnel and property from such equipment are adequately controlled.

b. Program/project or directorate organizations (and their associated contractors) shall develop documented processes for accomplishing these system safety and reliability engineering requirements on systems and operations for which they have contractual responsibility. When applicable per contract, procedures involving system safety and reliability analyses shall follow the methodology defined in KNPR 8700.2, KSC Systems Safety and Reliability Analyses Methodology Procedural Requirements. All documentation and data shall be available for review by NASA.

c. Program/project or directorate organizations shall ensure their contractors develop and maintain a list of all systems and equipment for which they have contractual system safety and reliability engineering responsibility. This list shall include the type and level of system safety and reliability analysis performed or required to be performed.

16.2 HAZARD ANALYSIS/RISK IDENTIFICATION PROCESS

The hazard analysis/assessment process is a principal factor in the understanding and management of technical risk. This process serves several purposes, including assessing compliance of safety requirements; providing feedback throughout the system design; and development process to support the optimization of the inherent safety of designs.

16.2.1 Program/project or directorate organizations (and their associated contractors) are responsible for the performance of vigorous, proactive system safety engineering hazard analyses throughout the program/project lifecycle (i.e., design, test, operations). The analyses performed shall identify and document hazards to:

a. Assess compliance of safety requirements.

b. Identify and document system safety and mission success risks early in the program/project and update the status of these risks throughout the program/project.

c. Provide feedback throughout the system design and development process to support the optimization of the inherent safety of designs.

d. Analyze ground processing operations, beginning in the system design phase, to identify and mitigate any operational hazards, integration hazards, and human factor issues (including human error as part of the overall hazard analysis). **Shuttle-Specific Requirements for 16.2.1.d are contained in Chapter 18**.

e. Analyze and prioritize hazards (risks) for probability (Likelihood of Occurrence) and impact (Severity).

f. Ensure that valid and verifiable hazard controls are established, implemented, and tracked in a closed-loop system. **Shuttle-Specific Requirements for 16.2.1.f are contained in Chapter 18.**

g. Provide for management acceptance of risks.

16.2.2 **Reserved**

Shuttle-Specific Requirements for this section are contained in Chapter 18.

16.2.3 Hazards will be mitigated according to the following order of precedence. Hazard mitigation shall:

a. Eliminate hazards.

b. Design for minimum hazards (including uncertainty reduction).

c. Incorporate safety devices to control the hazard.

d. Provide Caution and Warning (C&W) devices.

e. Develop and implement special procedures.

16.2.3.1 All pertinent details of the hazard analysis and review shall be traceable from the initial identification of the hazard through its resolution (i.e. until accepted mitigation are verified) and any updates, using the continuous risk management approach, until determined no longer necessary by S&MA.

16.3 RELIABILITY AND MAINTAINABILITY (R&M) ENGINEERING

Program/project or directorate organizations (and their associated contractors) shall integrate R&M engineering functions into the overall design, sustaining engineering, and logistics support requirements. For system development efforts, the contractor shall develop system R&M requirements appropriate to the mission profile and shall assess designs to ensure the requirements are met. R&M assessments shall be provided to support maintenance planning, logistics support analysis, and ongoing Reliability Centered Maintenance (RCM) efforts including trending of equipment reliability and effectiveness of the maintenance program.

16.3.1 Program/project or directorate organizations (and their associated contractors) shall develop a documented approach to reliability and maintainability engineering, which addresses, as a minimum, the following three support functions:

a. The safety risk management process.

b. The capability for as-scheduled mission success.

c. Cost-effective ground systems maintenance and support.

16.3.2 Program/project or directorate organizations (and their associated contractors) shall develop and implement reliability analysis processes that shall verify the fail-safe design requirement for GSE and facility systems developed and used at KSC. Noncompliance's with the fail-safe requirement shall be identified, documented, and processed for management risk visibility/acceptance in accordance with applicable programmatic requirements.

16.3.3 There are several reliability and maintainability analyses that can be used to support fail-safe verification and other R&M objectives. Example reliability and maintainability analyses that can be utilized include:

a. Criticality Assessment

b. Failure Modes and Effects Analysis (FMEA)

c. Reliability Block Diagram Analysis (RBDA)

16.4 NASA-MANAGED DEVELOPMENT PROJECTS

NASA KSC Project Managers, or Lead Designers with assigned project responsibility, are responsible for ensuring the safety and reliability of their developed systems and equipment. This responsibility begins with identification of safety and reliability requirements during the project planning phase and ensuring safety and reliability engineering tasks are included in the project schedule, funded, and executed.

a. NASA KSC developed systems and equipment shall be designed to minimize hazards and shall incorporate the fail-safe design philosophy.

b. System safety and reliability analyses shall be selected which provide verification of the safety and reliability design requirements, as well as ensure identification and mitigation of risks (i.e., hazards and critical items) present in the design and the intended operation(s) of the systems and equipment.

c. These analyses shall be performed per KNPR 8700.2, KSC Systems Safety and Reliability Analyses Methodology Procedural Requirements.

d. As a minimum, analysis results shall be provided to the design team in sequence with equipment/system design process to allow for design correction of any deficiencies identified by the analyses.

CHAPTER 17: LAUNCH AND LANDING OPERATIONS

Shuttle-Specific Requirements for this section are contained in Chapter 18.

These requirements are program-specific and shall be developed by the program and documented elsewhere, if applicable.

CHAPTER 18: SHUTTLE-SPECIFIC REQUIREMENTS

During the transition period between the Space Shuttle Program (SSP) and the Constellation Program (CxP), it became necessary to remove Shuttle-Specific Requirements from the main body of this KNPR to utilize this document in the planning process for Constellation. However, these items could not simply be deleted from the document, since the requirements still apply to the SSP as long as the Shuttle flies.

To bridge the gap between these programs while still providing KSC Safety Practices Procedural Requirements required for both SSP operations and CxP planning, the requirements in the body of this KNPR were evaluated and revised to satisfy the needs of the CxP. Those requirements designated as Shuttle-specific were moved to this chapter. The body of the KNPR contains requirements applicable to the entire Kennedy Space Center (KSC) (including SSP); in cases where Shuttle-specific requirements were relocated to this chapter, a note appears in the text stating:

"Shuttle-Specific Requirements for this section are contained in Chapter 18."

Within **Chapter 18**, each section of the main KNPR is represented. Sections in which there were no changes read "SABD" (Same as Basic Document). Sections that contain Shuttle-specific requirements are contained here, and the requirements presented supersede requirements presented in the main body of the document FOR SHUTTLE OPERATIONS ONLY.

In some cases where consecutive sections contained no Shuttle-specific requirements, this chapter contains notation indicating that the span is SABD. For example, **"3.3.3 through 3.3.4 - SABD,"** indicates that the entirety of 3.3.3 and 3.3.4 contain no Shuttle-specific requirements and that the requirements for that section are available in the main body of the KNPR. These SABD requirements apply to ALL programs and operations at KSC, including Shuttle.

Preface - Same as Basic Document (SABD)

Chapter 1: General Requirements - SABD

Chapter 2: Weather

2.1 - SABD

2.2 ADVERSE WEATHER NOTIFICATION

2.2.1 The Space Program Operations Contractor (SPOC) shall notify the Institutional Services Contractor (ISC) and the Checkout Assembly & Payload Processing Services (CAPPS) of adverse weather conditions affecting KSC operating areas.

2.2.2 The SPOC shall make an all-area page, preceded by a special tone, announcing the following adverse weather affecting KSC operating areas:

a. Phase I and Phase 2 Lightning Advisory, and

b. Severe Weather Warnings.

2.2.3 Phase 2 Lightning Warning notifications and Severe Weather Warnings shall be repeated every hour until the advisory is terminated.

2.2.4 Adverse weather shall be announced on applicable KSC radio nets by the respective Duty Officer (DO)/Monitor. Phase 2 Lightning Warning notifications and Severe Weather Warnings shall be repeated every hour until the advisory is terminated.

2.2.5 Termination and change of state of adverse conditions shall be announced in a similar manner.

2.3 - SABD

CHAPTER 3: PERSONNEL

3.1 GENERAL - SABD

3.2 PERSONNEL CONTROLS

3.2.1 - SABD

3.2.2 - SABD

3.2.2.a

a. Approvals

(1) Access to the VAB roof shall be coordinated by the sponsoring organization and approved in advance and in writing by the Director of Launch Vehicle Processing OR the Director of External Relations; AND the Chief, Institutional S&MA Division, or designee.

(2) The approval letter shall include the date, anticipated time of the visit, the size of the group and any other pertinent information, and be distributed to the CTC Office, NASA Test Director (NTD) Office, the VAB Site Manager, VAB Safety, and USA Operations Security. Any last minute changes to group size (increases) shall strictly adhere to the requirements stated herein.

3.2.2.b through 3.3 - SABD

3.3.1 ORBITER ACCESS REQUIREMENTS

a. Access to the Orbiter requires specific training, justification, certification, and badging.

b. The following training requirements are mandatory for Certification # 800, “Orbiter Mid Body and Forward Access”

OV283USA, Orbiter Wiring Awareness (24 month recert)
OV289LSC, Crew Module/Payload Bay Access (24 month recert)
QS205LSK, How Clean Is Clean Enough (One time – no recert)

c. The following training requirements are mandatory for Certification # 801, “Orbiter AFT Access”

OV21lLSC, AFT Area Access (24 month recert)
OV283USA, Orbiter Wiring Awareness (24 month recert)
QS205LSK, How Clean Is Clean Enough (One time – no recert)

d. Upon completion of all mandatory training requirements, KSC form 29-890, “Orbiter Access Justification,” is completed and processed to obtain the necessary certification(s). Supervisory/managerial signature is required.

e. If access to the Orbiter is required less than once per month, Certification 800/801 is not authorized. A “KSC Form 4-536, “One Time/One Day Entry Permit” will be utilized.

f. KSC Area Permit Numbers 70-73, as well as other numbers (dependent upon Orbiter location, i.e., Pad, OPF, VAB) are required for unescorted access to the Orbiter.

3.3.2 SPECIAL CREW TRAINING REQUIREMENTS

The matrix that follows provides a list of special crew training requirements in addition to the area access requirements:

MINIMUM KSC SAFETY TRAINING REQUIREMENTS FOR SPECIAL CREWS (IN ADDITION TO AREA ACCESS SAFETY TRAINING)

COURSE NUMBER	COURSE TITLE	FLIGHT CREW	* CLOSE OUT CREW	FIRE RESCUE TEAM	FINAL INSPECTION TEAM	RED CREW	RECERT PERIOD	TYPE/LOCATION
OV 211 LSC	AFT Area Access	X					24 Mo.	Video
OV 281 LSK	Flight Crew Emergency Egress (Orbiter)		X				18 Mo.	Live/JSC
OV 282 LSK**	Flight Crew Emergency Egress (Pad)		X				18 Mo.	Live/KSC
OV289LSC	Crew Module/Payload Bay Access	X	X				24 Mo.	Video
QG 218 KSC**	Closeout Crew Fire Suppression		X				12 Mo.	Live/KSC
QG 221 KSC	Flight Crew Fire Suppression	X					12 Mo.	Live/KSC
QG 310 KSC-REV	Basic CPR And First Aid	X	X	X	X		None	Live/KSC-JSC
QG 313 KSC-REV	CPR/Basic First Aid Recertification	X	X	X	X		24 Mo.	Live/KSC-JSC
QG 316 KSC	Red Crew Fire Supp/Emergency Egress				X	X	12 Mo.	Live/KSC
QS 200 LSK	Red Crew Familiarization					X	None	Live/KSC
QG 325 KSC**	Robert Shaw Mini Resuscitator	X	X				12 Mo.	Live/KSC-JSC
QG 333 KSC	Flt Crew Rescue-Launch Pad Vertical			X			None	Live/KSC
QG 340 KSC**	Liquid Air Pack Operation		X	X			12 Mo.	Live/KSC
QG 250 KSC	Hypergolic Fire Suppression	X	X	X			12 Mo.	Live/KSC
QG 389 KSC	Driver Operation, M-113 Tank	X		X			12 Mo.	Live/KSC
QS 22A LSK**	Crew Emergency Egress (Part A – Classroom)		X		X		18 Mo.	Live/KSC
QS 22B LSK	Crew Emergency Egress (Part B – Pad Walkdown)	X	X		X		12 Mo.	Live/KSC
QG 381 JBO or QS 505 USA	Supplied Air Respirator Fit Test		X	X		X	12 Mo.	Live/KSC

* Includes Training Requirements for JSC Suit Techs, Support Astronauts
** Courses are taught in block form sequence

NOTES:

1. All special crews require Orbiter Access Certification Numbers 800/801. Current qualifications include the following video training: OV211LSC, OV283USA, OV 289LSC, QS205LSK, and QS210LSK-REV
2. A current respirator (RE3) physical is required for all personnel attending QG218KSC, QG221KSC, QG316KSC, or QG340KSC
3. Current respirator (RE3), SCAPE (SS), and Primary Crew Contact (PCC) physicals are required for all personnel assigned to the Closeout Crew.
4. A Fireman Paramedic KSC (FR) physical is required for all personnel assigned to the Fire Rescue Team.

3.4 REFRESHER TRAINING - SABD

3.5 MAXIMUM WORK TIME

3.5.1 through 3.5.5.3.q - SABD

3.5.5.3.r Specific operational/processing scenarios (i.e., Shuttle TAL Support, Shuttle CONUS Predeployment Landing Support, Shuttle/SCA Ferry Operations, SRB Retrieval Operations, External Tank Transport Barge Operations) are exempted from the consecutive day deviation requirements, since the work profile is such that exceeding the limits is a reasonably expected condition, and the nature of the work is such that the limits can be exceeded without causing excessive employee fatigue."

3.5.5.3.s through 3.5.7 - SABD

CHAPTER 4: CONTROL AREAS

4.1 GENERAL

4.1.1 through 4.1.2 - SABD

4.1.3 There shall be a control area of 100-feet radius from the centerline for all Orbiter moves and Mobile Launch Platform moves, stacked or partially stacked.

4.2 through 4.5 - SABD

CHAPTER 5: OPERATIONAL SAFETY

5.1 through 5.6.3 - SABD

5.6.4 Spark-Producing Devices and Smoking

Spark-producing devices and smoking shall be prohibited within the following areas:

a. Orbiter Processing Facility (OPF) perimeter fenced area;

b. 100 feet of propellant storage containers;

c. 25 feet of propellant transfer lines;

d. 25 feet of explosives;

e. 50 feet of Crawler Transporter (CT) operations;

f. 100 feet of CT operations with stacked or partially stacked segments;

5.7 through 5.9.1.a - SABD

5.9.1.b If the inert gas lines of the Mobile Launch Platform (MLP) are to remain pressurized during transfer, the ODMS shall remain operational in the local mode.

5.9.2 - SABD

5.9.3 HAZARDOUS GAS DETECTION SYSTEM (HGDS)

a. At least one HGDS shall be operational prior to any remote Hydrogen (H2) operation. A HGDS monitor shall keep the team advised of H2 readings.

b. Lower Explosive Limit (LEL) detectors shall be utilized for all local H2 operations.

c. If H2 readings exceed 10,000 parts per million (ppm) the Task Team Leader (TTL) shall evaluate the magnitude of the leak and determine the actions to take to protect personnel and equipment.

d. Loss of HGDS during Power Reactant Supply and Distribution (PRSD) tank pressurization, and before stabilization, shall require depressurization immediately. Loss of HGDS after tank stabilization shall not require depressurization if no leaks are present.

5.9.4 - SABD

5.10 CRYOGENICS

5.10.a The Orbiter Maneuvering Subsystem/Forward Reaction Control System (OMS/FRCS), wings/mid-body/payload bay, and aft compartments shall be inerted to less than 1 percent O_2 prior to PRSD tank servicing and External Tank (ET) loading.

5.10.b through 5.10.d - SABD

5.10.1 through 5.11 - SABD

5.12 Handling of Flammable/Combustible Liquids near flight hardware

5.12.1 Containers used for liquids, flammable/combustible or not, shall be labeled to specify the contents.

5.12.2 All flammable/combustible liquids brought into, or within 3 feet of, the Orbiter, ET, Solid Rocket Booster (SRB) or International Space Station (ISS)/payload hardware shall be in nonshatterable containers equipped with leak-proof closures that can be positively secured in the closed position. The container material shall be compatible with the contents.

5.12.3 Individual containers of flammable liquids exceeding 1 pint and allowed within 50 feet of flight hardware shall meet the following requirements:

a. A risk assessment for operational use shall be performed by the program/project or directorate organization.

b. The process for use shall be controlled by a hazardous TOP per section 9.3.

5.12.4 Plastic squeeze bottles that produce a mist shall not be used to dispense flammable liquids with a flash point below 100 degrees Fahrenheit (^{o}F).

5.13 through 5.19 - SABD

CHAPTER 6: UNIQUE HAZARDOUS FACILITIES REQUIREMENTS

6.1 - SABD

6.2 VEHICLE ASSEMBLY BUILDING

6.2.1 DUAL OPERATIONS

a. Additional crane operations involving the other 175/250/325 ton cranes shall not be permitted during Orbiter breakover or when lifting an Orbiter, SRM segment, or SRB forward assembly to/from the transfer aisle and high bay. External tank entry, fire protection outages, and Operations and Maintenance (O&M) activities requiring personnel above the ET checkout cells or on the VAB roof shall not be scheduled during the above crane operations.

b. Major hardware moves and other operations requiring opening the VAB doors shall be evaluated for impact on other operations within the building.

c. VAB crane operations involving nonhazardous/noncritical equipment and O&M activities shall be permitted outside the control area during ET lifts or when supporting the Orbiter or SRM if the crane is static and the Orbiter or SRM is within 5 feet of the transfer aisle floor.

6.2.2 through 6.2.3 - SABD

6.2.4 AFT BOOSTER AND SEGMENT LIFT

Aft booster and segment lifts shall only be permitted from the transfer aisle to within 3 feet of the holddown posts and clevis, respectively, between the hours of 4:30 p.m. to 6:30 a.m., Monday through Friday. Exceptions must have the concurrence of the KSC Launch Director, KSC S&MA Launch Vehicle Processing Division Chief and the SPOC Safety, Quality, and Mission Assurance (SQ&MA) Director.

6.2.5 DOOR CONFIGURATION

The VAB doors shall be configured based on operational needs, personnel safety and egress, effects of high winds, lightning, solar radiation, large sail areas, multiple operations, and RF controls. VAB door configurations shall be based on KSC-5600-7312, VAB SRM Inadvertent Ignition Venting Study, dated May 2005.

6.3 through 6.3.3.b - SABD

6.3.3.c. The SRM Shuttle Wagon/SRM Transporter may enter the Rotation Building without an Internal Combustion permit to move railcars or segments, providing there is no open grain. The SRM Shuttle Wagon shall require a spacer car only when open grain exists in the building.

6.3.3.d through 6.4 - SABD

CHAPTER 7: MATERIALS PROCESSING - SABD

CHAPTER 8: KSC SUPPLEMENT TO OSHA 29 CODE OF FEDERAL REGULATIONS (CFR), PARTS 1910/1926

8.1 through 8.3.2 - SABD

8.3.3 ELEVATOR SUPPORT FOR SCAPE OPERATIONS AT LAUNCH COMPLEX (LC) 39 A/B

a. For operations below the Rotating Service Structure (RSS) 120-foot level and Fixed Service Structure (FSS) 115-foot level, a minimum of two of the three elevators shall be accessible based on Pad configuration, and operational prior to starting SCAPE operations.

b. For operations at the RSS 120-foot level and above the FSS 95-foot level, both FSS elevators shall be operational prior to starting SCAPE operations. Once SCAPE operations have begun, at least one elevator shall remain operational throughout the operation.

c. For operations in the Payload Changeout Room (PCR), the PCR elevator shall be operational prior to start of SCAPE operations.

8.3.4 through 8.4.3 - SABD

8.4.4 The Pad Slidewire System shall be operational at all times except during scheduled outages.

8.4.5 At least one ELSA shall be provided at the workstation for every person in the Orbiter forward and aft compartments. When a hazardous payload is installed in the Orbiter, ELSAs shall be provided for each person working in the mid-body anytime the payload bay doors are closed. ELSAs shall not be required when the payload bay doors are open, regardless of payload, or when closed with no hazardous payload, provided the ODMS is installed and operational.

8.4.6 through 8.9 - SABD

CHAPTER 9: TECHNICAL OPERATING PROCEDURES (TOPs) (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS)

9.1 through 9.10.3 - SABD

9.10.4 Prior to use, all repetitive TOPs shall be reviewed and updated, if needed, for compliance with current requirements (e.g., ORMSD, QPRD, KNPRs) if it has been 3 years since its last publication.

CHAPTER 10: MISHAPS AND CLOSE CALLS (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS)

10.1 GENERAL REQUIREMENTS

All mishaps and close calls shall be reported to the responsible supervisor and the organizational (NASA or contractor) safety office and shall be investigated to determine the root cause(s), to develop and implement corrective actions in order to prevent recurrence, and to document and share lessons learned. In addition, all mishaps and close calls shall be electronically entered into the NASA Incident Reporting Information System (IRIS) database. The requirements stated herein implement NPR 8621.1, NASA Procedural Requirements for

Mishap and Close Call Report, Investigating, and Recordkeeping. The KSC mishap and close call processes are documented in the respective Launch Contingency Plans **(**KSC-PLN-2001, ISS/Payload Processing Contingency Action Plan; KSC-PLN-1705 KSC Shuttle Program Contingency Plan; and LSP Contingency Plan is LSP-PLN-365.01); Kennedy Documented Procedure (KDP)-KSC-P-1473, KSC Mishap Reporting and Investigating; KDP-KSC-P-1474, Mishap Investigation Board; and KDP-KSC-P-2111, Reporting Close Calls.

10.2 through 10.4.2 - SABD

10.4.3 TYPE C OR D MISHAPS AND CLOSE CALLS

10.4.3.a Contractor

The responsible contractor organization shall, within four hours of the event (or by 7:30 AM the next workday for mishaps occurring during shifts other than first shift), submit an initial report (e-mail or fax) to the S&MA Directorate in accordance with KDP-KSC-P-1473. All mishaps and close calls shall be reported to the responsible supervisor and the organizational (NASA or contractor) safety office and shall be investigated to determine the root cause(s), to develop and implement corrective actions in order to prevent recurrence, and to document and share lessons learned. In addition, all mishaps and close calls shall be electronically entered into the NASA Incident Reporting Information System (IRIS) database while complying with section 10.4.1.b. The requirements stated herein implement NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping. The KSC mishap and close call processes are documented in the respective Launch Contingency Plans **(**KSC-PLN-2001, ISS/Payload Processing Contingency Action Plan; KSC-PLN-1705 KSC Shuttle Program Contingency Plan; and LSP Contingency Plan is LSP-PLN-365.01); KDP-KSC-P-1473 Mishap Reporting and Investigation; KDP-KSC-P-1474 Mishap Investigation Board; and KDP-KSC-P-2111, Reporting Close Calls.

The initial report shall contain a description, the time, the location, and the organizations involved in the event, a preliminary worst case estimate of the injuries and/or cost estimate of the damage resulting from the event. Within 15 working days, the responsible contractor organization shall enter the mishap report into the NASA IRIS database.

10.4.3.b through 10.10 - SABD

CHAPTER 11: SAFETY PROGRAM (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS) - SABD

CHAPTER 12: KSC SUPPLEMENT TO NFPA 70, NATIONAL ELECTRIC CODE

12.1 through 12.1.1 - SABD

12.1.2 GROUNDING OF FLIGHT HARDWARE

a. The Orbiter shall be electrically grounded at all times.

b. After moving an External Tank (ET) between the Turn Basin and the Vehicle Assembly Building (VAB), the ET transporter static ground strap shall be connected to VAB ground.

c. The forward assembly/aft skirt shall be connected to facility ground except when transporting. Forward assembly/aft skirt to pallet to transporter ground shall be maintained during moves.

d. A payload or canister containing explosives or hazardous fluids shall be grounded to facility ground upon arrival at the facility/handling mechanism.

12.1.3 through 12.1.4.e - SABD

12.1.4.f

f. All grounding devices shall be checked to ensure proper resistance prior to payload canister lift.

12.2 - SABD

CHAPTER 13: NASA KSC REQUIREMENTS FOR GROUND-BASED VESSELS AND PRESSURIZED SYSTEMS (PVS)

13.1 through 13.8.2 - SABD

13.8.3 FLIGHT VEHICLE VESSELS AND SYSTEMS

Pressure vessels and systems that have been pressurized to operating pressure as complete systems prior to delivery to KSC shall require further testing as part of the receiving inspection/ acceptance activity. Retest shall be performed only as specified in approved Technical Operating Procedure (TOP).

a. Flight Vehicle Fracture Critical Vessels and Systems

(1) Space Shuttle Program/International Space Station (SSP/ISS) Pressure vessels that are controlled as fracture critical shall be tested/pressurized to levels specified in the appropriate Fracture Mechanics Plan and JSC 08934, “Shuttle Operational Data Book,” Volume I, “Shuttle Systems Performance and Constraints Data.”

(2) Pressure vessels and systems shall be processed through turnaround flow at temperature adjusted operating pressures, only if the operating pressures are sufficiently below the threshold pressures to avoid sub-critical flaw growth. The MAWP shall be specified in the applicable operating procedure.

(3) Fracture critical controlled vessels/systems shall be pressurized to operating pressures, using specified liquids/gases, without remote controls, only if the vessels/systems have been previously pressurized to operating pressure levels.

(4) A logbook shall be maintained on each Fracture Mechanics controlled pressure vessel/system processed at KSC. The log shall identify how many times the vessel/system has been pressurized, the pressure levels, liquids/gases used, duration of the pressure cycles, and any other pertinent data. The log shall also identify the total number of cycles for which the vessel/system was designed.

(5) A logbook shall be maintained for each PVS processed at KSC. The log shall identify how many times the vessel/system has been pressurized, the pressurization levels, fluids used, duration of the pressure cycles, and any other pertinent data. The log shall also identify the design criteria used in fabricating the vessel/system.

b. Flight Vehicle Non-Fracture Critical Vessels and Systems

(1) PVS shall not be pressurized above 50 percent of design burst pressure, adjusted for temperature.

(2) PVS shall be processed through turnaround flow at pressure levels not to exceed 50 percent of design burst pressure, adjusted for temperature, if warranted by operational considerations.

(3) PVS that have not been tested as a system prior to delivery to KSC shall require personnel evacuation and remote controls for the initial (first-time) pressurization and for any subsequent pressurization that will exceed the highest level of pressure reached during previous testing as a system.

(4) PVS shall be pressurized using fluids specified in JSC 08934, "Shuttle Operational Data Book," Volume I, "Shuttle Systems Performance and Constraints Data." Pressurization levels specified herein shall not exceed those specified in JSC 08934, Volume I.

13.8.4 through 13.17 - SABD

13.18 SAFETY REQUIREMENTS FOR DESIGN, TEST, AND GROUND PROCESSING OF FLIGHT COMPOSITE OVERWRAPPED PRESSURE VESSELS (COPVs) AT THE KENNEDY SPACE CENTER (KSC), CAPE CANAVERAL AIR FORCE STATION (CCAFS), AND THE VANDENBERG AIR FORCE BASE (VAFB)

NOTE: The interim requirements letter between NASA KSC and the Air Force dated November 23, 1993, remains in effect for COPVs processed at KSC, CCAFS, VAFB, and Dryden under the requirements of AFSPCMAN 91-710 0.

13.18.1 GRAPHITE/EPOXY (GR/EP) COMPOSITE OVERWRAPPED PRESSURE VESSELS (COPVs)

a. The design, qualification, and acceptance testing of Gr/Ep COPVs shall comply with the requirements of ANSI/AIAA S-081A-2006, "Space Systems-Composite Overwrapped Pressure Vessels (COPVs)." All existing Gr/Ep COPVs used in Space Shuttle Orbiter flight systems are approved for use and exempt from this design requirement.

b. Gr/Ep COPVs shall employ proven processes and procedures for manufacture and inspection. The fabrication process shall provide for initial, in-process, and final inspections of the liner and overwrap to support the safe operation and mission success of the vessels as required by ANSI/AIAA S-081A-2006. All existing Gr/Ep COPVs used in Space Shuttle Orbiter flight systems are approved for use and exempt from this requirement.

c. Prior to the first pressurization of Gr/Ep COPVs at the KSC, CCAFS, VAFB or Dryden, 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 S-081-2006, Paragraph 5.5.3). If this inspection is not possible at the launch site (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.

d. After completing the visual inspection, and determining that there is no evidence of critical damage to the Gr/Ep COPV, the vessel shall be pressure tested to 1.1 times the ground maximum operating pressure. The pressure shall be held a minimum of ten (10) minutes. This pressurization shall be conducted remotely or a blast shield shall be used to protect personnel.

e. If Gr/Ep COPVs are to be pressurized at the KSC, CCAFS, VAFB, or Dryden to pressures greater than one third 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 ten (10) minutes after pressurization is completed.

f. 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.

g. 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. Space Shuttle Orbiter moves shall not be restricted to “off-shift” time periods and shall be performed per existing approved procedures, which limit personnel access/exposure.

h. 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 NASA Safety organization.

i. Users shall develop Emergency Response Plans (ERPs) that include contingency safing and backout plans for Gr/Ep COPVs containing hazardous fluids or in proximity to hazardous commodities. The ERPs shall consider 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 prior to the start of ground operations by the applicable NASA Safety organization.

13.18.2 KEVLAR COMPOSITE OVERWRAPPED PRESSURE VESSELS (COPVS)

a. All new Kevlar COPVs shall comply with the design, qualification, and acceptance testing requirements of ANSI/AIAA S-081A-2006. All existing Kevlar COPVs used in SPACE Shuttle Orbiter flight systems are approved for use and exempt from this design requirement.

b. Kevlar COPVs shall employ proven processes and procedures for manufacture and inspection. The fabrication process shall provide for initial, in-process, and final inspections of the liner and overwrap to support the safe operation and mission success of the vessels as required by ANSI/AIAA S-081A-2006. All existing Kevlar COPVs used in Space Shuttle Orbiter flight systems are approved for use and exempt from this requirement.

c. Prior to the first pressurization of Kevlar COPVs at the KSC, CCAFS, VAFB or Dryden, 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 S-081-2006, Paragraph 5.5.3). If this inspection is not possible at the launch site (i.e. the Kevlar COPV is not accessible), then it shall be conducted the last time the Kevlar COPV is accessible for inspection.

d. After completing the visual inspection, and determining that there is no evidence of critical damage to the Kevlar COPV, the vessel shall be pressure tested to 1.1 times the ground maximum operating pressure. The pressure shall be held a minimum of ten (10) minutes. This pressurization shall be conducted remotely or a blast shield shall be used to protect personnel.

e. If the Kevlar COPVs are to be pressurized at the KSC, CCAFS, VAFB, or Dryden to pressures greater than one-third the Kevlar COPV design burst pressure, the pressurization shall be conducted 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 ten (10) minutes after pressurization is completed.

f. Personnel limits for each operation on or near the Kevlar COPV/Spacecraft shall be established to minimize personnel exposure to the pressurized tank when at pressures greater than one third design burst pressure.

g. The transport of pressurized Kevlar 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. Space Shuttle Orbiter moves shall not be restricted to “off-shift” time periods and shall be performed per existing approved procedures which limit personnel access/exposure.

h. The Mechanical Damage Control Plan (MDCP) for the Kevlar COPVs shall be provided by the design agency for review by the applicable NASA Safety organization.

i. Users shall develop Emergency Response Plans (ERPs) that include contingency safing and backout plans for Kevlar COPVs containing hazardous fluids or in proximity to hazardous commodities. The ERPs shall consider 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 prior to the start of ground operations by the applicable NASA Safety organization.

CHAPTER 14: KSC SUPPLEMENT TO NSS 1740.12, NASA SAFETY STANDARD FOR EXPLOSIVES, PROPELLANTS, AND PYROTECHNICS

14.1 through 14.1.2.a - SABD

14.1.2 b. All operations where Orbiter Docking Systems (ODS) pyrotechnic devices are to be electrically disconnected, reconnected, or exposed for testing shall not be permitted.

14.1.2.c through 14.2.3 - SABD

14.2.4 Operations

14.2.4.1 EED devices shall not be electrically connected to systems until power on/power off stray voltage tests are performed.

14.2.4.2 The Space Shuttle Vehicle (SSV) [i.e., the Orbiter, External Tank (ET), SRB, Payload within the Orbiter) as an integrated vehicle or single element and Pyro Initiator Controller (PIC) Ground Support Equipment (GSE) shall be powered down during electrical connection/disconnection of explosive/pyrotechnic devices, except as allowed in 14.2.4.7, 14.2.4.8, and 14.2.4.9 below.

14.2.4.3 Controlled switching and Radio Frequency (RF) silence shall be in effect during electrical connection/ disconnection or during the removal of Faraday cap/shorting plug of explosive/pyrotechnic devices.

14.2.4.4 Facility doors and openings shall be closed during electrical connection/disconnection of pyrotechnic devices, except where required for Vehicle Assembly Building (VAB) chimney effect.

14.2.4.5 Safety concurrence shall be required prior to payload power-up testing after payload Category A final explosives connection.

14.2.4.6 RF Transmissions

a. Cellular phones, answer back pagers (RF), portable computers, and portable hand-held KSC-controlled radio transceivers operating in the Very High Frequency (VHF) and Ultra High Frequency (UHF) ranges shall not be allowed within 25 feet of flight hardware or launch accessory equipment containing EEDs, which includes NASA Standard Initiators (NSIs), when the shorting/Faraday caps are removed either from the explosives or firing line(s) connected to explosives. Faraday caps shall remain on EEDs at all times unless RF silence has been established. Shorting plugs shall not be acceptable unless provided with a shielding cap that is designed to provide RF protection.

b. Mobile, KSC-controlled radio transceivers shall not transmit within 50 feet of flight hardware or launch accessory equipment containing EEDs, which include NSIs, when the shorting/Faraday caps are removed and/or firing circuits are not connected.

c. Unapproved radio transceivers, Citizen Band, and amateur radios shall not transmit within 600 feet of flight hardware or launch accessory equipment containing EEDs, which include NSIs, when the shorting/Faraday caps are removed either from the explosives or firing line(s) connected to explosives.

14.2.4.7 SAFE AND ARM (S&A) DEVICES

a. Pin Removal

Two firing inhibits shall remain when removing an S&A safing pin.

b. Rotation

(1) Rotation of the Shuttle Range Safety System (SRSS) S&As during ground test and processing shall be performed with the Explosive Transfer Assembly (ETA) or Confined Detonating Fuse (CDF) disconnected from the S&A or at the point of terminus. All rotation testing of S&As shall be completed before the firing circuits are electrically connected, except as required after ordnance connection. Rotation testing of SRSS S&As, with only the initiators electrically connected, shall be performed with a 10-foot clear minimum.

(2) If a condition exists whereby the firing circuits must be connected during the rotation test, a safety assessment shall be provided to show that inadvertent ignition of the detonators shall not occur.

(3) For rotations that require the ETA connected (one-time postordnance connection), all personnel shall clear the appropriate Blast Danger Area (BDA), and a remote rotation shall be completed. Safety shall be notified prior to rotation of all S&As. SRB ignition S&As shall not be rotated in the VAB.

(4) S&A rotation during Phase 1 or 2 lightning warnings shall be prohibited.

c. Installation/Removal

(1) Upon S&A removal, the igniter well shall be covered with an appropriate hard cover.

(2) Faraday caps shall remain on EEDs when installing or removing the S&A.

14.2.4.8 ORBITER HATCH T-HANDLE EXPLOSIVES

a. The pyrotechnics activation T-handle enclosure lock shall be available at each landing and Transatlantic Abort Landing (TAL) site and shall be installed as soon as possible after a Forward Assessment Team inspection.

b. The lock shall not be removed during processing until the T-6 hour BDA clear for the start of ET tanking.

c. Removal of the T-handle enclosure lock shall only be per an approved TOP. A pyrotechnic engineer shall control the T-handle enclosure whenever it is unlocked unless the lock is removed and transported to an approved explosive storage facility. The TOP shall provide a line item “OK To Proceed” real-time signature by the pyrotechnic engineer and Safety immediately prior to lock removal.

d. Whenever the T-handle enclosure is unlocked, safety pip pins shall remain installed in the hatch and cabin vent T-handles.

14.2.4.9 SSV EXPLOSIVES INSTALLATION, CONNECTION, VERIFICATION AND SAFEGUARDS

a. SSV hypergolic servicing normally will be accomplished prior to SSV explosives operations (Operations and Maintenance Instruction [OMI] S5009, Part I), thus avoiding the need for SRB power up after ordnance operations. Exceptions for SRB power up will be: ordnance (Part II), instrument reads, and launch countdown (OMI S0007).

b. For those payloads that are installed in the Orbiter prior to rollout and do not require payload bay access at the Pad, SSV hypergolic servicing will be performed prior to SSV explosives operations (OMI S5009, Part I). For SSV flows where payloads are installed in the Orbiter at the Pad, and perform explosives operations in parallel with SSV ordnance operations, SSV hypergolic servicing may be scheduled following OMI S5009, Part I.

c. The following SSV explosives operations and safeguard requirements shall be followed upon completion of OMI S5009, Part I, through launch:

(1) During OMI S5009 Part I, all vehicle and GSE explosives items, except the Range Safety initiators, Range Safety CDF, and the SRM Ignition S&A control cables, shall be connected.

(a) Prior to any explosives connection, functional tests shall be performed on critical Master Events Controller (MEC) PIC circuits.

(b) After completion of the functional tests, the MEC Critical Commands shall be disabled and the SSV and GSE PIC racks shall be powered down.

(c) In parallel with the subsequent pad clear, the active version of TCS sequence VFC81 shall be replaced with a dummy version (Rev. 0) in the C10 console and any hot spare console that is loaded with C10 software. Console dumps shall be performed to verify that VFC81 Rev. 0 is loaded in both consoles.

(d) Power-off stray voltage checks will be performed prior to installing/connecting the explosives

(e) After completion of explosives connection, the SSV and GSE PIC racks will be powered up for PIC resistance tests.

(f) After PIC resistance tests, the SRBs shall be remotely powered down. The MECs shall be powered down after Space Craft Operator (SCO) ingress.

(2) After the SRBs are powered down, the following safeguards shall be in effect:

(a) VFC81 Rev. 0 shall remain loaded at C10 and the hot spare(s).

(b) MEC Critical Commands shall remain disabled.

(c) Ground Operation Aerospace Language (GOAL) programs capable of firing PICs, except SRSS PICs, shall not be activated.

(d) SRB power shall be applied for instrumentation reads only, except in OMI S0024, Prelaunch Propellant Loading; OMI S5009, Part II; and OMI S0007 Launch Countdown. Any other exceptions shall be approved by the Space Program Operations Contractor (SPOC) and the KSC S&MA Launch Vehicle Processing Division.

(3) OMI S5009, Part II, shall be performed in the following sequence:

(a) SSV powered up for the Range Safety Open Loop Test, flight code insertion and the Closed Loop Test.

(b) SRBs, ET, Orbiter, and MEC power removed, power off stray voltage checks performed, and the SRSS NSIs, SRSS CDF, and SRM Ignition S&A control cables connected.

(c) SRM Ignition S&A safing pins removed.

(d) After completion of explosives Part II (S&A hookup), the forward skirts and ET/Intertank (IT) doors will be controlled with safety signs until flight doors are installed.

(e) The BDA shall be cleared and the Orbiter/SRB/GSE PIC resistance tests shall be performed, and all S&As (SRM ignition and SRSS) will be rotated to the armed position, then back to the safe position.

(f) The SRBs will be powered down (remotely), the SCO will ingress, and the MECs will be powered down.

(g) The S&As will be physically inspected to verify that they are in the safe position, then final SRB forward skirts and ET inner tank area closeouts will continue.

(4) After SRB final power down in OMI S5009 Part II, the following safeguard restrictions shall be in effect in addition to those in effect for Part I:

(a) GOAL programs capable of arming or firing SRSS PICs, or arming SRSS or SRM Ignition S&A devices, shall not be activated.

(b) SRSS vehicle power shall remain off.

(5) If OMI S5009, Part III is performed (i.e., all explosives connected during one operation), the same restrictions for Parts I and II shall apply, and OMI S0024 (i.e., SRM power up) shall be performed before OMI S5009, Part III is authorized to start.

(6) During SSV explosives operations, the following clearing requirements shall be in effect:

(a) During explosives installation/connection, nonessential personnel shall be cleared to the Pad fence.

(b) After explosives connection, and prior to the first MEC power up, all personnel, except the SCO, shall be cleared to the Pad fence.

(c) After explosives connection, and prior to the first SRB power up, all personnel shall be cleared from the BDA.

(d) All personnel shall be cleared from the BDA for the PIC resistance tests.

(7) During processing in the Orbiter Processing Facility (OPF) or at the Dryden Flight Research Facility (DFRF), Orbiter power down is not required for pyro interrupt box installation. Orbiter power down is required for disconnection of live drag chute explosives.

(a) For disconnections of live explosives, a hazardous control area shall be established, RF silence and controlled switching shall be in effect, and the OMI shall ensure that PIC circuits are safed by verifying PIC capacitors are discharged.

(b) A Problem Report (PR) shall be written and the Orbiter powered down prior to disconnection of all live explosives encountered, which was expected to be spent (Nose Landing Gear Strut Thruster and Separation Pyros).

(c) Orbiter power down or controlled switching is not required when connections/disconnections are made to pyrotechnic circuits that are shorted or isolated from the Orbiter electrical system.

d. SSV Ordnance Rollback Configuration

If there is a rollback to the VAB after OMI S5009 has been performed, the minimum ordnance configuration shall be as follows:

(1) No vehicle power in the VAB. Ordnance disconnect is not required [ET Vent Arm System (ETVAS) ordnance disconnect required because of physical ET separation from launch pad]. GSE PICs, ground PIC rack circuit breakers open and tagged out. VFC81 Rev. 0 shall remain loaded.

(2) Orbiter power only in the VAB. Ordnance disconnect not required (ETVAS ordnance disconnect required because of physical ET separation from launch pad). MEC 1 and 2 switches open and tagged out. GSE PICs, ground PIC rack circuit breakers open and tagged out. VFC81 Rev. 0 shall remain loaded.

(3) Orbiter and SRB power in the VAB. Orbiter and SRB ordnance disconnect required in accordance with OMI S5009. GSE ordnance disconnect not required (ETVAS ordnance disconnect required because of physical ET separation from launch pad). GSE PICs, ground PIC rack circuit breakers open and tagged out. VFC81 Rev. 0 shall remain loaded.

(4) Ordnance system work required in the VAB. Orbiter, SRB, and GSE ordnance will be disconnected in accordance with OMI S5009.

14.3 PROPELLANT REQUIREMENTS

14.3.1 GENERAL HYPERGOLIC PROPELLANT SYSTEMS OPERATIONS

a. Propellant transfers shall be performed only in Safety-approved areas.

b. Prior to starting, Hypergolic Vent Exhaust System (HVES) shall be operational.

c. Toxic propellant systems shall be drained and flushed or purged to nonhazardous concentration levels prior to opening unless personnel are properly protected.

d. Prior to replacement or storage of components or system repair, hypergolic or toxic system components shall be flushed and purged of all residual propellants and appropriately capped or bagged and labeled prior to movement.

e. Toxic and/or flammable vapor monitoring shall be required during break-in to any propellant system that has been contaminated by propellants and during the handling of contaminated parts. Toxic vapor monitoring shall also be required at the conclusion of any hazardous operation prior to opening of the control area to unprotected personnel.

f. Component parts and tools which have been in contact with the oxidizers/fuels shall be decontaminated or considered contaminated and as such shall be handled and transported with the same level of safety precautions applied to the oxidizers/ fuels.

g. Hypergol Deservicing (OPF-1/2)

In the event of a hypergol propellant release during times personnel are authorized in one bay while performing Orbiter hypergol deservice in the other, the following procedure shall be followed, as appropriate:

(1) In the event of a liquid spill, leak or heavy vapor release, the air conditioning system shall be shut down immediately.

(2) In event of a vapor release or leak in the OPF scrubber or outside GSE system, and the OPF is downwind, the air conditioning system shall be shut down immediately.

14.3.2 - SABD

14.3.3 AUXILIARY POWER UNIT (APU)/HYDRAULIC POWER UNIT (HPU) EXHAUST/DRAIN PLUGS REMOVAL

APU/HPU plug removal shall be as late as possible prior to clearing the control area for test/launch. Toxic Vapor Checks (TVCs) shall be performed during removal. No other checks shall be required prior to test/launch if a zero reading is obtained at the time of plug removal.

a. TVCs of the SRB APU exhaust and drain ports shall be performed upon test completion or launch scrub. Plugs shall be installed prior to opening the control area. When the Rotating Service Structure (RSS) is retracted for test, TVCs and Orbiter exhaust plug installation shall be performed upon completion of the first rotation of the RSS to the Orbiter mate position following the tests.

b. The Orbiter APU exhaust ducts shall be vented outside the Payload Changeout Room (PCR) when the PCR doors are open and plugs are removed. TVCs of the APU exhaust ports shall not be required when the plugs are installed and PCR doors are closed. The Orbiter/SRB APUs shall have TVCs performed daily when the Orbiter/SRB Fuel Supply Modules (FSMs)/APU systems are fueled with N_2H_4 and the exhaust plug is removed.

14.3.4 HYPERGOLIC PROPELLANT SCRUBBER OPERATIONS

a. Scrubber system configuration shall be verified before the power-up of the fuel and oxidizer scrubbers in storage facilities, except in emergency conditions. Restrictions shall be implemented in accordance with Chapter 4 of this KNPR. All scrubber liquor shall be sampled.

b. OPF Hyper Scrubbers

(1) Each scrubber shall be limited to 400 Standard Cubic Feet per Minute (SCFM) flow.

(2) The scrubber shall be running when two aspirators are used simultaneously.

(3) TVCs shall be documented for each backyard entry.

14.3.5 - SABD

14.3.6 Flowing/Venting of Inert/Toxic Gases/Vapors

a. TVCs shall be performed following the flow or venting of toxic fluids or gases.

b. Oxygen level checks shall be performed prior to entry into the Orbiter access white room, all Orbiter compartments, and any other areas if inert gases have been activated or released.

c. Warning signs shall be posted on or in close proximity to all engines being actively purged with an inert gas. Signs need not be attached to the engine but shall be readily visible and worded to alert personnel of the hazard.

14.3.7 ORBITER PROCESSING WITH HYPERGOLICS ONBOARD

14.3.7.1 INTRODUCTION

These requirements delineate specific information, actions, and controls that relate to processing an Orbiter containing Orbital Maneuvering Subsystem/Reaction Control System (OMS/RCS) propellants. These requirements complement current Emergency Procedures Documents (EPDs), which provide emergency actions for routine and major test operations at their respective sites.

The Orbiter is processed through a normal turnaround with residual hypergolic propellants in the OMS and RCS tanks. In addition, propellants are retained in the RCS manifolds, the OMS feedlines, and the OMS pod crossfeed system.

14.3.7.2 SYSTEM CONFIGURATION GROUND RULES MATRIX

a. Dual Isolation: All OMS/RCS systems shall maintain dual valve isolation between tank bulk fluids and ambient air from OPF safing until Pad propellant servicing for launch, except when hardware failures, including component removal and replacement, dictate an alternate configuration or when circumstances are such that single valve isolation better protects the system from possible thruster valve leakage.

b. RCS Thruster Thermal Conditioning: The RCS primary thrusters must be thermally conditioned to prevent thruster valve leakage of propellant.

14.3.7.3 SAFETY CONSIDERATIONS/REQUIREMENTS FOR ARMING THE DRIVER SWITCHES (VAB)

Arming of drivers or removal of switch guards is not allowed.

14.3.7.4 SAFETY CONSIDERATIONS/REQUIREMENTS FOR ARMING THE DRIVER SWITCHES (OPF/PAD)

a. OPF Bay clear or Pad clear above surface, except for two SCOs (in the crew compartment) with emergency breathing devices available.

b. In the event of a thruster activation, emergency exhaust fans will be turned on. The SCO will immediately set all driver switches to OFF. SCOs will remain at their station inside the crew module until directed to evacuate by the Orbiter Test Conductor. (The crew compartment is purged, which should prevent vapor concentrations from intruding.) In the event vapors are

detected in the crew compartment, emergency breathing apparatus should be donned and evacuation expedited.

c. The driver guards shall be installed and locked prior to resuming scheduled work.

14.3.7.5 RCS Trickle Current Testing:

During trickle current testing, a short 12-15 volt driver output pulse of approximately six milliseconds can occur when a driver is turned on with driver power OFF. While there is adequate margin to preclude any primary thruster valve motion, analysis has shown that a negative margin could exist in the worst-case conditions for vernier testing. Procedures are required to preclude personnel exposure if negative margin causes momentary valve motion.

14.3.7.6 SYSTEM MONITORING TASKS

Work areas containing hypergolic propellants shall be monitored periodically for leaks.

14.3.7.7 through 14.3.7.13 - SABD

14.4 - SABD

CHAPTER 15: KSC SUPPLEMENT TO NASA-STD-8719.9, NASA SAFETY STANDARD FOR LIFTING DEVICES AND EQUIPMENT

15.1 through 15.2 - SABD

15.3 HOISTING AND HANDLING

15.3.1 LIFTING / SUSPENSION OF LOADS

a. Loads shall not be lifted, suspended, or transported over flight hardware or one-of-a-kind Ground Support Equipment (GSE), whose loss would have serious programmatic impact, unless the lift is essential to perform a Technical Operating Procedure (TOP) controlled task. Lifting the External Tank (ET) over the Orbiter sling is permitted.

b. Loads shall not be lifted, lowered, or left suspended any longer than necessary to accomplish the task. In the event a problem occurs during a lifting operation that prevents completion of the operation, the load will be safed, to include returning the load to the pre-lift position if necessary. Approved procedures will be used to resolve the problem before the operation resumes.

c. Space Shuttle flight hardware lifting, stacking or mating operations in progress during launch countdown shall be static or soft-mated by L-1 hour. Static conditions for Solid Rocket Motor (SRM) segments shall either be within 5 feet of the transfer aisle floor, or if not soft-mated, the segments shall not engage the clevis or Field Joint Assembly Fixture (FJAF). The forward assembly shall remain static above and shall not engage the forward segment. Static condition for the Orbiter and ET, if not soft-mated, shall be in the transfer aisle.

15.3.2 CRITICAL LIFTS

a. Lifting and movement of flight hardware packaged per its applicable shipment specification shall not be considered a critical lift. The LDEM and affected organizations may designate the handling of specific packaged flight hardware as critical if circumstances dictate.

b. Lifting and movement of flight bulk parts (e.g., fasteners) and raw materials shall not be considered a critical lift except for those items with hazards where loss of containment would result in immediate physical harm to operators or other personnel involved in the operation.

c. A critical lift for a powered industrial truck would be to directly lift unpackaged flight hardware or any other lift designated critical by the LDEM and affected organizations.

d. Transport and lifting of in-process manufacturing products not yet certified or designated as flight hardware shall not be considered a critical lift.

15.3.3 LOAD TESTING

15.3.3.1 Lifting equipment load tests shall not be performed above flight hardware or critical GSE or when failure of the lifting equipment could damage flight hardware or critical GSE unless a risk assessment has been performed with concurrence by the LDEM and appropriate management.

15.3.3.2 Orbiter and Solid Rocket Booster (SRB) Engine Service Platform (ESP) winch load tests should be performed before SRB stacking begins; however, these load tests may be performed at other times based on the following restrictions.

a. When the Orbiter is mated to the External Tank, Orbiter ESP winch load tests may be performed only if the Orbiter ESP is in position and supported by the cobra heads. Orbiter ESP winch load tests may be performed with the SRBs stacked or partially stacked.

b. When the SRBs are stacked or partially stacked, SRB ESP winch load tests may be performed only if the SRB ESP is in position and supported by the cobra heads.

15.3.3.3 CRANES USED FOR LOAD TESTING

a. The KSC list of cranes permitted to be used for load testing other lifting devices is posted at the following website:

http://www-ph.ksc.nasa.gov/sma/KSC_LDE_files/slide0001.htm

b. Primary organizations responsible for design, procurement, operations or maintenance of lifting equipment shall submit requests for changes to the LDEM, with rationale, to the list of cranes used for load testing. The LDEM will approve/disapprove changes to the list. Requests for changes to the list shall state what load testing will be performed and should include the following:

(1) Design standard(s),

(2) Design safety factor(s),

(3) Test history,

(4) Operations history,

(5) Maintenance history, and

(6) Other acceptance rationale to perform the load testing.

15.3.3.4 NON-LOAD TEST SLINGS

a. The KSC List of Non-Load Test Slings (i.e., slings not requiring periodic load tests) is posted at the following website:

http://www-ph.ksc.nasa.gov/sma/KSC_LDE_files/slide0001.htm

b. Program / project or directorate organizations responsible for design, procurement, operations or maintenance of lifting equipment slings shall submit requests for changes to the LDEM, with rationale, to the List of Non-Load Test Slings. The LDEM will approve/disapprove changes to the list. Requests for additions to the list shall state why the periodic load test will not be performed and should include the following:

(1) Design standard(s),

(2) Design safety factor(s),

(3) Rated load versus actual load,

(4) Test history,

(5) Operations history,

(6) Planned future use,

(7) Material / construction properties,

(8) Storage provisions,

(9) Maintenance performed, and

(10) Other information that is acceptance rationale not to perform the periodic load test.

15.3.3.5 For slings (reference NASA-STD-8719.9, Section 10, Slings and Rigging), the periodic load test factor shall be a minimum of 1.0, however may be tested up to a maximum periodic load test factor of 1.25 at the discretion of the responsible engineer.

15.3.4 TRANSIT OF CRANES

a. Prior to any crane move, the route of travel shall be planned and checked to ensure that adequate clearances exist along the selected route and that the route is adequate for the loads being transported.

b. All cranes shall maintain adequate clearance from walls, overhead trestles, columns, and other structures.

15.3.5 Grounding During Hoisting of Flight Hardware

Electrical grounding shall be required, when explosives and/or flammable fluids are involved, per the requirements of Chapter 12 of this KNPR.

15.4 - SABD

CHAPTER 16: SYSTEM SAFETY AND RELIABILITY ENGINEERING REQUIREMENTS

16.1 GENERAL

The system safety and reliability engineering requirements delineated herein are intended for systems and operations directly supporting the performance of KSC's mission. Formal, documented system safety and reliability analyses are required for equipment (i.e., facility systems, Ground Support Equipment [GSE]) that supports the KSC institutional infrastructure and is directly involved in flight hardware processing.

a. Ground systems used at KSC, for which KSC does not have sustaining engineering responsibility, shall meet the applicable system safety and reliability analysis requirements of the NASA Center or Program having sustaining engineering responsibility. KSC shall have the right to review all engineering documentation to assure that risks to KSC personnel and property from such equipment are adequately controlled.

b. Program/project or directorate organizations (and their associated contractors) shall develop documented processes for accomplishing these system safety and reliability engineering requirements on systems and operations for which they have contractual responsibility. All documentation and data shall be available for review by NASA.

c. Program/project or directorate organizations shall ensure their contractors develop and maintain a list of all systems and equipment for which they have contractual system safety and reliability engineering responsibility. This list shall include the type and level of system safety and reliability analysis performed or required to be performed.

d. Systems and equipment designed for use in the Space Shuttle, Space Station, and Launch Support Program (LSP) programs shall meet the system safety and reliability engineering requirements of those programs. It is anticipated that other future programs that are implemented at KSC will also have specific ground system safety and reliability engineering requirements that shall be imposed on NASA KSC-managed development projects.

16.2 - SABD

16.2.1 through 16.2.1.c - SABD

16.2.1.d Analyze ground processing operations, beginning in the system design phase, to identify and mitigate any operational hazards, integration hazards and human factor issues.

16.2.1.e - SABD

16.2.1.f Ensure that valid and verifiable hazard controls are established, implemented, and tracked.

16.2.1.g - SABD

16.2.2 There are several system safety analyses that can be used to identify hazards. They encompass various degrees of specialization, and represent both qualitative and quantitative methods. Example system safety analyses that can be utilized include:

a. Preliminary Hazard Analysis (PHA)

b. Subsystem/System Hazard Analysis (SSHA/SHA)

c. Operating and Support Hazard Analysis (O&SHA)

d. Software Safety Analysis (SSA)

e. Failure Modes and Effects Analysis (FMEA)

f. Fault Tree Analysis (FTA)

g. Probabilistic Risk Assessment (PRA)

h. Lessons Learned

16.2.3 - SABD

CHAPTER 17: LAUNCH AND LANDING OPERATIONS

17.1 FLIGHT HARDWARE ACCESS AFTER PRSD SERVICING

17.1.1 Payload experiments/equipment shall be planned for installation to minimize late stowage requirements during launch countdown.

17.1.2 Experiments/equipment requiring late installation/ early removal at the middeck level may be performed after prelaunch Power Reactant Supply and Distribution (PRSD) servicing and prior to External Tank (ET) Liquid Hydrogen (LH_2) boiloff or postlanding PRSD deservicing upon completion of Orbiter/pad safing operations.

17.1.3 HABITABLE PAYLOAD MODULE ACCESS

a. Science experiments requiring late access to minimize science degradation may be serviced after PRSD cryo load and prior to ET cryo load. Allowable access shall be only via the Orbiter crew compartment.

b. Access to a habitable module via the airlock during postlanding Orbiter Processing Facility (OPF) processing may be allowed EXCEPT during the following:

(1) Orbiter jacking and leveling.

(2) At the start of PRSD controlled venting, when a 25-foot clear is imposed, and during cryo tank offload.

(3) When the Orbiter is powered-down, prior to the establishment of PRSD-controlled venting.

(4) When the control area imposed by other priority hazardous operations would preclude access to the habitable payload module.

c. Initial runway postlanding access via the airlock may be granted after the Safety Assessment Team and the NASA Convoy Commander (NCC) have given a total safety downgrade of the Orbiter, providing:

(1) The Orbiter is powered up, or

(2) Controlled venting via the S70-1214 and the S70-1215, T-0 Cryo Vent Package has been established.

17.2 SCRUB OPERATIONS

17.2.1 During launch scrub securing, the Safety Control Center (SCC) shall verify the following in sequence:

17.2.1.1 For scrubs with no personnel on pad:

a. Hazardous Gas Detection System (HGDS) and LH_2 fire sensors indicate safe.

b. LH_2 in/to stable Replenish, Stopflow, Revert or Terminal Count Safing.

c. Safe to start Liquid Oxygen (LO_2) drain.

d. LO_2 in stable drain.

e. Safe to start LH_2 drain.

f. Safing/securing teams may proceed to BDA.

g. ET LH_2/LO_2 de-tanking is completed, LH_2/LO_2 engine cutoff (ECO) sensors indicate dry and LH_2 leak and fire detectors indicate safe.

17.2.1.2 For scrubs with personnel on pad:

a. HGDS and LH_2 fire sensors indicate safe.

b. LH_2 in/to stable Replenish, Stopflow or Revert.

c. LO_2 in/to stable Replenish, Stopflow or Revert.

d. All explosive devices are safed.

e. Flight crew egress has begun.

f Flight crew is clear of the Blast Danger Area (BDA).

g. Closeout crew has secured the cabin and white room and cleared the BDA.

h. Safe to start ET LO_2 drain.

i. ET LO_2 in stable drain.

j. Safe to start ET LH_2 drain.

k. Safing/securing teams may proceed to BDA.

l. ET LH_2/LO_2 de-tanking is completed, LH_2/LO_2 engine cutoff (ECO) sensors indicate dry, and LH_2 leak and fire detectors indicate safe.

17.2.1.3 For scrubs with only Flight Crew on pad:

a. HGDS and LH_2 fire sensors indicate safe.

b. All explosive devices are safed.

c. LH_2 in/to stable Replenish, Stopflow, Revert or Terminal Count Safing.

d. LO_2 in stable drain.

e. Safe to start ET LH_2 preparations for drain.

f. Closeout crew is proceeding to the white room.

g. White Room O_2 atmosphere is acceptable.

h. Flight crew egress has begun.

i. Flight and closeout crews are clear of the BDA.

j. Safe to start ET LH_2 drain.

k. Securing teams may proceed to BDA.

l. ET LH_2/LO_2 de-tanking is completed, LH_2/LO_2 engine cutoff (ECO) sensors indicate dry, and LH_2 leak and fire detectors indicate safe.

17.2.1.4 Prior to reentry of safing teams:

a. Ground Pyro Initiator Controller (PIC) racks are powered off.

b. BDA roadblocks are maintained.

c. Gaseous Nitrogen (GN_2)/air changeover is completed (HGDS switches from prime to backup).

d. Solid Rocket Boosters (SRBs) are powered off.

e. SRB aft skirt purge is terminated.

f. Mobile Launch Platform (MLP) Oxygen Deficiency Monitoring System (ODMS) indicates safe.

g. Orbiter HGDS (backup system) is active.

h. LH_2/LO_2 transfer line purges initiated.

i. HGDS (backup system) is monitored during boiloff to less than 1percent H_2.

17.2.2 During launch scrub securing, the Post Launch Convoy shall proceed to the pad gate and perform the following tasks in sequence:

a. Enter the pad after notification by the SCC.

b. LH_2/LO_2 storage area inspection and atmosphere H_2 sampling checks.

c. Start the MLP skid inspection and atmosphere H_2 sampling checks.

d. Establish local control area of 150-foot radius of LO_2 and 200-foot radius of LH_2 storage tanks.

e. Start Pad Terminal Connection Room (PTCR)/Environmental Control System (ECS) depressurization, O_2 checks and GN_2 valves lockout.

f. Verify less than 1 percent H_2 in LH_2 Cross-country line and LH_2 Storage Area vaporizers (less than 4 percent in vaporizers only for 24-hour scrub. If a longer scrub is determined, the vaporizers shall be purged/verified less than 1 percent H_2.)

g. Close E road at pad apron and at Perimeter Road if Gaseous Oxygen (GOX) is present in the LO_2 dump basin.

h. Start MLP O_2 checks and depressurization. (Entry to the MLP is prohibited, except for Safety inspection team, until acceptable atmosphere sampling (toxic O_2) checks are performed.)

i. Sound suppression water valve closed and locks installed.

j. Advise SCC when BDA roadblocks may be released.

17.3 TURNAROUND OPERATIONS

Following launch scrub securing, the following requirements shall be adhered to for turnaround operations:

17.3.1 Entry into the pad (slope and above) shall only be for turnaround safing and securing operations.

17.3.2 HGDS and backup system shall remain powered up and monitored until ET H_2 is less than 1 percent.

17.3.3 Following PRSD tank service through scrub/turnaround, except for the white room and crew cabin, the Orbiter mid/aft/fuselage will remain closed until the PRSD tanks are deserviced and Ground Support Equipment (GSE) inerted. Entry into the aft shall only be performed after concurrence of the KSC Launch Director, S&MA Launch Vehicle Processing Division Chief, and the Space Program Operations Contractor (SPOC) Safety, Quality, and Mission Assurance (SQ&MA) Director. Any off-nominal conditions that exist with the vehicle or Pad systems will be evaluated and identified either as a constraint or no constraint to aft entry in the scrub turnaround meeting. The following requirements shall be met prior to and during aft entry.

a. GN_2 purge to the Orbiter has been secured and the manual valves are chained and locked in the ECS room.

b. LO_2 and/or LH_2 TSM ordnance shall be mechanically safed prior to lowering the triple flip platforms for aft access.

c. PRSD T-0 supply line may be pressurized with GH_2 venting or gas supply during aft entry. If work is to be performed within four (4) feet of the aft interior side of the LH_2 T-0 umbilical, a cover must be installed to protect the exposed PRSD GH_2 line, or the PRSD GH_2 system shall be safed by isolating/terminating the GH_2 line pressure source (i.e., secure tank venting and/or terminate T-0 ground reactant gas supply). If access to the T-0 is required, the PRSD system shall be safed.

d. Safety shall verify acceptable O_2 prior to entry and monitor O_2 and H_2 levels during the operation.

e. Personnel shall be attired in safety-approved, flame-retardant coveralls and will be briefed on the hazards of the operation.

f. Only the minimum number of personnel essential to the completion of the task shall be allowed entry into the aft.

g. Only the minimum amount of platforms necessary to safely accomplish the task and allow egress through the 50-1 and/or 50-2 doors shall be installed.

h. The TSM final ordnance and closeout for launch or scrub turnaround safing per Operations and Maintenance Instructions (OMIs) S0007 and V3517/V3518, may be performed after PRSD tank service. TSM access for non-standard work is permitted after PRSD tank service and during ET LH_2 boiloff during launch countdown and scrub turnaround safing. Any off-nominal conditions that exist with the vehicle and Pad systems will be evaluated and identified as either a constraint or no constraint to TSM entry in the Scrub Turnaround Meeting. The following requirements shall be met prior to and during TSM entry:

(1) No LH_2 TSM access is permitted during active ET LH_2 tank venting through the TSM or during LH_2 tank inerting. Access between tank vents is permitted but must be coordinated with Safety and ET LH_2 engineering.

(2) ECS GN_2 purge to the TSMs must be secured and the manual valves must be chained and locked in the ECS room.

(3) TSM bathtub purges must be off. Both the Orbiter/ET disconnect cavity purge and the T-0 umbilical carrier plate purge may be active.

(4) Personnel shall be attired in flame retardant overalls and will be briefed on the hazards of the operation.

(5) Acceptable O_2 levels must be verified prior to entry and O_2 and H_2 levels are continuously monitored by Safety during the operation.

(6) TSM ordnance shall be secured per the appropriate operation in OMIs V3517 and V3518 prior to commencement of any non-standard work within the TSM.

(7) LO_2 and/or LH_2 TSM carrier plate shall be mechanically safed prior to lowering the triple flip platforms

17.3.4 The following facilities/GSE shall remain closed for duration of ET LH_2 boiloff:

a. LH_2/LO_2 TSMs.

b. H_2 disconnect tower.

c. H_2 flare stack area.

d. 50 feet of LH_2 cross-country vent line.

e. North and ECS bridges.

f. LO_2 dump basin.

g. GO_2/GH_2 facility.

h. MLP zero-level between sound suppression pipes and SRB flame hole.

i. Within 10 feet of GH_2 panel on FSS 75-foot level.

j. Within 50 feet of GO_2 and GH_2 facility cross-country lines.

k. For turnarounds involving Space Shuttle Main Engine (SSME) firings, access to LH_2 Tail Service Mast TSM may occur to connect SSME drying purge with Safety concurrence.

17.3.5 The rotation of the Rotating Service Structure (RSS) in a scrub turnaround is normally performed after the completion of ET H_2 boiloff and inert to less than 1.0% H_2. The rotation of the RSS prior to completion of ET H_2 boiloff and inert to less than 1.0% H_2, requires the concurrence of the KSC Launch Director, S&MA Shuttle Division Chief, and the SPOC SQ&MA Director. Any off-nominal conditions that exist with the vehicle of Pad systems will be evaluated and identified either as a constraint or no constraint to RSS rotation in the scrub turnaround meeting. For additional information, see KSC Hazard Report LL-0112, “Early Rotation of the Rotating Service Structure Prior to External Tank boiloff and Inert to Less Than One Percent GH_2.”

The following requirements shall be met prior to the start of RSS rotation preoperations tasks:

a. Ground PIC racks shall be powered ***OFF***.

b. BDA roadblocks shall be maintained, as applicable.

c. The GN_2/air changeover shall be completed (HGDS shall switch from prime to backup).

d. SRBs shall be powered ***OFF***.

e. SRB aft skirt purge shall be terminated.

f. The MLP O_2 ODMS shall indicate ***SAFE***.

g. The Orbiter HGDS (backup system) shall be active.

h. Pad safing/securing teams shall have completed initial pad safing.

i. ET LH_2 boiloff shall be stable.

j. H_2 fire and leak detectors shall be active and monitored.

k. There shall be no H_2/O_2 leaks from the Orbiter, ET or GSE systems. Leaks in the storage facilities shall be evaluated to ensure no impact or safety concern to the RSS rotation operation.

17.3.6 SRB/SSME engine service platforms shall not be installed until boiloff is complete.

17.3.7 PRSD servicing shall be prohibited until ET LH_2 purge and inerting after boiloff is complete and less than 1 percent LH_2 has been verified in the ET LH_2 tank

17.4 POSTLAUNCH OPERATIONS

Following launch, the Postlaunch Convoy shall:

a. Proceed to the BDA upon direction from the Test Director (TD)/SCC.

b. Hold at the BDA until a safe condition is verified at the pad gate.

c. Enter the Pad upon concurrence from the TD and after the SCC has verified that:

(1) The PIC resistance tests are complete and the system is powered down.

(2) The Safety Operational Television (OTV) scan is complete with no anomalies.

(3) The fire/leak detector status is complete with no anomalies.

(4) The LO_2/LH_2 transfer line purges are initiated.

(5) MLP GN_2-to-air changeover is complete.

17.5 ORBITER NOMINAL LANDING

17.5.1 The entire landing facility area shall be under security-controlled access prior to Orbiter approach. The controlled access area is defined as a 5500-foot radius established from the runway centerline down the entire length of the runway. This control area shall be established 3 hours prior to landing until the Orbiter lands and it is verified there are no major hazardous materials spills.

17.5.2 All essential personnel required to be within the 5500-foot radius shall:

a. Have satisfactorily completed emergency escape training for the facility.

b. Have egress capability and communications available to someone who can direct evacuation.

17.5.3 KSC GUEST VIEWING RESTRICTIONS

a. Viewing shall be at the Shuttle Landing Facility (SLF) Midfield Press viewing site. Visitors shall not be permitted at the viewing site during abort landings. The total combined number of guest and press buses shall be limited to 24 at the viewing site. Buses used to transport visitors shall be parked in a manner to provide for evacuation as quickly as possible and visitors shall be separated from convoy and emergency crews/ equipment by fencing.

b. The KSC Center Director or his/her designee shall approve runway access for KSC Senior Management during Orbiter postlanding processing. The Launch Director (LD) or his/her designee shall accompany Senior Management and remain in communication with the NCC. The NCC shall give the LD an OK to proceed to the runway after the following operational requirements are met:

(1) Landing + 45 minutes

(2) Total Downgrade declared by the NCC

17.5.4 The condition of the Orbiter and wind direction shall determine the safety control area, position of the vehicles after Orbiter landing, and the Safety Assessment Team attire. The following shall be the minimum acceptable control areas until the Safety Assessment Team finishes the safety assessment of the Orbiter and the surrounding area:

a. A 1250-foot radius of the Orbiter after wheel stop shall be established and maintained as the safety control area. All vehicles and personnel shall remain at the 1250-foot radius until ingress of required safing vehicles and personnel is allowed.

b. A 200-foot upwind and a 700-foot downwind, control area shall be established for hypergolic release/leak potentials until safety assessments are accomplished.

17.5.5 The Safety Assessment Team shall perform the following in sequence, upon direction from the operating organization:

a. Approach the Orbiter in the Self Contained Atmospheric Protective Ensemble (SCAPE) vehicle, wearing Self-Contained Breathing Apparatus (SCBA):

(1) Upwind Landing: Proceed to a point 200 feet from the nose of the Orbiter, deploy the Assessment Team, and return to the rear of the mini-convoy. The Safety Assessment Team shall take continuous vapor readings and proceed to approximately 50 feet from the Orbiter and hold until advised by the operating organization.

(2) Downwind Landing (or winds less than 3 knots): Proceed to a point 700 feet from the Orbiter as directed by the operating organization. Deploy the Safety Assessment Team and return to the rear of the mini-convoy. The Safety Assessment Team shall take continuous vapor readings and proceed to 50 feet from the Orbiter and hold until advised by the operating organization.

b. Start the assessment, proceed towards the Orbiter taking continuous readings.

(1) If readings are acceptable, proceed with the forward and aft assessments as outlined in the applicable TOP.

(2) If the initial readings exceed Orbiter postlanding GH_2 requirements (per Table K-1) then fallback and proceed to personnel evacuations as outlined in section 17.5.11 of Chapter 18.

(3) While performing the forward and aft assessments, checks shall be made for gas or fluid leaks, fire, hot wheels/brakes, and tire damage, staying outside the danger areas outlined in section 17.5.11 of Chapter 18.

(4) Any anomalies found during any part of the safety assessment shall be immediately reported to the operating organization.

c. After the forward assessment is completed and acceptable, the vehicles required for safing and crew egress may move into position to perform their assigned tasks at the direction of NCC, Safety, and the operating organization. Any critical entry requirement, beyond the required vehicles, shall require approval by NCC, NASA Safety, and the operating organization.

d. After the aft ground-level safety assessment downgrade is given, then the remaining safing vehicles may move within 50 feet aft of the Orbiter. Umbilical access vehicles shall not be positioned at the Orbiter until after Auxiliary Power Unite (APU) shutdown.

e. Upon connection of T-0 panels and HGDS Quick Disconnects (QDs), Safety shall monitor for GH_2 content in the aft, payload, and mid-fuselage ports.

f. After the forward and aft ground level assessment is complete and acceptable, essential payload and/or flight crew systems personnel and vehicles may move into position as approved by NCC, Safety, and the operating organization.

g. Upon acceptable reading of payload bay HGDS hydrogen sampling and following the Payload Bay 10-minute purge, support vehicles may move into the control area with approval from NCC and Safety.

h. If mission-returned cargo contains hydrazine, monitor vent doors numbers 8 and 9 after purge has been initiated.

i. Continue to monitor toxic vapor sensing instruments and general area of Orbiter during postlanding inspection and tow operation.

j. Personal Protective Equipment (PPE) downgrade shall take place only after toxic and explosive atmospheric checks are within acceptable limits

k. A 25-foot radial control area shall be maintained around the T-0 S70-1214/1215 prior to initiating controlled PRSD venting.

H_2 CONCEN-TRATIONS	VENT DOOR #3 READING (NOTE 6)	INITIAL HAZ GAS READING (NOTE 5)	FIRST 10 MINUTE MONITOR	AFTER 10 MINUTE MONITOR
Over 1% (NOTE 2)	• Reposition vent doors • Power down Orbiter • Evacuate Flight Crew • Evacuate all personnel • Assess quantities and leakage for reassessment • Try to initiate purge • Monitor Vent Door #3 until repositioned	• Power down Orbiter • Evacuate Flight Crew • Evacuate all personnel • Try to initiate purge • Take another Haz Gas reading	• Power down Orbiter • Evacuate Flight Crew • Evacuate all personnel • Maintain purge • Take another Haz Gas reading	• Power down Orbiter • Evacuate Flight Crew • Evacuate all personnel • Maintain purge • Take another Haz Gas reading
Trace 1% (NOTE 2)			• Essential ops (NOTE 4) • Maintain Orbiter power • Maintain purge • Continuous monitor (NOTE 1)	• Essential ops (NOTE 4) • Maintain Orbiter power • Maintain purge • Continuous monitor (NOTE 1)
0%	Controlled ops (NOTE 3)	Controlled ops (NOTE 3)	Controlled ops (NOTE 3)	Controlled ops (NOTE 3)

TABLE K-1: ORBITER POSTLANDING GH2 REQUIREMENTS

Table K-1 Notes:

(1) Spikes are expected; you should expect a downward trend within five minutes of initiating purge (should be below one percent H_2 within 15 minutes of initiating purge).

(2) Meter Readings: (All readings above baseline zero percent Lower Explosive Level (LEL) shall be reported.)

(a) Trace: A meter reading of at least 10 percent LEL for 30 seconds.

(b) Over 1 percent: A meter reading of at least 25 percent LEL for 30 seconds.

(3) Controlled Operations: Definition as currently stated in landing OMI.

(4) Essential Operations: To maintain purge, cooling, Orbiter power, and flight crew egress only.

(5) Initiate purge after initial Haz Gas reading or within 30 minutes of upper aft downgrade, whichever occurs first. Without Haz Gas readings, initiate purge and monitor vent door No. 9. If reading is less than trace after five minutes, open upper aft left and right for controlled operations per landing OMI. Monitor vent door No. 9 until Haz Gas reading is available.

(6) If vent door No. 3 reading is 1 percent or less, it is acceptable to use the white room vehicle to evacuate the flight crew, provided ground level hydrogen at hatch area is also 1 percent or less.

17.5.6 When Orbiter power-down is required after the safety assessment, the S70-1214/1215 PRSD vent panels shall be installed.

17.5.7 Personnel shall remain clear of Main Landing Gear (MLG) for a minimum of 45 minutes after landing. The restricted area shall be bounded by 20-foot radius circles around MLG struts and 60-foot radius, 45-degree sectors whose apexes shall be at center of wheels. The centerline shall be projected from wheel axles. Strobe lights shall be placed 60 feet from the Orbiter MLG (both sides). Strobes shall be activated after ground level downgrade is completed and acceptable and shall be turned off 45 minutes after wheel stop.

17.5.8 Personnel shall remain clear of restricted area around the Orbiter side hatch until the Convoy Commander receives confirmation of hatch safe. Restricted area is a 15-foot by 100-foot corridor projected out from the side hatch.

17.5.9 Mission-returned cargo containing hydrazine and/or nitrogen tetroxide shall be checked at Orbiter left and right hand vent doors No. 3 for toxic and explosive vapor readings. If acceptable readings are exceeded, SCAPE is required to continue safing operations. Acceptable readings are 0 to 1 ppm for fuel and 0 to 20 ppm for oxidizer. If hydrazine readings exceed 180 ppm, the following shall be implemented:

a. Crew performs an expedited power-down.

b. Mode V aided egress.

c. Evacuate all personnel to 1250 feet of the Orbiter.

d. Upon the direction of NCC and Safety, attempt to establish purge.

17.5.10 If the drag chute fails to deploy during rollout, personnel and vehicles shall stay clear of drag chute deployment area (10 degrees left to 47 degrees right of Orbiter centerline and 100 feet aft) until pyrotechnic circuits are verified safed. Confirm circuit breaker in crew compartment is verified open.

17.5.11 PERSONNEL CLEARS FOR POSTLANDING OPERATIONS

a. In coordination with the operating organization and the Convoy Commander, all personnel, including flight crew, shall be cleared to a minimum of 1250 feet from the Orbiter area when explosive/flammability readings are above the maximum allowable concentrations.

b. All personnel shall be cleared 200 feet upwind and 700 feet downwind of the Orbiter when hypergolic Threshold Limit Value (TLV) readings are above the allowable limits (unless personnel attired in SCAPE).

c. After clearing all personnel, the operating organization shall wait a minimum of 10 minutes and activate the fan machine (if not already activated) before directing the assessment team to approach the Orbiter (upwind) for additional assessments. If this assessment also exceeds the TLV limits, but less than the explosive limits, then further operations shall be conducted in SCAPE.

CHAPTER 19: INTERNATIONAL SPACE STATION-SPECIFIC REQUIREMENTS

In an effort to generalize the requirements presented in this KNPR, it became necessary to remove certain International Space Station (ISS)-Specific Requirements from the main body of this KNPR to utilize this document in the planning process for Constellation. However, these items could not simply be deleted from the document since the requirements still apply to ISS.

Section 13.8.3, below, was moved to this chapter. The previous chapters of the KNPR contain requirements applicable to the entire Kennedy Space Center (KSC) (including ISS); in cases where ISS-specific requirements were relocated to this chapter, a note appears in the text stating:

"International Space Station-Specific Requirements for this section are contained in Chapter 19."

Within Chapter 19 , each section of the main KNPR is represented. Sections in which there were no changes read "SABD" (Same as Basic Document). Section 13.8.3 contains ISS-specific requirements, and the requirements presented supersede requirements presented in the main body of the document FOR ISS OPERATIONS ONLY.

In this case, 13.8.3 is the only section that contains ISS-specific requirements, so this chapter contains notation indicating that the portion of the document before and after this section is SABD. For example, **"Preface through 13.8.2 - SABD,"** indicates that the entire document from Preface through 13.8.2 contains no ISS-specific requirements and that the requirements for that section are available in the main body of the KNPR. These SABD requirements apply to ALL programs and operations at KSC, including ISS.

Preface through 13.8.2 - SABD

13.8.3 FLIGHT VEHICLE VESSELS AND SYSTEMS

Pressure vessels and systems that have been pressurized to operating pressure as complete systems prior to delivery to KSC shall require further testing as part of the receiving inspection/ acceptance activity. Retest shall be performed only as specified in approved Technical Operating Procedure (TOP).

a. Flight Vehicle Fracture Critical Vessels and Systems

(1) Space Shuttle Program/International Space Station (SSP/ISS) Pressure vessels that are controlled as fracture critical shall be tested/pressurized to levels specified in the appropriate Fracture Mechanics Plan and JSC 08934, "Shuttle Operational Data Book," Volume I, "Shuttle Systems Performance and Constraints Data."

(2) Pressure vessels and systems shall be processed through turnaround flow at temperature adjusted operating pressures, only if the operating pressures are sufficiently below the threshold pressures to avoid sub-critical flaw growth. The MAWP shall be specified in the applicable operating procedure.

(3) Fracture critical controlled vessels/systems shall be pressurized to operating pressures, using specified liquids/gases, without remote controls, only if the vessels/systems have been previously pressurized to operating pressure levels.

(4) A logbook shall be maintained on each Fracture Mechanics controlled pressure vessel/system processed at KSC. The log shall identify how many times the vessel/system has been pressurized, the pressure levels, liquids/gases used, duration of the pressure cycles, and any other pertinent data. The log shall also identify the total number of cycles for which the vessel/system was designed.

(5) A logbook shall be maintained for each PVS processed at KSC. The log shall identify how many times the vessel/system has been pressurized, the pressurization levels, fluids used, duration of the pressure cycles, and any other pertinent data. The log shall also identify the design criteria used in fabricating the vessel/system.

b. Flight Vehicle Non-Fracture Critical Vessels and Systems

(1) PVS shall not be pressurized above 50 percent of design burst pressure, adjusted for temperature.

(2) PVS shall be processed through turnaround flow at pressure levels not to exceed 50 percent of design burst pressure, adjusted for temperature, if warranted by operational considerations.

(3) PVS that have not been tested as a system prior to delivery to KSC shall require personnel evacuation and remote controls for the initial (first-time) pressurization and for any subsequent pressurization that will exceed the highest level of pressure reached during previous testing as a system.

(4) PVS shall be pressurized using fluids specified in JSC 08934, “Shuttle Operational Data Book,” Volume I, “Shuttle Systems Performance and Constraints Data.” Pressurization levels specified herein shall not exceed those specified in JSC 08934, Volume I.

13.8.4 through Chapter 17 - SABD

CHAPTER 20: NASA KSC PAYLOAD & CARGO GROUND SAFETY REQUIREMENTS

a. As the Space Shuttle Program (SSP) nears completion, it has become necessary to separate Shuttle/ISS-Specific Requirements from the main body of this KNPR so that this document may be used in the planning of future documents. To bridge the gap between Shuttle/ISS and future programs while still providing KSC Safety Practices Procedural Requirements required through the completion of these programs, Kennedy Handbook (KHB) 1700.7, Space Shuttle Payload Ground Safety Handbook, has been included as this chapter of KNPR 8715.3.

b. The requirements presented in this chapter shall ONLY be applicable to the following groups:

(1) All organizations processing SSP/International Space Station Program (ISSP) payloads or experiments in those areas under the jurisdiction of the Kennedy Space Center. This includes all government organizations (e.g., NASA, DOD, other domestic, or foreign government or alliance organizations) and independent foreign or domestic enterprises.

(2) Contractors in direct support of the above organizations.

(3) Other organizations or agencies providing direct personnel and equipment interface to payload or payload GSE support.

(4) Any of the above organizations required to support SSP/ISSP payload post-landing operations at any landing site.

c. If disagreement exists between the requirements of this chapter and those present in the other chapters of this KNPR, the requirements in this chapter shall supersede those requirements ONLY as applicable to the aforementioned groups.

d. The purpose of this chapter is to present the SSP/ISSP payload ground safety procedures and the criteria applicable to payload/GSE design and to ground processing from arrival to liftoff and during post landing activities to qualify SSP/ISSP payloads and associated GSE for safety certification by the payload organization to the Launch Site Safety Office (LSSO).

e. NASA policy is to achieve a consistent level of safety by applying reasonable criteria, giving the SSP payload or the International Space Station Program (ISSP) and ground support equipment (GSE) designer, operator, processor, and user the requirements to develop effective, efficient ground processing procedures usable at all SSP/ISSP and cargo processing locations. The requirements to assure payload mission success are the responsibility of the payload organization and are not within the scope of this document.

f. This chapter establishes the minimum NASA ground processing safety procedures, criteria, and requirements for SSP/ISSP payloads and associated payload organization provided GSE. It provides the detailed safety requirements for ground operations and payload/GSE design not contained in NSTS 1700.7B "Safety Policy and Requirements for Payloads Using the Space Transportation System," the NSTS 1700.7B ISS Addendum, “Safety Policy and Requirements for Payloads Using the Space Station,” and SSP 50021, “Flight Safety Requirements.”

g. This document does not apply to facility GSE, non-SSP/ISSP program elements, or flight safety. Additionally, this chapter does not apply to equipment under the jurisdiction of SSP 50004, “Ground Support Design Requirements” and the ISSP Support Equipment Control Board

nor to equipment under the control of the KSC Checkout, Assembly and Payload Processing Services (CAPPS) Contractor. Specific implementation of design requirements is sometimes omitted to allow the payload organization flexibility in developing payload/GSE design. The payload organization's implementation of design requirements shall be coordinated with the LSSO.

20.1 RESPONSIBILITIES

The KSC Director has been assigned overall authority for safety for all SSP/ISSP payload activities conducted at KSC.

a. The Director of Safety and Mission Assurance is responsible for implementing the safety policy and criteria for SSP/ISSP payload activities.

b. Delegation

(1) The LSSO is the designated office responsible to the Director of S&MA for implementation of these requirements.

(2) The Launch Site Safety Representative (LSSR) is the designated representative of the LSSO and has been delegated the following authorities:

(a) Monitors LSSO-selected operations and has safety approval authority for procedural deviations.

(b) Gives concurrence to start these selected operations.

(c) May halt any operation deemed unsafe.

20.2 PHASE SAFETY REVIEWS

a. The payload organization personnel are responsible for the safety of their own systems and personnel. They are also responsible to the SSP/ISSP operator and the launch site operator not to compromise the safety of the other SSP/ISSP payloads, the Orbiter, launch site facilities, and personnel.

NOTE 1: To implement this safety effort, the NASA programs conduct phase safety reviews as implemented by NSTS 13830C, “Payload Safety Review and Data Submittal Requirements,” and SSP 30599, “Safety Review Process.” These procedures provide for an early safety interface to be established between the payload organization and the launch site.

NOTE 2: The phase safety reviews are conducted by a team of representatives from many different backgrounds to provide a broad spectrum of knowledge on the subject of safety. It is their task to advise payload organizations on matters of system safety. Included in this team are representatives of the processing sites. It is their task, in addition to the above, to verify that the payload and its support equipment comply with the requirements of this document.

NOTE 3: NASA normally conducts flight safety reviews for the payload at JSC and a separate ground safety review on ground operations and GSE design at KSC. They may, however, be held concurrently at either site or at a site jointly agreed on by JSC and KSC. These reviews provide for the delivery of safety documentation required by the launch site prior to delivery of

the payload to that site. This documentation is further discussed in section 20.3 of this document. In the past, some payload organizations have not fully understood the extent of these data requirements, and this has created problems. The procedures explained and outlined in this text preclude these problems and bring about a smooth transition from the factory to the launch site, through the launch and, if applicable, through recovery.

b. The documentation requirements of this document and the phase safety reviews shall be based upon the hazardous nature and degree of complexity of the payload systems.

c. When flight payload safety reviews and ground payload reviews are separate reviews, an assessment shall be made by the payload organization to assure hazards identified in each package are assessed for applicability to the other

EXAMPLE: If a ground safety hazard report on inadvertent thruster firing does not exist, the flight safety hazard report must be referenced in the ground safety package and it must contain a discussion of the applicability of the flight safety controls on ground safety.

20.3 DOCUMENTATION

20.3.1 Phase Safety Review Documentation

a. The payload organization shall demonstrate to the LSSO that hazards not eliminated by design exist for valid technical reasons and are not for operational convenience or cost savings.

NOTE: These hazards can cause operational restrictions that could limit personnel numbers, require a specific sequence of operations, or limit operations to specific facilities.

b. The LSSO shall communicate to the payload organization the rationale for any restrictions imposed as early as possible and shall assist the payload organization in determining the course of action which can best serve operational efficiency.

c. The payload organization shall, in accordance with NSTS 13830C or SSP 30599, provide the Ground Safety Review Panel (GSRP) the following data consistent with the program phase:

(1) Block diagrams, schematics, and descriptions of safety-critical subsystems, which includes tables of design and operating parameters for such items as lifting equipment, pressure systems, propellants, tanks, ordnance, and batteries.

(2) Launch site processing plan including timelines for handling, storage, assembly, servicing, and checkout operations.

(3) List of Technical Operating Procedures (TOPs), a synopsis of each procedure, and their preliminary classifications (i.e., hazardous or nonhazardous).

(4) Documentation certifying compliance with ionizing and non-ionizing radiation control requirements.

NOTE: This includes such items as Radio Frequency (RF) personnel hazards and RF susceptibility of Electro-Explosive Devices (EEDs).

(5) Hazard reports addressing both design and operations.

(6) Failure/accident summary reports.

(7) Copies of all noncompliance reports.

(8) Ordnance storage and handling data requirements in accordance with paragraph 20.6.5.7.

(9) A list of all hazardous materials and physical agents. Material Safety Data Sheets (MSDS) as required by the Code of Federal Regulations (CFR 1910.1200) shall be provided to the Launch Site Support Engineer (LSSE) for all materials or agents brought to the ER by the payload organization.

(10) A list of all Plastic Films, Foams, and Adhesives (PFAs) quantity, and location of use.

(11) List of the payload T-0 Umbilical functions.

(12) Critical software commands shall be identified and managed. These critical software commands include commands which, if executed or executed out of sequence, would create a hazardous condition or would remove a safety inhibit.

(13) A Mechanical Damage Control Plan (MDCP) for any Graphite/Epoxy (Gr/Ep) Composite Overwrapped Pressure Vessels (COPVs).

20.3.2 Post Phase III Approval Changes

Changes or modifications which affect any approved phase safety review or launch site documentation shall be provided to the LSSO for review and re-approval.

20.3.3 Launch Site Documentation

20.3.3.1 Payload Organization Launch Site Safety Plan

a. The payload organization Launch Site Safety Plan shall demonstrate the means by which the organization manages and interfaces safety within its organization and how it applies the launch site safety requirements.

b. For NASA and NASA-sponsored payloads, the specifics of the plan contents shall be identified to the payload organization early in the phase safety review process.

c. All plans shall be tailored to the complexity of the payload element and be provided to the LSSO for review and approval at least 30 days prior to first hardware delivery to the launch site.

20.3.3.2 Payload Safety Noncompliance Reports

a. The payload organization shall comply with all the requirements of this chapter or obtain an approved waiver/deviation for each case of inability to comply with a specific safety requirement.

b. Waiver/Deviation requests shall be submitted to the GSRP for evaluation.

c. Payload organizations shall be formally notified of the disposition of the waiver/deviation request.

(1) Each waiver request shall be limited to a specific subsystem or component in a specific application.

(2) The payload organization is responsible for correcting the waived condition prior to the reflight of the payload on another Space Shuttle mission or the flight of subsequent payloads of the same series. If the waived condition is not corrected, a new waiver request is required. The new request shall contain additional rationale, justifying continued noncompliance, and a copy of the original waiver shall be attached.

(3) Waiver requests shall be submitted as soon as the need is identified. Prior to submittal, all waiver requests shall be coordinated with the appropriate governmental sponsor and submitted to the LSSO. The waiver request shall contain the following:

(a) Payload name and the model of the payload or support equipment as applicable.

(b) Specific component and the subsystem in which the component functions shall be identified.

(c) Specific requirement (one per waiver) and document and paragraph number against which the waiver is being sought.

(d) Hazard created by noncompliance to this requirement and a cross-reference to the related hazard report. (The related hazard report shall reference the waiver.)

(e) Reason for noncompliance to this requirement.

(f) Rationale for acceptance of this waiver, including any required support data and drawings, and list possible methods and techniques used in mitigating the hazards.

(g) Waiver request shall be signed by the program manager of the payload organization.

(4) When a deviation is granted, the noncompliance condition may be approved for more than one mission. Deviations shall be applicable where the associated hazard to the Space Shuttle is not affected by manifesting with other SSP/ISSP payloads, location of the payload in the Orbiter, or mission-unique environmental conditions.

NOTE: Noncompliance reports to be considered for a deviation will be those where the design, procedure, configuration, etc., do not comply with the safety requirement in the exact manner specified, but the intent of the requirement has been satisfied and a comparable or higher degree of safety is achieved.

20.3.3.3 Technical Operating Procedures (TOPs)

a. In order to be accomplished in a safe and orderly manner, payload ground operations shall be conducted using detailed step-by-step instructions in TOPs, which are established in Chapter 9 of this KNPR.

NOTE: The Safety Community applies the generic term, Technical Operating Procedures (TOPs), to all test or operations procedures. The term "TOPs" only implies that the procedure must meet minimum content and processing standards. In practice, procedures will carry the nomenclature of the system under which they are developed such as Operations and

Maintenance Instructions (OMIs) of the Operations and Maintenance Documentation (OMD) system, test procedures (TPs) of the Universal Documentation System (UDS)/Air Force Satellite Control Facility (AFSCF) Support Documentation Guide or Detailed Operations Procedures (DOP) for Inertial Upper Stage (IUS) procedures. The host organization prescribes the system to be used.

b. All TOPs designated hazardous by the LSSO or by the payload organization are required to be approved by the LSSO and published 10 calendar days prior to use (7 days prior to use for revisions).

NOTE: Draft or preliminary procedures should be submitted to the LSSO when available.

c. Where procedures are used to control hazards identified in the hazard reports, a listing of those procedures and the applicable step numbers which control the hazard shall be identified in the Phase III data package.

NOTE: Hazardous classification of procedures is provided in paragraph 20.4.3.

20.4 OPERATIONAL CONSIDERATIONS

20.4.1 Failure Tolerance

a. The interaction of payload, GSE, launch site facilities and operator monitoring/intervention shall tolerate a minimum number of credible failures and/or operator errors as determined by the hazard level analyses.

b. When the technical requirements do not provide for failure tolerance, the adequacy of the controls shall be determined during the safety review process.

NOTE: This applies when failure to perform a function or the inadvertent performance of a function results in a hazardous event. The requirements contained in this section are intended to provide the proper failure tolerance for GSE when used alone or in conjunction with a payload and/or facility. Verification of compliance with the technical requirements of this document will normally demonstrate the intent of this paragraph.

20.4.2 Personnel Policies

a. Payload organizations shall provide a description of their Training/Certification Program to the LSSO as part of the payload organization Launch Site Safety Plan.

b. This program shall specify the personnel training required and the certification procedures employed to establish acceptable skill levels for all personnel involved in the ground processing of SSP/ISSP payloads and GSE.

c. Ground processing shall be performed only by persons certified in the discipline required for that process.

20.4.2.1 Training

a. Safety and health inputs to training programs shall be tailored to the task categories involved and included in lesson plans and examinations.

b. Safety training of operating personnel shall be the responsibility of the payload organization.

c. The payload organization shall meet the applicable facility and operating site requirements.

NOTE: It should be noted that there are certain launch site safety training requirements which are necessary in the process of obtaining area badging permits.

d. Safety training shall include the following:

(1) Hazard types, recognition, causes, and effects.

(2) Prevention and control measures.

(3) Safe operating procedures.

(4) Checklists.

(5) Safeguards and safety devices.

(6) Personal protective equipment (PPE).

(7) Monitoring and warning devices.

(8) Emergency and contingency procedures.

20.4.2.2 Certification

The payload organization shall provide a list, to the LSSO prior to commencement of hazardous operations, of all personnel authorized to participate in hazardous operations; certifying each individual's training and qualification by system to perform a specific hazardous operation.

20.4.2.3 Physical Examination

a. Personnel performing selected hazardous operations shall have up-to-date physical examinations which meet the requirements of the cognizant medical office.

NOTE: Examples of personnel who require these examinations include ordnance workers, crane operators, propellant handlers, Propellant Handlers Ensemble (PHE) operators, and personnel working with certain types of ionizing and non-ionizing radiation.

b. The individual examination records shall be furnished to cognizant medical office.

NOTE: The requirements necessary to satisfy this examination may be obtained from the cognizant medical office.

20.4.2.4 Safety Enforcement

a. The payload organization shall describe the means by which occupational and operational safety requirements of the launch site and this chapter are enforced in the Launch Site Safety Plan (LSSP) (see section 20.3.3.1).

b. The LSSP shall address how violations of safety requirements are handled within the organization and what measures will be taken to preclude further violations.

20.4.3 Hazardous Operations

a. A ground processing activity shall be classified as hazardous based on the following considerations:

(1) Energy is involved and loss of control could result in injury to personnel or damage to equipment.

(2) A significant change from ambient condition will occur; e.g., increase or decrease of oxygen content, pressure, or temperature.

(3) Presence of hazardous materials or physical agents which presents potential exposure to personnel.

b. The LSSR shall be notified of all hazardous or LSSO-designated procedures at least 24 hours prior to their performance.

c. Concurrent hazardous operations within the same hazard control area shall require the approval of the LSSR or LSSO.

20.4.4 Safety Inspection

a. LSSR and payload organizations shall perform joint systematic safety inspections of the facility, working environment, related GSE, and any work in progress which could cause accidental injury to personnel or damage to hardware.

b. Primary emphasis shall include payload/GSE, critical processing equipment, facility maintenance status and associated equipment locations, and facility ingress/egress provisions and routing.

c. Discrepancies identified from any of the inspections shall be corrected by the appropriate organization prior to conducting hazardous operations or bringing hazardous materials into the area.

d. These safety inspections shall be performed on payload processing facilities at the following minimum times:

(1) Prior to payload/GSE installation in the facility.

(2) Immediately after installation of payload/GSE.

(3) Immediately before the start of LSSO selected hazardous operations.

(4) After any facility or equipment modification which may affect hazard potential.

20.4.5 Safety Equipment

a. The payload organization shall ensure that personnel protection is provided when engineering controls alone are not adequate to provide sufficient employee protection.

b. Payload processing activities which are considered normal to general industry shall be in compliance with the requirements of accepted industrial safety practices.

c. The payload organization shall review, with the LSSO and health officials, those operations not specifically identified which might require PPE.

d. The LSSO and Health Officials shall approve all PPE.

20.4.6 Tools

Tools shall be handled per the requirements in section 5.3 of this KNPR.

20.4.7 Photography

a. The use of photographic lighting equipment (e.g., flashbulbs, strobe lights, and photofloods) shall be restricted within 100 feet of the Orbiter/payload whenever they are loaded with any propellant, within 100 feet of a propellant storage tank, and within 10 feet of exposed solid propellants.

b. Photo equipment used above a payload shall be tethered and the light sources shielded to prevent debris from falling onto the payload.

c. The payload organization shall obtain LSSO approval to use photographic equipment in these and other hazardous atmosphere locations.

20.5 PERSONNEL SAFETY

The payload organization shall ensure a safe and healthful working environment through good design, effective training, and appropriate PPE.

20.5.1 Human Factors

Potential hazards resulting from the human interface shall be addressed by the payload organization during the Phase Review Process.

20.5.2 Human Error

a. Controls shall be instituted to prevent a hazardous condition which may result from human error (e.g., mismating a connector, throwing the wrong switch, misreading a gauge, etc.).

b. Controls shall be instituted via design rather than procedural control where feasible.

c. All equipment controls shall be labeled.

20.5.3 Noise

a. The payload organization shall implement a hearing conservation program to provide hearing protection for any noise levels of 85 decibels A-scale (dBA) or greater, regardless of the length of exposure.

b. Where noise levels occur on intervals of 1 second or less, they shall be considered continuous.

c. If such controls fail to reduce sound levels to below 85 dBA, PPE shall be provided and used.

d. Exposure to impulsive or impact noise shall not exceed 140 decibels (dB).

20.5.4 Hazardous Materials

The payload organization shall assure through design/procedural controls that payload/ground processing GSE and operations will not expose personnel to hazardous materials in excess of the limits specified by the cognizant health officials.

20.5.5 Physical

a. Accidental contact with sharp surfaces or protrusions shall be prevented by the use of ductile materials, energy absorbing devices, shields, rounded corners, and flush-mounted features.

NOTE: Sharp surfaces or protrusions include edges, crevices, points, burrs, wire ends, screw heads, corners, brackets, rivets, braided cable, cable swages, cable strands, clamps, pins, latches, lap joints, bolt ends, lock nuts, etc., which if contacted, could injure operating personnel.

b. Hazards shall not be created by the inaccessibility of flight or ground hardware.

c. Physical access for safety critical operations or maintenance functions shall be provided.

d. Protrusions which create a hazard (e.g., hoses, wave guides, cables, brackets, etc.) which cannot be eliminated by design shall be made to be removable during service or maintenance functions.

e. Moving parts (e.g., fans, belt drives, turbine wheels, and similar components) that could cause personnel injury or equipment damage due to inadvertent contact or entrapment of floating objects shall be provided with guards or other protective devices.

f. Wherever possible, equipment requiring adjustment during its operation shall have external adjustment provisions and provide electrical shock protection when applicable.

g. GSE shall be designed to minimize the requirement for operations and maintenance personnel to wear protective clothing during normal operations and maintenance.

h. Valves, gauges, levers, bolts, nuts, and any other item required to be moved, turned, manipulated, or monitored by personnel in protective equipment shall be sized to facilitate operation.

i. Suitable provisions to prevent damaging the protective equipment and to prevent personnel fatigue and discomfort shall be included in the GSE design.

NOTE: Such items should be located to optimize access to the item while the operator is in a standing position. Sufficient clearance should be provided to preclude brushing against other surfaces.

j. All GSE designs shall include a center-of-gravity analysis to ensure that the GSE/flight hardware does not tip, fall, slide, or allow for any type of sudden load shift.

20.5.6 Temperature

a. The payload organization shall protect personnel from equipment which generates high or low temperatures greater than 45 degrees Centigrade (C) (113 degrees Fahrenheit) or less than 0 degrees C (32 degrees Fahrenheit).

b. This equipment shall be shielded, insulated, isolated, and/or oriented away from personnel and labeled to warn them of the danger.

20.6 PAYLOADS AND GROUND SUPPORT EQUIPMENT (GSE)

20.6.1 Biomedical Subsystems

The payload operator shall provide complete handling procedures for all hazardous biomedical subsystems.

NOTE: Hazardous biomedical subsystems consist of medical experiment equipment designed to obtain data on man's adaptation and performance in the space environment. They also consist of scientific equipment designed to obtain experimental data on the effects of space environments on microorganisms, plants, and animal life.

20.6.2 Electrical

All electrical equipment shall meet the requirements of this section to preclude hazardous conditions.

20.6.2.1 Electrical Requirements

a. Electrical connectors shall be designed to make it physically impossible to inadvertently reverse a connection or mate the wrong connectors if a hazardous condition can be created.

b. Connectors for energized circuits shall be of "scoop-proof" design so a partial inadvertent mismate will not provide temporary, undesirable pin-to-pin contact.

c. Electrical equipment shall not cause ignition of adjacent materials.

NOTE: The requirements for explosion/hazard proofing at the launch site are identified in paragraphs 20.7.2.3 and 20.7.2.4.

d. Malfunction of the payload or GSE circuitry shall not induce overload into the Orbiter, GSE, or facility electrical systems.

e. Electrical equipment shall be designed to provide personnel protection from accidental contact with alternating current (AC) voltages in excess of 30 volts root mean square (rms) or 50 volts direct current (DC) or any lower voltage that could cause injury.

f. Construction of the payload and electrical GSE shall assure all conductive external parts and surfaces are at ground potential at all times.

g. Cables extending across work areas shall be protected against damage from personnel activity or equipment use.

h. Switches/controls which can create hazardous conditions if inadvertently operated shall be guarded, shielded, or otherwise protected against inadvertent switching.

i. Electrical fuse and switch boxes shall be labeled on the outside or inside cover to show the voltage present, rated fuse capacity, and equipment that the circuit controls.

j. Non-bypassable interlocks shall be used to prevent possible shock whenever a voltage in excess of 500 volts is exposed upon opening an access door, cover, or plate.

k. All electrical GSE shall meet the requirements of the "National Electrical Code (NEC), National Fire Protection Association 70 (NFPA 70)."

l. Dead-end wires shall be completely insulated.

m. Three-phase power sequencing shall be verified in each KSC processing facility prior to connection.

n. Battery charging/conditioning shall be accomplished in the battery laboratories unless approval is granted from the LSSO to accomplish the charging elsewhere.

o. Battery charging equipment shall be continuously monitored by personnel.

p. Charging/conditioning performed in hazardous locations shall comply with paragraph 20.7.2.

NOTE: The payload organization should consider incorporating voltage and current limiters, fuses, diodes, and temperature and pressure monitors in the charging/conditioning electrical GSE.

q. The payload shall be assessed to determine if the loss of power during any phase of ground processing is a hazard to personnel or equipment. If so, an alternate or backup power source may be required.

20.6.2.2 Grounding, Bonding, and Shielding

a. The design, construction, and installation of equipment shall be such that all external parts, surfaces, and shields are at ground potential at all times.

b. Grounding and bonding schemes shall ensure proper interfacing between equipment and facility.

c. Power cords on GSE shall provide a non-current carrying ground conductor unless the unit is double insulated.

d. Grounding/bonding connections of GSE shall be designed to minimize the possibility of inadvertent disconnection.

e. Solder shall not be used for external connections.

f. Threaded fasteners shall use lock washers.

g. GSE external bonding straps and jumpers shall be capable of carrying the maximum expected fault current.

NOTE: Additional grounding requirements for ordnance and propellant operations are included in the applicable sections.

20.6.2.3 Electrical Maintenance Operations

Maintenance operations on energized electrical circuits are normally prohibited. Maintenance operations shall be performed in accordance with accepted industrial practice. In addition, the following shall be included:

a. Any accessible capacitor circuitry which presents a hazard to personnel shall be discharged prior to performing maintenance.

b. Protective equipment such as nonconducting fuse pullers, rubber gloves, nonconductive matting, etc., shall be used when working on energized circuits which could cause personal injury.

c. Procedures for tagging and lockout of control switches and circuit breakers shall be provided.

d. All grounds shall be verified to be intact.

e. Worn, abraded, or defective insulating material shall be repaired or replaced.

f. Only fuses of proper voltage and current ratings shall be used in circuits. No other material shall be used in place of a fuse.

20.6.2.4 Electrical Control of Hazardous Functions

a. Where electrical GSE is used to control a potentially hazardous function, it shall be designed to be failure tolerant.

b. Acceptable failure tolerance shall be determined by the LSSO during the safety review process.

c. Where feasible, failure tolerance shall be implemented through design control rather than procedural control.

NOTE: Design control can be implemented by eliminating the potential hazard (e.g., the current-limiting features in EED bridgewire checkers), providing a fail safe design (e.g., current-

limiting fuses) or requiring multiple component failures and/or operator actions prior to a hazardous event occurring.

20.6.2.5 Energized Electrical Equipment

a. Energized equipment shall be manned or connected to the manned facility emergency power shut-off system.

b. The electrical equipment shall be powered down during non-working hours.

c. All electrical equipment located outside a hazardous processing area shall be inhibited from supplying power to electrical equipment located within the hazardous processing area during non-working hours.

d. Electrical equipment that must remain energized for hazardous operations (e.g., maintaining spacecraft thruster solenoid valves in an opened or closed state) shall be equipped with an uninterrupted power source such as a battery backup.

e. Battery charging operations shall occur in an approved charging facility.

f. Battery charging requirements for batteries that cannot be removed from flight hardware shall be assessed on a case-by-case basis.

20.6.3 Pressure/Vacuum Systems

Pressurized systems contain fluids above atmospheric pressure. Vacuum systems contain fluids below atmospheric pressure. Pressure system elements include tanks, accumulators, lines (e.g., piping, tubes, and hoses), fittings, gauges, filters, valves, regulators, and other components.

20.6.3.1 Pressure System Requirements

a. Flight pressure systems shall meet the requirements of NSTS 1700.7B, Chapter 2, Technical Requirements.

b. The following requirements shall be met by both flight and ground pressure systems:

(1) To preclude personnel injury, provisions shall be made for accomplishing remotely controlled pressurization of the flight pressure system.

NOTE: Exception to this requirement is when the conditions of paragraph 20.6.3.6.a do not apply or when the payload operator provides a certification statement of system pressure testing to the LSSO in accordance with paragraph 20.6.3.6.b.

NOTE: Normally, remote pressurization of GSE is not required.

(2) Regulator failure shall not create a hazard to personnel or equipment during ground processing.

(3) All items, including gauges, which come in contact with the service fluid, shall be of compatible material.

(4) All pressure system connectors shall be selected to make it physically impossible to mix fluid media if a hazardous condition can be created by mixing two fluids.

EXAMPLE: Fuels and oxidizers or GN_2 and GHe in an LH_2 system.

20.6.3.2 GSE Containing Pressure Systems

GSE containing pressure systems shall meet the following requirements:

a. Pressure vessels used in GSE systems shall meet the design, test, labeling, marking (it is desired but not necessary to have the pressure vessel code stamped), and operating requirements as specified in "American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes," Section VIII, Unfired Pressure Vessels, Division I or Division II, as applicable.

b. If the pressure test is based on a level less than the pressure vessel maximum allowable working pressure (MAWP), the vessel shall be derated to maximum operating pressure (MOP).

c. Pressure vessels shall be registered with the National Board of Boiler and Pressure Vessel Inspectors, or the user shall maintain the design drawings and design and stress calculations for the life of the vessel.

d. GSE pressure systems hardware other than pressure vessels shall be marked as follows:

(1) Pressure system lines (where the function of the line is not immediately apparent) shall be labeled with the MOP, fluid content, and direction of flow.

NOTE: Labeling and, if used, color coding should be in accordance with KSC-STD-SF-0004B, “Safety Standard for Ground Piping Systems Color Coding and Identification.”

(2) Other system components shall be labeled with their manufacturer's name and part number, serial number (if applicable), pressure rating, and direction of flow.

e. Pressure systems components (excluding pressure vessels) shall have a design burst pressure (D.B.) of at least 4 times the MOP of the system (low carbon stainless steels shall have a D.B. of 4.5 times MOP)

NOTE: Pressure systems components (excluding pressure vessels) should conform to either MIL-STD-1522A, "Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems," or JSC SW-E-0002, "Space Shuttle Ground Support Equipment General Design Requirements."

f. Components shall be pressure tested at 1.5 times MOP unless otherwise approved by the LSSO.

g. Regulators shall be selected so that their working pressure falls within the center 50 percent of their total pressure range if susceptible to inaccuracies or creep.

h. Flight and GSE components downstream of a GSE regulator shall be designed to safely operate under full upstream pressure.

NOTE: Open-ended purge systems may be protected by flow restriction orifice devices.

i. If the requirements of section 20.6.3.2.h cannot be met, relief devices shall be provided in accordance with ASME/ANSI codes, and at a minimum shall be provided as follows:

(1) Downstream of last GSE regulator prior to flight hardware interface.

(2) GSE pressure vessels.

(3) Downstream of regulators where upstream pressure exceeds downstream design operating pressure.

(4) Container purge systems using metal tubing or flexhose.

(5) Container purge systems using plastic tubing when the failure of the tube provides sufficient margin of safety to the downstream equipment.

(6) All relief devices shall be relief valves when pressure exceeds 149 psig.

j. Set pressures shall comply with the following:

(1) Pressure relief valves shall be set to relieve at a pressure not to exceed the MAWP of the vessel or the design pressure of the system involved (including flight systems).

(2) The set limits shall be specified in the Operation and Maintenance Requirements and Specifications Document (OMRSD) or other operating and maintenance documents.

(3) The set pressure of relief valves shall always be sufficiently higher than the operating pressure to ensure that the valves will reclose above the operating pressure.

NOTE: See ASME Code, Section VIII, Division 1, paragraph UG-134, and Appendix M, paragraph M-11, and ANSI/ASME B31.3, paragraph 322.6.3.

k. Required relieving capacity shall be determined as follows:

(1) For pressure vessels, the required relieving capacity shall be determined in accordance with the ASME Code, Section VIII, Division 1, paragraph UG-133, or Division 2, paragraph AR-150.

(2) For piping/tubing systems, the required relieving capacity shall be equal to or greater than the maximum flow capability of the upstream regulator or pressure source and shall prevent the pressure from rising above the limits specified in ANSI B31.3.

NOTE: See ASME Code, Section VIII, Division 1, paragraph UG-133, and Division 2, paragraph AR-150, and ANSI/ASME B31.3, paragraphs 301.2 and 322.6.3.

l. Relief devices shall be located so other components such as shut-off valves cannot render them inoperative.

m. Relief devices and their associated discharge plumbing shall be adequately supported such that their discharge impulse will not cause structural failure.

n. Pressure relief for toxic liquids and/or vapors shall be designed and located so that gases and liquids or vapors will not enter any inhabited areas.

o. Pressure relief for inert gases shall not be discharged into a confined, occupied area where oxygen content could be lowered below acceptable limits.

p. Pressure reliefs for high pressure gases and liquids shall be located such that the discharge will not endanger personnel.

q. Pressure systems shall be equipped with gauges as follows:

(1) Downstream of each regulator.

(2) On any storage system.

(3) On any section of the system where pressure trapped by isolation valves creates a hazard.

r. All pressure gauges shall comply with the following requirements:

(1) Gauges shall be selected so that the operating pressure is not more than 75 percent of the highest graduation.

(2) Pressure gauges shall be of one piece, solid front construction and shall have an optically clear shatterproof window.

NOTE: Gauges should be designed for bolted flush front panel mounting.

(3) Gauges shall have blowout backs to allow unrestricted venting in the event the gauge sensing element ruptures.

(4) All items which come in contact with the service fluid shall be constructed of compatible material. Use of material other than 316SS requires LSSO approval. Bourdon-tube bleed screws may be of any 300SS.

(5) A due date calibration sticker shall be affixed to gauges used for safety-critical monitoring.

(6) Gauges shall be equipped with a bourdon-tube bleeder or equivalent device to facilitate cleaning.

s. All GSE using flexhoses with pressures above 150 psig shall be designed to provide attachments for flexhose restraining devices.

t. Isolation valves shall be designed to permit flow or isolation in both directions at the valve's MAWP.

u. Pressure systems shall be designed so pressure cannot be trapped in any part of the system without bleed capability.

v. Manually operated valves and regulators shall be selected so over-torquing the valve stem or regulator adjustment cannot damage soft seats to the extent seat failure occurs. Designs using uncontained seats are unacceptable.

w. Pressure system elements which are not intended to be reversible shall be designed or marked such that they cannot be connected in a reverse mode.

x. Lines, relief devices, and other pressure system elements shall be routed and/or located to provide for the protection of other systems and personnel.

y. Control stations shall have adequate instrumentation to allow personnel to monitor pressure levels and confirm initiated actions have occurred.

z. Control stations shall be designed so the operator does not have to leave the station to monitor hazard levels.

aa. Systems shall have shut-off valves located as close to the supply vessel as practicable.

bb. Check valves shall be provided where backflow of fluids would create a hazard.

20.6.3.3 Vacuum Systems

See paragraph 20.6.3.7.

20.6.3.4 Flexible Hoses

Flexible hoses consist of an inner liner tube of teflon or other material (compatible with the service fluid) reinforced by layers of wire and/or fabric braid or wrap.

NOTE: Use of flex hoses should be minimized.

Requirements for flexible hoses are as follows:

(1) Connection, disconnection, installation, inspection, maintenance, and testing shall be accomplished in accordance with the manufacturer's specifications and recommendations unless otherwise specified in this document.

(2) Flexible hoses shall be installed so they do not carry any external mechanical load and are not subjected to tension, torsion, or overheating.

(3) All flexible hoses shall have a design burst pressure equal to or greater than 4 times the MAWP.

(4) All flexible hoses pressurized to 150.0 psig (10.34 bars) or greater shall be contained or restrained.

(5) Hose restraint shall be accomplished using a chain or cable securely anchored to a substantial object and to the hose assembly at the following points:

(a) Hose end connector;

(b) Each union or hose splice; and

(c) Intervals not to exceed 6 feet (1.83 meters).

(6) Hose restraint devices and attachment methods shall be approved by the LSSO.

(7) The payload organization shall establish criteria and obtain LSSO approval for periods of inspection and retest. Time in service, type of service, and pressure are factors for determining need of pressure test.

(8) LSSO approval shall be obtained prior to performing pressure testing at the launch site.

(9) All flexible hoses shall be inspected prior to use.

(10) Flexible hoses which show signs of physical damage shall be replaced.

(11) Flexible hose assemblies shall be pressure tested to 1.5 times their MAWP.

(12) GSE flexible hoses shall be identified and marked.

(13) Each flexible hose assembly shall have a metal tag(s) attached which bears the following information:

(a) Date of proof test (month and year).

(b) Dedicated fluid service; e.g., fuels, oxidizers, hydraulics.

(c) MAWP.

(d) Identifier (manufacturer/part number).

(14) After each pressure test recertification, the old tag(s) shall be removed and new ones attached.

20.6.3.5 GSE Hydraulic Systems

(1) GSE hydraulic systems shall comply with MIL-STD-1522A and the requirements herein.

(2) Hoses shall be in accordance with MIL-H-25579, "Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure," Class 1, or "Society of Automotive Engineers (SAE) Standards,"

(3) Hoses shall be suitably protected against chafing where necessary to prevent damage to the hose or adjoining structure, tubing, wiring, and other equipment.

NOTE: Systems over 3,000 psi will be handled on a case-by-case basis.

(4) Only system compatible lubricants shall be used on threaded fluid line connections.

(5) Pressurized reservoirs shall have the pressure controlled by a pressure regulator.

(6) Pressurized reservoirs shall have an air-space relief valve to protect from excessive pressure.

(7) Reservoirs shall be provided with a fluid level indicator.

(8) The suction head of all pumps shall be maintained between the limits recommended by the pump manufacturer.

(9) Pump pulsations shall not adversely affect system tubing, components, and supports and shall not cause damage or improper operation of the equipment on flight systems.

(10) The system shall not cause damage to critical systems due to reduced flow, such as that caused by single pump operation of a multipump system, or increased flow, such as that caused by accumulator operations.

20.6.3.6 Pressure System Operations

a. The following flight and ground support system pressurization operations shall be accomplished remotely (e.g., locate control station behind a blast shield) unless otherwise approved by the LSSO:

(1) The first time a flight system is pressurized above 25 percent of the design burst at the launch site.

NOTE: This pressure is designated the "initial pressurization level."

(2) Any flight system pressurization above the initial pressurization level

NOTE: This latter pressurization becomes the new initial pressurization level.

(3) Any pressurization above MOP/MAWP.

(4) Any pressurization of a system that has suspect integrity.

b. It shall be permissible to conduct flight and ground support system pressurization operations without the use of remote operation if the payload organization provides documentation certifying the following:

(1) The assembled system has been pressure tested at a pressure which is at least 1.5 times the system MOP unless otherwise approved by the LSSO.

NOTE: Flight systems may be pressure tested at the component level if welds will be x-rayed after assembly.

(2) The assembled system has been functionally leak tested at a pressure equal to or greater than MOP.

(3) The system log book shall track system handling/movement in addition to pressurizations, maintenance, etc.

(4) System configuration has not been modified or repaired subsequent to the above testing.

NOTE: Unwelded relief or sensing devices may be replaced after system pressure testing but not after system leak testing, in accordance with item 20.6.3.6.m, below.

(5) A procedure has been written which:

(a) Requires inspection of the system upon arrival at the launch site for damage sustained during transportation and handling.

(b) Requires a check of the pressure system log book to verify that activity after the pressure test and leak test did not affect the integrity of the system.

(6) Procedure name and number, step numbers and test which require the inspection, and any additional inspection criteria shall be provided to the LSSO.

c. Personnel shall be allowed in the immediate proximity of pressure systems only when pressure does not exceed the system MOP.

d. System integrity shall not be broken on pressurized systems without first depressurizing to 10 psig or less.

e. Depressurization shall be accomplished only using components designed for the purpose.

NOTE: Backing off of line fittings to depressurize when pressures exceed 10 psig is permitted if the trapped volume does not exceed 1.5 cubic inches.

f. Tightening of line fittings under pressure shall be prohibited.

g. Systems shall not be pressurized or depressurized at rates which present unsafe situations, such as heat rise to auto-ignition.

h. These rates shall be identified in the applicable operating procedure.

i. Pressure system bolts and fittings shall not be torqued while the component is under pressure.

j. Relief valves shall be inspected, reset, tested, and labeled annually.

k. Pressure gauges shall be inspected and calibrated annually and a due date label applied where used in safety critical systems.

l. All nonhydraulic pressure systems shall be leak tested with an inert medium at MOP at the launch site prior to using propellants or hazardous gases.

m. Any time a component is modified, repaired, or replaced, it shall be pressure tested to 1.5 times MOP at the component level. If the component is welded into the system, the welds shall also be pressure tested at 1.5 times MOP. The reassembled system shall again be leak tested at MOP using an inert medium.

20.6.3.7 Vacuum Systems and Requirements

Negative pressure protection shall be provided for systems not designed to withstand pressure below one atmosphere.

EXAMPLE: This can be accomplished by the use of check valves or ambient automatic pressure valves.

NOTE: Vacuum systems should be designed to T.O. 00-25-223, "Integrated Pressure Systems and Components (Portable and Installed)."

20.6.3.8 Design, Test, and Ground Processing of Payloads/Elements/Cargo Containing Graphite/Epoxy (Gr/EP) COPVs

Payload organizations shall comply with the safety requirements for the design, test, and ground processing of payloads/elements/cargo containing graphite/epoxy (Gr/Ep) COPVs are established within Chapter 13.18 of this KNPR.

20.6.4 Radiation

a. Sources of ionizing and non-ionizing radiation shall be adequately controlled during all phases of ground, launch, and post-launch operations to assure the protection of personnel, facilities, and equipment, and the compliance with applicable federal, state, and NASA/DOD regulations and requirements.

NOTE: Such sources include radioactive materials, radiation-producing equipment (e.g., x-ray devices, particle accelerators, radio frequency/microwave emitters, etc.), lasers, and optical emitters (e.g., ultraviolet, infrared, and high intensity visible light sources).

b. All payload organizations shall be responsible for compliance with the applicable launch site requirements as stated in their approved Radiation Use Authorization.

20.6.5 Ordnance

20.6.5.1 Electroexplosive Device (EED) Categories

a. EEDs are categorized at ER based on the effects of inadvertent initiation. EED classifications are as follows:

(1) Category A: Category A electroexplosive devices are those which, 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.

(2) Category B: Category B electroexplosive devices are those which will not, in themselves, or by initiating a chain of events, cause injury to people or damage to property.

b. A device shall be assigned Category A prior to installation whenever test data to the contrary is not available.

NOTE: 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 LSSO. Conversely, a device assigned Category B prior to installation may require upgrading to Category A after installation.

c. The payload organization shall categorize all EEDs for both the pre- and post-installation situations and be able to provide the LSSO with supporting data for each categorization.

20.6.5.2 General Ordnance Requirements

All ordnance systems shall comply with the requirements of NSTS 1700.7B and the following:

a. All ordnance and solid propellant motors shall be handled and stored in accordance with the requirements of their hazard classification and storage compatibility grouping.

b. Items which have not previously been classified shall be tested in accordance with TB700-2/NAVSEAINST 8020.8B/T.O. 11A-1-47/DLAR 8220.1, Department of Defense Ammunition and Explosives Hazards Classifications Procedures, and classified accordingly.

c. NSS 1740.12, “Safety Standard for Explosives, Propellants, and Pyrotechnics,” and AFMAN 91-201,"Explosive Safety Standards," shall be used for guidance for storage, handling, and transportation of ordnance and propellants.

NOTE: See paragraph 20.6.5.7 for ordnance storage and handling data requirements.

d. All Category A ordnance circuits shall be capable of being physically disconnected between the ordnance device and the power source as close to the ordnance item as possible.

e. Category A ordnance and associated circuitry shall be accessible in the Orbiter to facilitate electrical checkout and connection as late as possible prior to launch.

f. All ordnance device installations at the launch site shall be in an ordnance sited or licensed facility.

g. For Category A EEDs, electrical connections shall be made in the Orbiter unless otherwise approved by the LSSO.

h. Prior to electrical connection of Category A EEDs, a DC power-on and power-off no-voltage check shall be made.

i. The power-off no-voltage check shall be performed immediately before the connection.

NOTE: Receipt of installed or early installation and connection of Category B EEDs may be accomplished with the LSSO approval, provided the connection of these devices does not restrict interface verification tasks.

20.6.5.3 Safe and Arm (S&A) Devices

a. Transition from the SAFE to the ARM position shall require 90 degrees of rotation of the mechanical barrier.

b. The S&A device shall not be capable of propagating the ordnance train with the barrier rotated less than 50 degrees from the SAFE position.

c. The visual and remote SAFE position shall not be indicated unless the device is less than 10 degrees from the normal SAFE position.

d. Firing circuits of S&A devices shall be electrically connected after payload installation in the Orbiter.

NOTE: S&A devices without a direct interface with the Orbiter may be electrically connected after final ordnance electrical system checks and power is removed from the system.

e. The S&A safing pin shall remain installed until final closeout of the payload bay.

f. S&A Rotation Tests

(1) Rotation of S&A devices during ground test and processing shall be done with the Explosive Transfer Assembly (ETA) disconnected from the S&A or at the point of ETA terminus.

(2) All rotation tests of S&As shall be completed before firing circuits are electrically connected.

(3) If the firing circuits are required to be connected during a rotation test, a safety assessment shall be provided to show that inadvertent ignition of the detonators will not cause a hazardous condition.

(4) All rotations shall require LSSO approval.

20.6.5.4 Ordnance Operations

a. Ordnance shall be processed only in those areas approved by the LSSO.

b. Solid/liquid propellants designated for one payload shall not share an operating location with items designated for another payload except for payload integration activities.

c. Test equipment used to check component and circuit operation shall be of a type that limits energy input and be approved by the LSSO.

NOTE: See paragraph 20.6.5.6 for additional test equipment requirements.

d. Electrical continuity and resistance checks of ordnance circuitry shall be performed using only in-calibration test equipment approved by the LSSO.

e. All ordnance deliveries to the launch site shall be coordinated with the LSSO.

f. All ordnance deliveries from storage to the payload organization shall be coordinated with the LSSR.

g. Electromagnetic Interference (EMI) testing shall not be conducted with live EEDs installed without approval of the LSSO.

h. Materials susceptible to the generation, collection, and holding of static electrical charges shall be selected from the LSSO-approved list.

i. Disposal of surplus or defective ordnance items shall be coordinated by the LSSO.

j. Disposition of surplus or defective ordnance items shall be determined jointly by the LSSO and the payload organization.

k. Based upon the RF and EED susceptibility, installation, removal, and electrical connection/disconnection may require RF silence. Local RF silence and no-switching periods shall be required.

l. The periods of RF silence shall be requested by the payload organization and shall be identified by an LSSO-approved TOP.

m. Grounding/bonding is required to ensure that electro-static charges cannot build up to levels which can cause ignition of ordnance items.

n. EED faraday caps shall be required during storage, handling, and after mechanical installation.

o. EED faraday caps shall not be removed until electrical connections are to be made.

p. All personnel within the hazard control area during ordnance operations shall wear nonstatic-producing, flame-retardant coveralls.

q. Persons performing ordnance work shall wear approved grounding devices.

20.6.5.5 Ordnance Marking

a. Live ordnance and associated flight items (e.g., arm plugs) shall be the natural body color of the device.

b. Nonflight items shall be color-coded.

c. The color-coding scheme shall be submitted to the LSSO as part of the ground safety data package.

20.6.5.6 Ordnance Test Equipment

a. Requests for approval for use of ordnance electrical test equipment used for testing explosive ordnance items or circuits connected to these items prior to or after installation shall be submitted to the LSSO.

b. The payload organization shall provide the model number, engineering drawings and specifications, and the system safety analysis of the test equipment.

c. Approval by the LSSO shall be by manufacturer model number and requires a valid calibration seal for use at the launch site.

20.6.5.6.1 EED Bridgewire Resistance Measurement Meters

a. The meter shall be designed such that maximum available applied current does not exceed 10 percent of the no-fire current of the EED or 50 mA, whichever is less.

b. It shall be designed so that in a worst case (multiple) failure condition, the available applied current cannot exceed the no-fire current of the EED.

NOTE: The optimum resistor location is adjacent to the output leads and inaccessible. Other locations are also acceptable, if it can be shown that by-passing the resistor is not credible.

c. Current-limiting resistors in the test leads, to meet the above requirements, are unacceptable.

d. Meter leads shall be shielded.

e. Connector shell-to-shell contact shall precede pin-to-pin contact.

f. Calibration shall be at least annually.

g. Calibration procedures shall verify the safe configuration

EXAMPLE: The proper voltage battery with the encapsulated current-limiting resistor installed.

20.6.5.6.2 No-Voltage Meters

a. No-voltage meters shall be designed to detect one-tenth of the no-fire level of the EED or 50 mV, whichever is less, at a pulse width of 1 millisecond.

b. The use of computerized no-voltage meters is acceptable if proper current-limiting can be demonstrated.

20.6.5.7 Ordnance Storage and Handling Data Requirements

a. The following data is required for all ordnance items:

(1) Payload Organization

(2) Item Identification/Name

(3) Item Manufacturer

(4) DOD Hazard Classification (Q.D. Class/Division)

(5) DOD/UN Storage Compatibility Group

(6) DOT Classification

(7) DOT Markings

(8) Explosive Weight (Per Item)

(9) Gross Weight (Including Container)

(10) Gross Weight (Less Container)

(11) Storage Container Dimensions (L x W x H)

(12) Hook Height Required

(13) Quantity Per Container

(14) Quantity to be Stored

(15) Environmental Controls (Temp/RH Requirements)

(16) Point of Contact (POC) - Name/Phone

b. This data shall be submitted in the Payload Organization's safety data package.

20.6.6 Mechanical, Electromechanical Devices

a. Mechanical or electromechanical devices used for such purposes as structure deployment or actuating release mechanisms shall be evaluated to establish whether in the event of inadvertent activation damage to equipment or injury to personnel could occur.

b. If it is determined inadvertent activation is either critical or catastrophic, then the device shall be failure tolerant in accordance with paragraph 20.4.1.

c. These devices shall be identified in the operational hazards analysis with the requirement for caution and warning notations incorporated in the TOPs (see paragraph 20.3.3.3).

20.6.7 Propellants

20.6.7.1 Propellant System Requirements

a. Materials selected for use in propellant systems shall be compatible with propellants used.

NOTE 1: This should include compatibility under operating pressure, shock, vibration, and temperature loadings and include analysis of items such as stress corrosion.

NOTE 2: Refer to Johns Hopkins University, Chemical Propulsion Information Agency (CPIA) Publication Number 394, Chemical Rocket/Propellant Hazards, Volume III, for specific propellant properties.

b. Propellants shall be separated so malfunction of either the oxidizer or fuel subsystems cannot cause mixing.

c. Incompatible system connections shall be keyed or sized so it is physically impossible to interconnect them.

d. For systems requiring nonmetallic materials, materials selected shall not result in hazardous reactions.

e. For systems requiring insulation or acoustic damping, nonabsorbent, nonflammable materials shall be used in compartments or spaces where fluids and/or vapors could invade the area.

20.6.7.2 Propellant Systems GSE Requirements

a. A positive means of shutting off propellant flow from tanks shall be provided.

b. The means for shutting off propellant flow shall be readily accessible.

c. The actuator for remotely controlled valves shall be capable of opening and closing the valve under design flow and pressure.

d. Throttle capability shall be considered in the selection of remotely controlled valves.

NOTE: Ball and gate valves should not be used.

e. Remotely controlled valves shall provide for remote monitoring of open and closed positions.

f. Normally open or closed valves shall have a spring on the actuator capable of operating the valve to the fail-safe position without an external actuating force under system operating conditions.

g. Manually operated valves shall be capable of being opened or closed under full system pressure.

h. Balanced manual valves that utilize external balancing ports or vents open to the atmosphere shall not be used.

i. The payload organization shall describe their plans for controlling a propellant leak throughout the ground processing timeline up to, and including, installation into the Orbiter payload bay.

j. Provisions shall be made so propellants cannot be trapped in any part of the system without provisions for draining.

k. Hypergol equipment (e.g., valves, quick disconnects) shall be designed to be compatible with and operated by personnel wearing PHE gloves.

l. Hazardous fluid vent system requirements are as follows:

(1) Pressure relief vents for hazardous fluids shall be designed and located so vapors will not enter any inhabited areas.

(2) Venting of toxic fluids shall be through a scrubber or neutralizing agent or by similar methods which would prevent unauthorized release.

(3) 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.

(4) Incompatible fluids shall not be discharged into the same vent or drain system.

(5) Fuel or toxic fluid vent systems shall be equipped with a means of purging the system with an inert gas to prevent explosive mixtures and/or to maintain system cleanliness.

(6) Vents shall be placed in a location normally inaccessible to personnel and at a height or location where venting will not normally be deposited into habitable spaces.

(7) Vents shall be conspicuously identified using appropriate warning signs, labels, and markings approved by the LSSO.

(8) Vent systems shall be sized to provide minimum back pressures consistent with required venting flow rates.

(9) Back pressures shall not interfere with proper operation of relief devices.

m. Serviceable hypergolic components, such as quick disconnects, filters, hoses, valves, etc., shall be permanently marked by electroetch, metal impression stamp, or other permanent method to indicate the specific hypergolic fluid to which the component will be exposed.

n. Items used in any fuel or oxidizer system shall not be interchanged after exposure to the respective media.

o. Lubricants for hypergolic systems shall be restricted to Krytox 240AC or equivalent.

p. Use of a lubricant other than Krytox 240AC shall be approved by the LSSO.

q. Hypergolic propellant pumps shall be specifically designed for the particular hypergolic fluid.

r. All components, including flow meters, used in hypergolic propellant systems shall be designed and qualified for hypergolic applications.

s. Flanged connections shall utilize the following types of flanges: slip-on, weldneck, lapped joint, or blind.

t. Bonding straps shall be used across flanged connections.

u. Materials used in contact with fuels, oxidizers, or combustible gases shall be selected, tested, and certified in accordance with the requirements of NASA-STD-6001, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion.

v. All controls and adjustments shall be identified by component number, system function, and direction of operation.

w. The direction of fluid flow shall be clearly indicated with permanent markings on the exterior of each component.

x. All calibration adjustments, locked or unlocked, shall be designed so the setting, position, or adjustment cannot be altered when the equipment is subjected to the service condition.

y. Sight glasses used for liquid level indicators shall be protected from physical damage.

z. The payload organization shall maintain records of the design, maintenance, checkout, and usage of GSE systems used at the launch sites.

aa. Records shall be available to the LSSO.

bb. Check valves (one-way flow) shall be provided whenever a hazardous/contaminated substance can backflow into another system.

cc. Liquid shall not be able to be trapped between valves if changes in ambient temperature can result in pressure rises above 110 percent of MOP.

dd. If the potential for pressure rises above 110 percent of MOP exists, automatic relieving is required.

20.6.7.3 Propellant Systems Operations

a. New, modified, and/or repaired propellant storage or transfer systems shall be validated by functional test prior to being certified for operational use.

b. The following shall be required as part of the certification procedure:

(1) A leak test at MOP with an inert gas shall be performed.

(2) Pressure control units shall be verified by use of certified, calibrated gauges.

(3) Emergency shutdown systems and procedures shall be demonstrated using a referee fluid.

(4) Proper operation of quick disconnects shall be demonstrated.

c. Simultaneous operations with hypergolic propellants shall be prohibited.

d. The payload and the propellant loading system shall be commonly grounded and bonded during propellant transfer operations.

e. Prior to opening a toxic propellant system, it shall be drained and flushed or purged to concentration levels approved by the LSSO.

f. Prior to replacement or storage of components or system repair, hypergolic or toxic system components shall be flushed and purged of all residual elements and appropriately capped or bagged and labeled prior to movement.

g. Disposal of propellants shall be coordinated with the LSSO.

h. Venting of toxic vapors to atmosphere shall only be done with LSSO approval.

i. Procedures shall contain emergency instructions developed by the payload organization to handle leaks and spills.

j. Procedures shall be consistent with CPIA #394, Volume III.

k. Propellant transfers shall be performed only in areas and at times approved by the LSSO.

l. Personnel shall be limited to those needed in direct support of propellant transfer operations.

m. PPE which provides full respiratory protection and body coverage shall be worn during any dynamic payload and/or GSE toxic propellant transfer operations, or whenever the toxic propellants are not in a sealed system.

n. At all other times that toxic propellants are present, emergency escape breathing devices shall be available for all personnel.

o. Full respiratory protection and body coverage is mandatory for the following:

(1) Any connection/disconnection of a propellant transfer system if it contains toxic propellants.

(2) Any connection/disconnection of a propellant transfer system that had contained toxic propellants and concentration levels have not been verified to be below safe concentration levels.

(3) All toxic propellant sampling operations.

(4) Any servicing/deservicing/internal circulation (dynamic flow) of toxic propellants until system integrity has been verified (i.e., no leakage is present).

(5) Any application of pressure to the toxic propellant transfer system until a stabilization period of 15 minutes minimum has been achieved and system integrity has been verified.

p. All PPE shall be compatible with the toxic propellants involved.

q. All PPE use shall be approved by the LSSO and the appropriate Bioenvironmental Engineering/Spaceport Services Office.

r. Toxic vapor monitoring shall be required during break-in to any propellant system which has been contaminated by propellants and during the handling of contaminated parts.

s. Toxic vapor monitoring shall be required at the conclusion of any hazardous operation listed in paragraph 20.6.7.3.o prior to opening of the control area to unprotected personnel.

20.6.8 Cryogenics

All cryogenic systems shall comply with the requirements of paragraph 20.6.7, Propellants, and the following requirements.

20.6.8.1 Cryogenic Systems Requirements

a. Source flow shall have throttling capability.

b. Pressure containing components within hydrogen systems shall be selected for minimum hydrogen blistering or hydrogen embrittlement susceptibility.

c. GSE cryogenic valves with extended stems shall be installed with the actuator approximately vertical above the valve.

d. Joints in piping systems shall be of either butt-welded, flanged, bayonet, or hub type.

e. Cryogenic systems shall provide for thermal expansion and contraction without imposing excessive loads on the system.

NOTE: Bellows, reactive thrust bellows, or other suitable load relieving flexible joints may be used.

f. GSE vacuum-jacketed systems shall be capable of having the vacuum verified.

g. Cryogenic systems shall be designed so anywhere a cryogen can be trapped between any valves in the system, automatic relief is incorporated to preclude excess pressure caused by conversion from liquid to gaseous state causing a rupture.

h. Cryogenic systems shall be insulated with an oxygen compatible material or be vacuum-jacketed to preclude liquefaction of air.

20.6.8.2 Cryogenic Systems Operations

a. Cryogenic systems shall be pressure tested with an inert medium at cryogenic temperature followed by a proof test at ambient temperatures (no less than 60 degrees Fahrenheit).

b. Pressure testing shall be 1.5 times MOP except where lesser factors (no less than 1.1 times MOP) are warranted to avoid adverse effects (e.g., plastic deformation or strain hardening) on the system.

c. Cryogenic systems, including vacuum-jacketed pipe, shall be cold-shock tested with an appropriate cryogenic inert medium (at MOP or greater) prior to introducing any hazardous commodity into the system.

d. For liquid hydrogen systems, a mass spectrometer leak test with liquid helium shall be performed.

NOTE: Cold-shock leak testing can be accomplished at proof pressure to satisfy the cryogenic proof requirements in paragraph 20.6.8.2.a above.

e. Simultaneous loading of fuels and oxidizers shall not occur without prior approval from the LSSO.

f. All personnel involved in cryogenic propellant transfer operations, repairs, or adjustments to the system shall wear LSSO and Biomedical and Bioenvironmental Engineering-approved PPE.

g. Flammable cryogenic systems shall be capable of being connected to an external vent system.

20.6.9 GSE Materials

a. A list of materials shall be maintained for each piece of GSE which interfaces with hazardous fluids.

EXAMPLE: Hazardous fluids include, but are not limited to, gaseous oxygen, liquid oxygen, gaseous hydrogen, liquid hydrogen, hydrazine, nitrogen tetroxide, monomethyl-hydrazine, Freon-21, ammonia, and potassium hydroxide.

b. The list shall be of sufficient detail to permit an evaluation of the compatibility of the GSE design with the environment in which it is to be used.

c. Mercury in liquid or vapor form shall not be used in GSE if a substitute of equivalent performance exists or an appropriate alternate design or method can be used.

d. Mercury shall not be used in any applications where contamination of flight hardware or exposure to personnel could result.

e. Cleaning solvents and adhesive materials shall be contained in NFPA-approved safety containers.

f. The use of and quantity of cleaning solvents and adhesive materials allowed in the payload processing work area shall require the approval of the LSSO.

g. All users of these materials shall comply with local fire, safety, and health regulations.

h. Except where approved by the LSSO, the use of glass containers is prohibited in all payload processing work areas.

i. Use of flammable materials and static-producing materials shall be kept to a minimum in all payload processing areas.

j. If any plastic film/foam/adhesive is to be used, the material shall be selected from the NASA KSC Plastic Films and Adhesive Tapes list.

k. The material, quantity, and location of use shall be included in the payload organization safety data package and approved by the LSSO prior to use.

l. If a plastic film is not on the approved list, a sample (minimum one square yard) shall be submitted to the LSSO for test/evaluation and approval.

m. GSE containing components made of shatterable materials, which is to be used inside the Orbiter or in areas where it could fall into the Orbiter, shall be designed to provide positive containment to prevent fragments from entering the Orbiter.

n. GSE designed for use directly in the Orbiter crew cabin or payload bay shall meet the same materials flammability requirements as the payload/experiment itself.

NOTE: For these requirements, see NSTS 1700.7B, paragraph 209, subparagraphs 2 and 3.

o. GSE used in flight vehicle habitable areas or in the payload bay shall not be painted or coated with materials subject to chipping, flaking, or scaling.

NOTE 1: Materials should be selected which are not nutrients for biological agents such as mold, mildew, fungus, etc.

NOTE 2: Experiments in habitable areas should not provide a source of contamination.

NOTE 3: Materials which are nutrients should be hermetically sealed or treated to render the exposed surfaces resistant to biological attack.

20.6.10 Industrial Hygiene

a. Hazardous materials and physical agents shall be controlled during all phases of launch/landing site operations to protect personnel by preventing exposures in excess of applicable limits and to comply with applicable federal and state regulations and requirements.

b. Descriptive information concerning proposed uses of hazardous materials and physical agents shall be provided by the payload organization to the LSSO for review and evaluation by Health Officials.

c. General Industrial Hygiene requirements include, but are not limited to, the following:

(1) Equipment which contains, possesses, or emits hazardous materials and/or physical agents shall be designed, constructed, installed, and operated in a manner to ensure the potential for exposure is kept as low as feasible.

(2) The payload organization shall provide a list of all hazardous materials and physical agents containing names, quantities, locations, and proposed uses [reference paragraph 20.3.1.c(9)] to the LSSO as part of the Ground Safety Data Package.

(3) The payload organization shall submit to the LSSO one copy of the MSDS for each of materials upon or before arrival at the ER.

(4) MSDS's shall be submitted if at any time additional materials, not previously identified, are introduced onto the ER.

(5) Hazardous materials and physical agents shall be used only by properly trained personnel and in accordance with procedures reviewed by the Health Officials and approved by the LSSO.

(6) Engineering or administrative controls shall be the primary means for preventing personnel exposures.

(7) When such controls are not feasible or adequate to control exposure, PPE shall be required.

(8) PPE shall be approved by the Health Officials.

(9) Planned releases of hazardous materials shall not be permitted without review and approval by the LSSO and the Health Officials.

(10) Supportive data shall be provided by the payload organization to identify maximum expected quantities and concentrations of planned releases.

NOTE: All activities involving hazardous materials or physical agents are subject to monitoring by the Health Officials.

20.6.11 Oxygen

The use of gaseous or cryogenic oxygen involves unique design requirements with respect to materials compatibility. Prior to commencement of design, the payload organization shall contact the LSSO to identify specific safety/compatibility requirements to be incorporated in design.

NOTE: Specific KSC documents providing results of compatibility testing are 79K09560 for liquid oxygen testing and 79K09561 for gaseous oxygen testing.

20.7 ENVIRONMENTAL

20.7.1 Meteorological Requirements

20.7.1.1 Propellants

Meteorological conditions established herein shall be observed by all agencies in scheduling and conducting transfer, handling, and use of toxic propellants.

a. Propellant operations shall not commence when the potential for passage of an electrical storm is within five miles.

b. Propellant operations during storm passage shall be interrupted or expeditiously concluded at the discretion of the LSSR or supervisor in charge of the operation.

c. The supervisor responsible for the transfer/handling operations shall be responsible for obtaining the prevailing meteorological conditions, determining that the conditions meet those specified herein, and obtaining LSSR approval to proceed.

d. In order to protect personnel not involved in toxic propellant operations and the public domain, downwind concentrations of toxic propellant materials shall be controlled by limiting operations to certain meteorological conditions.

e. Concentrations of toxic propellants shall be kept at or below Health Officials approved safe levels at the launch site boundaries in the public domain and in the launch site industrial areas.

f. Personnel shall be evacuated or provided with emergency escape breathing devices and communications equipment in areas potentially at risk from toxic propellant operations as determined by the LSSO.

g. Evacuation of personnel shall be used in those situations where the potential for injury/illness is present.

h. Local propellant operations shall require protection in the immediate downwind sector.

20.7.1.2 Ordnance

a. Ordnance items shall not be transported, handled, installed/removed, or electrically connected/disconnected when the passage of an electrical storm is within 5 nautical miles.

b. Ordnance operations shall be interrupted or safed during storm passage.

20.7.2 Hazardous Atmospheres

NOTE 1: Flammable/Explosive Atmospheres: A percentage of the Lower Explosive Level (LEL) will be established to define a hazardous atmosphere for flammable/explosive gases or vapors by the LSSO on a case-by-case basis. Factors such as commodity involved, quantity, confinement area, the presence of oxygen-enriched atmospheres (greater than 25 percent), credible time for a hazardous condition to develop, and response time to complete emergency actions shall be considered in establishing the percentage of the LEL. This percentage is usually 25 percent of the commodity LEL.

NOTE 2: Oxygen Deficient Atmospheres: A hazardous oxygen-deficient atmosphere may develop in enclosed spaces where operations or processes consume oxygen or release asphyxiating gases or vapors into the atmosphere. Entry into any atmosphere containing less than 19.5 percent oxygen is considered hazardous.

NOTE 3: Toxic/Corrosive Atmospheres: Hazardous toxic/corrosive atmospheres may be present where processes or operations generate airborne materials. Hazardous airborne materials include dusts, fibers, mists, fogs, smokes, fumes, gases, and vapors.

20.7.2.1 Confined Space Entry

Confined space entries shall be performed in accordance with KNPR 1840.19.

20.7.2.2 Hazardous Atmosphere Areas for Electrical Equipment

a. The hazardous atmospheric areas for flammable liquids, such as propellants, shall be as follows:

(1) Service carts, drums, storage vessels, or payload tanks - 50 feet radially from the container or as specified by the LSSO.

(2) Vents - 50 feet radially from the vent opening.

(3) Transfer lines - 25 feet radially from the line.

b. All installation configurations shall be evaluated for approval by the LSSO.

c. The hazardous atmospheric area for solid propellants is within 10 feet of any exposed propellant. Solid propellants shall be considered exposed when:

(1) The motor nozzle is not attached and the nozzle end does not have a cover that precludes propellant offgassing or,

(2) The nozzle is attached but does not have a nozzle plug installed sufficient to preclude propellant off-gassing or,

(3) Unassembled motor segments that do not have front and rear covers that prevent off-gassing.

20.7.2.3 Electrical Equipment in Hazardous Atmosphere Areas

a. When within areas prescribed in paragraph 20.7.2.3, electrical equipment that is operated during system pressurization or flow of flammable propellants shall be either explosion proofed in accordance with the NEC (NFPA 70) or hazard proofed.

NOTE: Hazard proofing may be obtained by potting, hermetically sealing, or by positive pressurization with an inert gas or clean air as described in NFPA 496.

b. The electrical equipment shall be monitored at all times when powered.

c. Electrical equipment to be operated in enclosed rooms or areas where propellants are present but in a static state (i.e., no flow or change of pressurization) shall be controlled by a switch at a single monitoring station capable of deactivating all "nonexplosion/nonhazard proof" equipment within the area.

d. This station shall be manned at all times when the equipment is in use.

e. The master switch shall be explosion/hazard proof if it is located within the hazard area.

f. Equipment which cannot be connected to the master switch shall be identified to the LSSO during the phase safety review process.

NOTE: Hazard groups for hazardous atmospheres are listed in the NEC (NFPA 70). For the purpose of this chapter, kerosene (RP & JP fuels), and solid propellants are to be considered Class I, Group D. Hydrazine is Class I, Group C.

20.7.3 Humidity

a. Any operations involving solid or liquid propellants or Category A EEDs shall not be conducted at humidity levels below 30 percent.

b. Exceptions shall be approved by the LSSO on a case-by-case basis.

20.7.4 Toxic Materials

The LSSO and Health Officials shall establish criteria for operational controls involving all toxic materials.

20.8 HANDLING AND TRANSPORTS

NOTE: Many standards and guides list design requirements written to achieve a safe operation, such as Code of Federal Regulations (CFR), 29 CFR, Occupational Safety and Health Administration, Department of Labor, Part 1910, and the Standard for Lifting Devices and

Equipment, NASA-STD-8719.9. The special nature of launch site safety mandates rigorous considerations in both design and process parameters.

The following definitions are to be used in this section:

a. Lifting devices - slings, linkage, mechanisms, etc., that extend between a lifting hook on a hoist and the object being lifted. Only those items below the lifting hook are intended to be designed to the criteria contained in this document. The requirements for the design of hoist, winches, and cranes are not included. Other systems, if required, shall comply with NASA-STD-8719.9.

b. Ground handling/transportation devices - trucks, dollies, transporters on which an object is placed for subsequent transportation or rotation.

c. Work stand - work platforms, ladders, etc., that are fixed structures, are designed specifically to support personnel, and do not experience the dynamic loading associated with lifting and transportation.

d. Support stand - GSE structure designed to support flight or ground equipment.

e. Rated load - the maximum static weight that the basic equipment can safely support or lift.

f. Working (actual) load - the expected or measured weight of a piece of equipment that is to be supported, lifted, or transported.

20.8.1 Hoisting and Handling

a. All payload organization lifting equipment and its usage shall meet the requirements of 29 CFR, Part 1910; the American National Standards Institute (ANSI), ANSI B30 Series, "American National Standard Safety Standards for Cranes, Derricks, Hoists, Hooks, Jacks and Slings", NASA-STD-8719.9, and the requirements herein.

b. All lifting and hoisting equipment shall show evidence of the equipment having been tested in compliance with the above reference documents and the requirements of the paragraphs in this section.

c. Testing shall be accomplished within one year prior to use.

d. Records of all testing and inspections shall be maintained and be made available to the LSSO upon request.

e. Rated loads shall be posted on all lifting and hoisting equipment and fixtures.

f. Magnetic particle, dye penetrant, radiography, or other suitable crack-detecting tests shall be performed on all load-bearing hooks, shackles, and eyebolts after the initial proof test of the assembled sling but prior to use and annually thereafter.

g. The nondestructive inspection (NDI) method selected shall require approval by the LSSO during the phase safety review process.

h. A defect-detecting method such as radiography or ultrasonics which evaluates the material through 100 percent of its depth shall be performed on all welds constituting a single point of failure (i.e., critical weld) after the initial proof test of the assembled sling.

i. Critical welds shall be eliminated where feasible.

NOTE: If the payload organization certifies that their lifting hardware is for a specific function, is properly controlled in terms of usage/misusage and the environment, and has undergone a thorough NDI prior to application of a protective coating, the LSSO may not require an annual NDI.

j. Thimbles, shackles, links, eyebolts, swaged fittings, wire ropes, and similar devices shall be subjected to and comply with the testing, preoperational and periodic inspection, and maintenance requirements set forth in the applicable ANSI B30 Series or the NASA-STD-8719.9.

NOTE: Eyebolts which are permanently fixed to the load are considered exempt from proofloading and NDI requirements.

k. Eyebolts shall comply with the design requirements of Figure 20-1.

SLING COMPONENT	SAFETY* FACTOR (ULTIMATE:RATED)	PROOF TEST (PROOF:RATED)	PERIODIC LOAD TEST (TEST:RATED)
		NASA KSC	
Wire Rope	5	2	1.25
Alloy Steel Chain	5	2	1.25
Metal Mesh	5	1.5	1.25
Natural or Synthetic Web	5	1	1
Natural or Synthetic Rope			
Manila	5**	1	1
Polypropylene	6**	1	1
Polyester	9**	1	1
Nylon	9**	1	1
Structural Members (e.g., spreader beams)	5***	2	1.25
Shackles, Tumbuckles, Eyebolts, etc.	5	2	1.25

* As relates to this table, safety factor is defined as the ratio of a load that predicts a failure to a rated load.

** Use of rope slings will be limited to 50% of the rated capacity (manufacturer's rating).

*** A 3:1 safety factor against the worst case failure mode that will result in local yielding is acceptable.

FIGURE 20-1: SLING REQUIREMENTS

l. Eyebolts that can be removed and replaced shall have a positive means of determination of full thread engagement (e.g., shoulder, color marking, etc.).

m. Attach points to payloads for the purpose of ground handling shall be classified as either utilizing the flight structural interfaces to the Orbiter or having special attach fittings for the purpose of ground handling.

n. When utilizing the flight attach fittings for ground handling, structural analysis shall not be required if this determination has been made for flight dynamics.

o. When special fittings for ground handling are used, an analysis shall be conducted to ensure the load paths have adequate safety factors for ground handling.

p. The attach points for the Spacecraft (S/C) and fittings (GSE) shall be adequately described in the safety data package, including single failure points, verification methods (e.g., prooftesting, NDI), and the methods used to assure proper connection during ground handling.

q. Proofloading and associated NDI shall be reaccomplished for modified or repaired lifting equipment.

20.8.2 Requirements for Slings

a. Slings shall be designed and tested as an assembled unit (unless otherwise approved by the LSSO) which includes spreader beams and drop legs (ropes, chains, shackles, eyebolts, pins, turnbuckles, etc.) in accordance with NASA-STD 8719.9.

b. Proof or periodic load test shall be accomplished within one year prior to use.

c. All sling assemblies shall be visually inspected each day prior to use.

d. A periodic inspection shall be performed by the using organization on a regular basis with frequency of inspection based on frequency of sling use, severity of service conditions, nature of lifts being performed, and experience gained on the service life of slings used in similar circumstances.

e. Any deterioration which could result in appreciable loss of original strength shall be carefully noted, and an engineering evaluation shall be performed to determine whether further use of the sling would constitute a safety hazard.

f. Periodic inspections shall be conducted annually, as a minimum.

g. Structural sling inspection shall be performed at least annually.

20.8.2.1 Wire Rope Slings

Wire rope slings shall be immediately removed from service if any of the following conditions are present:

a. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.

b. Wear or scraping of one-third the original diameter of outside individual wires.

c. Kinking, crushing, bird caging, or any other damage resulting in distortion of the wire rope structure.

d. Evidence of significant heat damage.

e. End attachments that are cracked, deformed, or worn.

f. Hooks that have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10º from the plane of the unbent hook.

g. Significant corrosion of the rope or end attachment.

20.8.2.2 Replacing Due to Deficiencies Identified During Inspection

a. Discrepancies found during the following inspections shall be cause for replacement or repair:

(1) Verify, overall, that there is no evidence of visual damage, gouges in metal, flaking paint, loose bolts, rivets, connections, or deformation such as galling or gouges in pins, eyes, and end connections.

(2) Ensure there are no bent, deformed, cracked, or excessively corroded support or main members.

(3) Inspect load-bearing bolts and verify that there is no visual evidence of bending, cracking, gross wear, or improper configuration.

(4) Inspect attached and lifting lugs for visual deformation and evidence of local yielding.

(5) Ensure there are no elongated attach or lifting holes.

(6) Inspect around fasteners for local yielding and deformation.

(7) Remove and inspect load-bearing slip pins for visual deformation, evidence of bending, abnormal defects such as galling, scoring, brinelling, and diameters not within drawing tolerances. NDI shall be used when required by design requirements or when cracks are suspected.

(8) Inspect pin bores visually for cracks, deformation, local yielding, scoring, galling, and brinelling. NDI shall be performed as required.

(9) Inspect welds for cracks and evidence of deformation, deterioration, damage, or other defects by -

(a) Visual inspection of all welds.

(b) Magnetic particle, x-ray, or other suitable crack-detecting methods as appropriate for critical welds as identified on the drawings.

(10) 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 uninspected areas; do not paint over cracks, deformations, deterioration, or other damage until an engineering assessment has been made.

20.8.2.3 Identification Requirements

a. For identification and onsite assurance purposes, equipment shall have a periodic recertification tag containing equipment identification, next required test date, and quality control stamp.

b. Hoists/winches and slings shall have proofload tags containing rated load, proofload, and proofload date.

c. Slings which have components that are normally disassembled shall be either marked, coded, or tethered to assure proper assembly of verified hardware.

NOTE: Components not marked, coded, or tethered will invalidate the proofload/certification of the whole assembly.

d. 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.

e. Synthetic or natural rope slings shall be derated by 50 percent after the proofload; this then becomes the rated load.

EXAMPLE: Manufacturer's rating x 1.0 (prooftest factor) x 0.50 (derating factor) = posted rated load.

20.8.3 Hydrasets

a. Hydrasets shall be initially load tested to 200 percent and annually thereafter to 125 percent of their rated load.

b. Hydrasets shall be tested to 125 percent whenever seals are replaced.

NOTE: Manufacturer's certification of test is acceptable for either new or reworked hydrasets.

c. The piston rod shall be fully extended for load test.

d. An operational test of the pump shall be done every six months.

20.8.4 Chainfalls

Chainfalls shall be initially and annually load-tested to 125 percent of rated load.

20.8.5 Load Cell

Load cells shall be annually load-tested and calibrated to 100 percent of their rated load.

20.8.6 Stands

a. Ground handling devices and support stands shall have a safety factor of 3:1 against yield.

b. Personnel work stands shall have a safety factor of 4:1 against ultimate.

c. A one-time prooftest and NDI of support stands shall be required based upon hazard potential.

d. The prooftest level shall be at least 1.25 times the rated load.

e. An LSSO-approved NDI shall be performed after the prooftest.

f. A prooftest and NDI shall be required after misuse or modification.

20.8.7 Transporters

a. Prior to use, checks shall be made to ensure:

(1) Proper tire inflation.

(2) An operable braking system.

(3) Tow bar and safety chains are properly fastened.

(4) Payload securing devices are properly tightened.

(5) Availability of wheel chocks.

(6) Availability of fire extinguisher(s).

b. Maximum speed shall be prominently and permanently displayed on both the front and rear of the transporter.

c. Transporters shall be parked only in approved areas.

d. Movement of transporters carrying liquid fuel, solid motors, or installed ordnance shall comply with AFMAN 91-201 and not commence when electrical storms are within 5 miles.

e. Transporters shall have a safety factor of 3:1 against yield

NOTE: Commercially available equipment (e.g., flatbed trailers) are acceptable.

20.9 MISHAP INVESTIGATION AND REPORT

NOTE: Requirements are established within this KNPR, Chapter 10.

APPENDIX A - DEFINITIONS

Acceptance: *(Safety Variances)* Taking the responsibility for the potential outcome of a documented increase in risk.

Affected Employee(s): *(Lockout/Tagout)* Those employees who operate or use the equipment being serviced or maintained, or others in the area where equipment is locked and/or tagged out.

Alteration: (PVS) Change that affects the pressure containing capability of a pressure vessel. Nonphysical changes such as an increase in the maximum allowable working or design pressure (internal or external) or design temperature of a pressure vessel is considered an alteration. A reduction in minimum temperature such that additional mechanical tests are required is also considered an alteration. See ANSI/NB-23, Chapter 1, Glossary of Terms.

Applicable Codes, Standards, Guides: Any national consensus code, standard or guide, or any NASA KSC accepted design code, standard or guide for the design verification of pressure vessels, systems, or their components.

Approval: *(Safety Variances)* Decision by the SMA TA that the request for relief is for relief from NASA policy and may be implemented after the appropriate person accepts the risk.

Authorized Employees: *(Lockout/Tagout)* Those employees who service or maintain equipment and perform lockout/tagout procedures.

Authorized Personnel: The maximum number of personnel permitted within a control area at any one time. Presence of all personnel is not mandatory. Mandatory personnel participation is normally controlled by call to stations and/or steps/sequences within the body of the procedure.

Blast Danger Area (BDA): A hazardous clear area. Clearance prior to establishment of a major explosive hazard, such as vehicle fuel/oxidizer load and pressurization. The area subject to fragment and direct overpressure resulting from the explosion of the booster/payload.

Breathing Escape Unit (BEU): Used only for escape from a hazardous environment.

Buddy System: An arrangement used when risk of injury is high, where personnel work in pairs with one person in the pair stationed nearby (the system does not demand shoulder-to-shoulder contact, but rather visual contact and a proximity that allows each buddy to help the other in an emergency), to serve as an observer to render assistance if needed.

Category I SCAPE: PHE with backpack. Operating time from air on to air off is 120 minutes.

Category IV SCAPE: Same as Category I with hose-line breathing in lieu of the backpack.

Category VI SCAPE: 'Chemturion' CPS - "blue suit" with hose-line breathing.

Caution: A notation before an operational step which, if not adhered to or observed, could result in damage to equipment.

Certification: (PVS) Documentation qualifying a vessel or system to operate in its particular service. GSE/GS functional validation of each critical function by test, analysis, and/or similarity.

Cleared Area: An area where a hazardous condition exists or a hazardous operation is in progress; personnel are prohibited from entering.

Close Call: An occurrence or a condition of employee concern in which there is no injury or only minor injury requiring first aid and no significant equipment/property damage/mission failure (less than $1000), but which possesses a potential to cause a mishap.

Code PVS: (PVS) Pressure vessels and pressurized systems that are designed, fabricated, installed, Code stamped, and maintained in strict conformance with the requirements of the national consensus code or standard.

Commercial Off the Shelf (COTS): Commercial items that require no unique Government modification or maintenance over the life cycle of the product to meet the needs of the procuring agency. A commercial item is one customarily used for non-Governmental purposes that has been or will be sold, leased, or licensed (or offered for sale, lease, or license) in quantity to the general public. An item that includes modifications customarily available in the commercial marketplace or minor modifications made to meet NASA requirements is still a commercial item.

Compatibility: (COPV) The ability of two materials or substances to come into contact without altering their structure or causing a reaction in terms of permeability, flammability, ignition/combustion, functional/material degradation, contamination, toxicity, pressure/ temperature, shock, oxidation, and corrosion.

Competent Person *(Electrical Extension Devices)* An individual who, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, is designated by the employer, and has authority to take appropriate actions by OSHA's definition a competent person.

Concurrence: (Safety Variances) Formal documentation of an agreement/recommendation/opinion, but with no authority to approve or accept risk.

Consequence (Severity): An assessment of the worst case credible potential effect(s) of a risk without any controls in place that is documented in terms of a consequence/severity level using the applicable risk matrix..

Control Area: A designated, limited-access area where a hazardous condition exists or a hazardous operation is in progress; nonessential personnel are prohibited from entering.

Control Point: The area or place where the task leader and any other support groups direct and monitor the operation.

Controlled Switching: No flight vehicle/element or GSE commands issued, no switches or circuit breakers operated on the flight elements or GSE electrically connected to the flight elements, except those commands and switch/ circuit breaker operations directed by the TD (and sub-tasks) requiring controlled switching.

Credible: A condition that can occur and is reasonably likely to occur. A condition is considered reasonably likely to occur (using numeric data if available), if conditions or failure

modes have a probability of occurrence greater than 1 X 10^{-6} in the projected usage/life of the equipment.

Critical Function: A system function which, if lost or improperly performed could result in a Level 4 or 5 consequence/severity effect per the applicable risk matrix.

Critical Lift: A lift where failure/loss of control could result in loss of life, loss of or damage to flight hardware, or a lift involving special, high dollar items, such as spacecraft, one-of-a-kind articles, or major facility components, whose loss would have serious programmatic or institutional impact. Critical lifts also include the lifting of personnel with a crane, lifts where personnel are required to work under a suspended load, and operations with special personnel and equipment safety concerns beyond normal lifting hazards.

Critical Position: A critical position is one in which the worker's job performance can directly impact ground safety, flight safety or mission success. This includes but is not limited to:

a. Workers dealing directly with flight hardware, software, or ground support equipment, or

b. Employees having authority to make decisions on flight hardware or software processing, or

c. Workers involved in launch or landing activities, or

d. Personnel who work in ground systems that have a functional or physical interface with flight systems, or

e. Employees working with other systems that are hazardous by nature.

In the types of positions delineated above, there is not more than one level of check and balance regarding the employee's decisions or actions.

Critical Lift: A lift where loss of control could result in loss of life, loss or damage to flight hardware or a lift involving special, high dollar items, such as spacecraft, one-of-a-kind articles or major facility components, etc., where loss would have serious programmatic impact.

Critical System: A system that has at least one critical function.

De-Rating: (PVS) The lowering of the maximum allowable working pressure or narrowing of the allowable operating temperature range of a pressure vessel or system.

Dead Front: (Electrical Extension Devices) Without live parts exposed to a person on the operating side of the equipment.

Design Burst Pressure: (PVS) The theoretical pressure at which a vessel or other pressurized component would burst, based on calculations using accepted formulas and material properties. Vessels and systems to be placed in service are never subjected to a burst pressure test.

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

Design Temperature: (PVS) The metal temperature used in the design of a vessel or system for determining the minimum required thickness of the components, and for selecting the maximum allowable stress for the materials used in the vessel or system.

Deviation:

(General) An authorization for temporary relief in advance from a specific requirement, requested during the formulation/planning/design stages of a program/project operation to address expected situations. OSHA refers to this as an alternate or supplemental standard.

(Safety Variances) A variance that authorizes temporary relief in advance from a specific requirement and is requested during the formulation/planning/design stages of a program/project operation to address expected situations.

(TOPs) Documented and approved permission that authorizes the addition, deletion, or modification of steps or sequences in a Category I or Category II TOP. KSC Form 4-30A can be used for this purpose.

DOT Service: (PVS) Those uses of PVS covered by the regulations contained in 49 CFR 100 – 185, Pipeline and Hazardous Materials Safety Administration.

Electroexplosive Device (EED): EED Categories – EEDs are categorized based on the effects of inadvertent initiation. EED categories are as follows:

a. Category A: EEDs which, by the expenditure of their own energy, or because they initiate a chain of events, may cause injury of death to people or damage to property.

b. Category B: EEDs, which, in themselves, or by initiating a chain of events, will not injure people or damage property.

Eliminated Hazard: A hazard that has been eliminated by completely removing the hazard causal factors.

Emergency Egress: The capability to exit a location and leave a hazardous situation within a specified amount of time.

Emergency Instructions: *(TOPs)* Instructions, contained within a TOP that provide for safing hardware and for implementing emergency actions required to evacuate or safeguard personnel, and prevent or limit the extent of damage should an emergency arise.

Emergency Life Support Apparatus (ELSA): A self-contained, short duration, portable breathing device consisting of a full hood attached to a compressed air cylinder to provide breathable air to personnel during emergency escape from hazardous environments.

Emergency Procedures Document (EPD): A document produced for work areas to provide the processing teams with procedures to be followed if an emergency occurs at any time in that facility.

End Item: A final combination of end products, components, parts, or materials that is ready for its intended use.

Essential Personnel: The number of personnel required within the control area for a particular operation as documented in the procedure.

Exception: A variance that authorizes permanent relief from a specific requirement which may be requested at any time during the life cycle of a program/project.

Excluded PVS: (PVS) A PVS that is not required to meet the certification (or recertification) requirements of NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems, and need not be included in the PVS configuration management system. Excluded PVS are subject to all applicable laws, regulations, safety requirements, NASA requirements, and appropriate NCS and must be maintained in accordance with applicable NCS.

Existing PVS: (PVS) PVS are considered to be "Existing PVS" if installed no later than 6 months from the date of original issue of this document.

Explosive Test Equipment: Electrical circuit test equipment used for testing explosives items, pyrotechnic devices, or circuits connected to those items before or after installation.

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.

Extension Device: (Electrical Extension Devices) Extension cord, power strip, wall multi-outlet plug that increases the number of outlets, power plug adapter.

Facility: A location where equipment/machinery resides (e.g., buildings, labs, shops, processing areas).

Factor of Safety (FOS or FS):

(General) Ratio of the design condition to the maximum operating conditions specified during design.

(COPVs) Ratio of design burst pressure to maximum ground processing pressure.

(*PVS)* Unless otherwise noted, this refers to the material design factor of safety on structural failure and is equal to the lesser of the material strength divided by the material stress under anticipated loading or the actual buckling load divided by the anticipated buckling load.

First Aid: Medical assistance provided to a person in need. Emergency First Aid is the first response to a life-threatening medical emergency until regular medical personnel can be notified or arrive onsite. Non-Emergency First Aid is the treatment of minor medical needs which may or may not require further medical treatment.

According to 29CFR 1904.7(b)(5)(ii)), the following actions are considered "First Aid":

(a) Using a non-prescription medication at nonprescription strength (for medications available in both prescription and non-prescription form, a recommendation by a physician or other licensed health care professional to use a non-prescription medication at prescription strength is considered medical treatment for recordkeeping purposes);

(b) Administering tetanus immunizations (other immunizations, such as Hepatitis B vaccine or rabies vaccine, are considered medical treatment);

(c) Cleaning, flushing or soaking wounds on the surface of the skin;

(d) Using wound coverings such as bandages, Band-Aids™, gauze pads, etc.; or using butterfly bandages or Steri-Strips™ (other wound closing devices such as sutures, staples, etc., are considered medical treatment);

(e) Using hot or cold therapy;

(f) Using any non-rigid means of support, such as elastic bandages, wraps, non-rigid back belts, etc. (devices with rigid stays or other systems designed to immobilize parts of the body are considered medical treatment for recordkeeping purposes);

(g) Using temporary immobilization devices while transporting an accident victim (e.g., splints, slings, neck collars, back boards, etc.).

(h) Drilling of a fingernail or toenail to relieve pressure, or draining fluid from a blister;

(i) Using eye patches;

(j) Removing foreign bodies from the eye using only irrigation or a cotton swab;

(k) Removing splinters or foreign material from areas other than the eye by irrigation, tweezers, cotton swabs or other simple means;

(l) Using finger guards;

(m) Using massages (physical therapy or chiropractic treatment are considered medical treatment for recordkeeping purposes); or

(n) Drinking fluids for relief of heat stress.

NOTE: Per 29CFR 1904.7(b)(5)(iii) this is a complete list of all treatments considered first aid.

Flexhose: There are two basic types of flexhoses – those constructed entirely of metal, herein described by the term “metal hose”, and those constructed of elastomeric material or a combination of elastomeric material and metal, herein described by the term “nonmetallic hose”.

a. Metal Hose: A metal hose consisting of a flexible metal pressure carrier tube surrounded by an outer layer of wire braid (some low pressure metal hoses do not utilize an outer layer of wire braid). The flexible metal pressure carrier tube and the wire braid are attached to the hose end fittings by welding, silver-soldering, or brazing (some metal hoses used for

cryogenic applications utilize an inner and outer flexible metal tube with a vacuum in the space between the inner and outer flexible tubes).

b. Nonmetallic Hose: A nonmetallic hose consists of a polytetrafluoroethylene or other flexible elastomeric material pressure carrier tube reinforced by fabric or wire braid with metal end fittings attached by mechanical means such as swaging or crimping.

Flight Hardware: Hardware designed and fabricated with the intent to fly.

Flight Hardware Processing Facilities: Buildings and areas, to include their respective perimeter fence, where flight hardware is processed.

Flight Termination System: A type of range safety system designed, tested, and incorporated into vehicles that provides for the independent and deliberate termination of an errant/erratic vehicle's flight.

Fracture Control: Fracture control is a set of policies and procedures involving the application of analysis and design methodology, manufacturing technology, and operating procedures to prevent structural failure due to the initiation of and/or propagation of flaws or crack-like defects during fabrication, testing, and service life.

Fracture Mechanics: An engineering concept used to predict flaw growth and fracture behavior in materials and structures containing cracks or crack-like flaws.

Ground-based PVS: (PVS) All PVS, including PVS based on barges, ships, or other transport vehicles, not specifically excluded in this document. Flight weight PVS used for their intended purpose aboard active air or space craft, even though on the ground, are not included in this definition, but flight weight PVS converted to ground use are included.

Ground-Fault Circuit-Interrupter: (Electrical Extension Devices) A device intended for the protection of personnel that functions to deenergize a circuit or a portion of a circuit within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

Ground Support Equipment (GSE): Nonflight systems, equipment, or devices and associated software with a physical or functional interface with flight hardware that are used to support the operations of transporting, storing, receiving, handling, assembly, inspection, tests, checkout, monitoring, controlling, servicing, launch, and recovery of aircraft, spacecraft, launch vehicles and payloads.

Ground System (GS): Ground-based systems used to transport, handle, test, checkout, service, and control aircraft, launch vehicles, spacecraft, or payloads

Hazard: A condition that has the potential to result in or contribute to injury, death, or equipment damage.

Hazard Analysis: Identification and evaluation of existing and potential hazards, and the recommended mitigation for the hazard sources found.

Hazardous Energy: (*Lockout/Tagout)* Any electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, gravity, or other energy that could cause injury to personnel.

Hazardous Fluids: (PVS) Gases or liquids of such a nature that a given quantity of the gas or liquid's vapor, when mixed or unmixed with air, is hazardous to personnel or equipment due to flammability, toxicity, or extremes of temperature. The following fluids are considered to be hazardous; additional fluids may be designated to be hazardous at the discretion of the KSC PSM.

a. Alcohol
b. Ammonia
c. Gaseous Hydrogen
d. Hydrazine
e. Liquefied Petroleum Gases (Propane, Butane, as defined in NFPA 58)
f. Liquid Air
g. Liquid Hydrogen
h. Liquid Nitrogen
i. Liquid Oxygen
j. Monomethylhydrazine
k. Nitrogen textroxide
l. Trichloroethylene

Hazardous Material: Any solid, liquid, or gaseous material which meets the hazard reporting requirements of 29CFR 1910.1200. This includes commodities that, under foreseeable conditions, are toxic, carcinogenic, cryogenic, explosive, flammable, pyrophoric, water-reactive, corrosive, an oxidizer, a compressed gas, a combustible liquid, or are chemically unstable.

Hazardous Operation (Hazardous Tasks): Any operation or other work activity that has a high potential to result in loss of life, serious injury to personnel or public, or damage to property due to the material or equipment involved or the nature of the operation/activity itself.

Hazardous Steps Affected/Added: All changes and deviations which:

a. Change or modify hazardous steps.

b. Initiate/add hazardous steps to existing hazardous/nonhazardous TOPs.

c. Intensify/extend hazardous steps to existing hazardous TOPs (e.g., extend duration/time of hazardous operation, extend hazardous control area, and add number of personnel in control area).

d. Change the existing safety requirements.

Hazardproof: Prevention of an explosive atmosphere penetrating electrical fixtures where sparking or arcing could occur.

Hydrostatic Test: (PVS) The test of a pressure vessel or system during which the vessel or system is filled with a liquid (usually water) and pressurized to a designated level in a manner prescribed in the applicable code. (Reference Paragraph UG-99, ASME Code, Section VIII, Division 1 or Article T-3, ASME Code, Section VIII, Division 2.)

Hydraulics: (PVS) Hydraulic systems using commercially available hydraulic fluid. Note: Associated pneumatic storage, actuation devices, or components that are used in a hydraulic system are not considered hydraulics. Pressurized hydraulic fluid containing devices are included if the system is included.

Hyper Ops Class A PPE: Personal protective equipment category that is the minimum PPE required for hypergolic operations that have a potential for liquid flow release and heavy vapor concentrations. Refer to Figure 8-2.

Hyper Ops Class B PPE: Personal protective equipment category that is the minimum PPE required for hypergolic operations that have very low or no potential for liquid flow, and a low potential for liquid residuals, and a potential for vapor release. Refer to Figure 8-2.

Hyper Ops Class C PPE: Personal protective equipment category that is the minimum PPE required for hypergolic operations that have no potential for liquid flow (hypergolic fluids), and a low potential for limited vapor release, and an expectation that the Threshold Limit Valve/time Weighted Average (TLV-TWA) will not be attained through the monitoring of the breathing zone, and there is a two-valve isolation (with independent controls) from liquid sources. Refer to Figure 8-2.

Identified: (Electrical Extension Devices) Approved as suitable for the specific purpose, function as applied to equipment use, environment, or application, where described in a particular requirement.

Impact Limit Line: A line defining a limit beyond which a missile/spacecraft or specified portions thereof will not be allowed to impact.

Inactive Vessels/Systems: (PVS) These are vessels/ systems which are not in service because of changes in program requirements and have no current planned usage but have not been determined to be unsafe.

Industrial Operation: A task, usually performed in one location, and consisting of one or more work elements in which the person(s) performing the task has had training (certificate, license, etc.) to meet the technical requirements for processes, procedures, practices and methods that have been adopted as standard (e.g., machinist, electrician, plumber, fork lift operator, chemical handler.)

Inservice Inspection (ISI): (PVS) A periodic inspection of a vessel or system while in service. If required, the vessel or system will be inoperative during the inspection.

Inservice Inspection (ISI) Plan: (PVS) The plan is a list of inspections and tests and the frequency to be performed on the pressure vessels and/or pressurized systems.

Integrated Procedure: A procedure requiring the concurrence/approval of more than one contractor or KSC Primary Directorate Government organization, or other independent separate organizations involving test of interfacing systems, components, or elements.

Interim Change: Change made to an existing and approved TOP when there is insufficient time available to prepare a formal change (e.g., change pages). OMI deviations are one form of an interim change.

Job Cards: A Category I TOP designed for computer release through work control.

Labeled: *(Electrical Extension Devices)* Equipment bearing a label, symbol, or other identifying mark indicating compliance with nationally recognized standards/tests to verify safe use in a specified manner, as confirmed by a nationally recognized testing laboratory which conducts periodic inspections of the production of the labeled equipment.

Leak Before Burst (LBB): (COPV) A failure mode such that any initial flaw in the Gr/Ep COPV liner will grow through the liner to cause leakage without burst of the overwrap.

Lethal Fluids: (PVS) Poisonous gases or liquids of such a nature that a very small amount of the gas or liquid mixed, or unmixed with air, is dangerous to life when inhaled. See ASME Code, Section VIII, Division 1, Paragraphs UW-2 and UCI-2, Division 2, Paragraph AG 301.1, and ASME B31.1, Appendix M. The following specification-grade fluids are to be considered lethal; additional fluids may be designated to be lethal at the discretion of the KSC PSM.

a. Aerozene 50
b. Hydrazine
c. Monomethyl Hydrazine
d. Nitrogen Tetroxide
e. Unsymmetrical Dimethyl Hydrazine

Lifting Devices and Equipment Manager (LDEM): The individual, designated by the KSC Center Director, who is responsible for the overall management of the KSC Lifting Devices and Equipment Program. The LDEM resides in the Launch Vehicle S&MA Division.

Likelihood (of Occurrence): An assessment of the likelihood or probability of a hazard's most severe effects transpiring. Likelihood (probability) takes into account that the hazard controls are in-place and effective.

Listed: *(Electrical Extension Devices)* Equipment is “listed” if it is of a kind mentioned in a list that is published by a nationally recognized laboratory that makes periodic inspection of the production of such equipment.

Local Control Area: A controlled access area (usually less than a 50-foot radius of the hazardous task) in which control is manageable on location by the operation and maintenance contractor and safety personnel using visual/voice contact to ensure personnel safety.

Lock: Lockout/tagout device that physically prevents the use of equipment or machinery.

Lockout Device: A mechanical block with a lock and key, or combination type, designed to secure an energy-isolation device in the safe position and prevent the energizing of equipment or machinery.

Lockout/Tagout: The process of configuring equipment in a temporary condition in which the release of energy is prevented from endangering personnel performing servicing and/or maintenance. The placement of a lock/tag on the energy isolating device in accordance with the established procedure, indicating that the energy isolating device shall not be operated until removal of the lock/tag in the accordance with the established procedure.

Major Control Area: A controlled access area (usually greater than a 50-foot radius of the hazardous task) in which access management requires additional positive controls to ensure the safety of personnel.

Manloading: The maximum number of personnel permitted to occupy a defined area at a single time.

Maximum Allowable Stress Value: (PVS) The maximum unit stress permissible for any specified material that may be used in the design formulas.

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

Maximum Operating Pressure (MOP): (PVS) The highest pressure at which a vessel or system component normally operates. This pressure is based on operating requirements and may not exceed the MAWP or design pressure. MOP is synonymous with MEOP (Maximum Expected Operating Pressure) or maximum working pressure.

Maximum Work Time Deviation: An authorized exceedance of the MWT provisions that is documented and approved prior to the exceedance.

Maximum Work Time Violation: Exceedance of MWT limits without preapproval.

Medical Treatment: (29CFR 1904.7(b)(5)(i)) "Medical treatment" means the management and care of a patient to combat disease or disorder. For the purposes of Part 1904, medical treatment does not include:

(a) Visits to a physician or other licensed health care professional solely for observation or counseling;

(b) The conduct of diagnostic procedures, such as x-rays and blood tests, including the administration of prescription medications used solely for diagnostic purposes (e.g., eye drops to dilate pupils); or

(c) "First aid" as defined – see **First Aid**.

Mishap: An undesired and unexpected event that results in injury requiring more than first aid, occupational illness to personnel, and/or damage to property greater than $1000. Mishaps also include injuries or occupational illnesses resulting from repetitive stresses or exposures over a prolonged period of time. For purposes of investigation and reporting, mishaps are categorized as follows: Type A, Type B, Type C or Type D.

National Consensus Standard: (PVS) Any standard, or modification thereof: (1) adopted or promulgated by a nationally recognized standards-producing organization using procedures that demonstrate to the Secretary of Labor for Occupational Safety and Health that those persons interested in or affected by the standard have reached substantial agreement on its adoption; (2) formulated so that an opportunity existed for diverse views to be considered; and (3)

designated by the Secretary or the Assistant Secretary, after consultation with other appropriate Federal agencies. (NOTE: A standard, as defined, requires appropriate conditions or activities to provide a safe and healthful employment environment.)

Non-Code PVS: (PVS) Any pressure vessel that is not stamped with the appropriate symbol and documented as complying with the original construction Code or any pressure piping system that does not meet the requirements of the appropriate fabrication code (e.g. ASME Section VIII, B31.1, B31.3), including PVS that were fabricated from non-Code materials by non-Code processes or organizations.

Non-Safety-Related Discrepancy: (PVS) Any discrepancy that does not increase the potential for injury or death to personnel or damage to hardware. The following are considered non-safety-related discrepancies (others may be added at the discretion of the KSC PSM):

a. Panels/systems not properly identified.

b. Stainless steel piping or tubing not coated for corrosion protection.

c. Missing or illegible identification tags on components (except for relief devices, pressure gages, and flex hoses).

d. Discrepancies between documentation and hardware.

e. Minor corrosion of vessels, piping, components, or supports.

Nondestructive Examination: (PVS) The application of technical methods to examine materials or components in ways that do not impair future usefulness and serviceability in order to detect, locate, measure, and evaluate flaws; to assess integrity, properties, and composition; and to measure geometrical characteristics.

Open Grain: Exposed solid propellant.

Operating or Working Temperature: (PVS) The metal temperature that will be maintained in the part of the vessel or system under consideration during normal operation.

Operating Pressure: (PVS) The gage pressure at which a vessel (top of the vessel) or system normally operates. For a vessel, the operating pressure does not exceed MAWP/design pressure, and for a system, it does not exceed the design pressure.

Operations Planning Sheets: A form used for repetitive TOPs, which is released for documentation and control of a single performance of a TOP.

Other Employees: (Lockout/Tagout) Those employees who may have reason to enter or work in the area where lockout/tagout procedures may be implemented.

Owner: (PVS) The management of the organization responsible for the PVS as defined in NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems.

Personal Protective Equipment: Portable equipment that provides a barrier between an individual employee and hazardous materials or agents in the workplace.

Phase 1 Lightning Watch: Conditions in the atmosphere, developing or observed, that is expected to produce, or is producing, lightning which will arrive at specified areas within 30 minutes.

Phase 2 Lightning Warning: Lightning observed or thunder heard within 5 nautical miles, or forecaster determines the threat of lightning is immediate.

Photographic Equipment: Cameras, still and video, and electronic and/or enclosed flash assemblies.

Physical Agent: Any environmental factor, such as noise, temperature extremes, vibrations, etc., which may cause harm or injury to personnel

Piggybacking/Daisy Chaining: (Electrical Extension Devices) Plugging one or more electrical extension devices into another.

Placard Procedure: A simple procedure written or printed on a plaque attached to a facility or GSE end item that provides instructions for activating/deactivating that item.

Pneumatic Test: (PVS) A test of a pressure vessel or system in which a gas is introduced and pressurized to a designated level in a manner prescribed in the applicable code. (Reference Paragraph UG-100, ASME Code, Section VIII, Division 1, or Article T-4, ASME Code, Section VIII, Division 2, and Paragraph 345.5, ASME B31.1.)

Power Strip: (Electrical Extension Devices) (Also known as a plug board, power board, power bar, distribution board, gang plug, plug bar, multibox, extension lead, or relocatable power tap) is a strip of sockets that attaches to the end of a flexible cable and allows multiple devices to be plugged in.

Pressure Cycle: (PVS) The initiation and establishment of new pressure levels followed by a return to the conditions that prevailed at the beginning of the cycle. Two types of pressure cycles are considered:

a. Full pressure (startup or shutdown) cycle: any pressure cycle which has atmospheric pressure as one of its extremes and normal operating conditions (not exceeding vessel MAWP/design pressure) as its other extreme.

b. Partial pressure (normal operating) cycle: any pressure cycle within the full pressure cycle, which is required for the vessel or system to perform its intended purpose.

Pressure Relief Device (PRD): (PVS) A pressure relief device designed to actuate on inlet static pressure and to reclose after normal conditions have been restored. This includes relief valves, safety valves, and safety relief valves (NOTE: this definition is that of ASME PTC 25-2001).

Pressure Relief Device Set Pressure: (PVS) The pressure at which a pressure relief device is set to operate. Set to operate means the set pressure of a relief valve or spring-loaded nonreclosing device, the bursting pressure of a rupture disk device or the breaking pressure of a breaking pin device. (Reference Paragraphs UG-125 and UG-134, ASME Code, Section VIII, Division 1, and Part AR, ASME Code, Section VIII, Division 2.)

Pressure System: (PVS) An assembly of components under pressure, including vessels, piping, valves, relief devices, pumps, expansion joints, gages, etc. This includes systems containing hazardous or lethal fluids at any pressure above 0 MPa (gage) (0 lb/in^2 (gage)) and systems containing nonhazardous or nonlethal fluids above 0.1 MPa (gage) (15 lb/in^2 (gage)), unless otherwise specifically excluded.

Pressure Systems Manager (PSM): (PVS) The individual designated by the KSC Center Director who is responsible for the overall management of the KSC Pressure Vessel/Systems (PVS) Certification Program. The KSC PSM resides in the Institutional S&MA Division.

Pressure Test: See **Hydrostatic Test** and **Pneumatic Test**.

Pressure Vessel: (PVS) Any vessel used for the storage or handling of gas or liquid under positive pressure. Included in this definition are components of systems (e.g., heat exchanger shells and drying towers, and other shell structures) for which the rules of the ASME Code, Section VIII, would apply. Vessels containing hazardous or lethal fluids at any pressure above 0 MPa (gage) (0 lb/in^2 (gage)), and vessels containing nonhazardous or nonlethal fluids above 0.1 MPa (gage) (15 lb/in^2 (gage)) are included unless otherwise specifically excluded.

Pretask Briefing: A briefing held immediately prior to the start of (a) hazardous sequence(s), which details the hazard(s) and objective(s) associated with that particular sequence.

Pretest Briefing: A briefing held prior to the start of a hazardous operation with a major control area, which details the hazard(s) and objective(s) of the operation and confirms that all operational and support elements are ready.

Processing Mishap/Close Call: A mishap or close call, which occurs during the act of ground processing of flight hardware.

Program/Project or Directorate Organization: The Government/contractor organization having direct responsibility for performing a task associated with: assembly/ disassembly; checkout, maintenance; servicing; repair; and operation of ground support equipment or flight hardware/systems.

Proof Tests to Establish Maximum Allowable Working Pressure: (PV) Pressure test which establishes the maximum allowable working pressure of a vessel, system, or component thereof, may be used: (1) When the strength cannot be computed with a satisfactory assurance of accuracy; (2) When the thickness cannot be determined by means of the design rules of the applicable code or standard; or (3) When the critical flaw size to cause failure at the certified pressure cannot be identified by other nondestructive test methods. This test is to be performed in a manner equivalent to one of the methods specified in Paragraph UG-101 of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition. Proof tests may be performed only upon approval of the KSC PSM.

PVS Representative: (PVS) The individual(s) assigned and who has been identified to the PSM as the representative for an organization in all matters relating to PVS.

Qualified: *(Electrical Extension Devices)* One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

Radio Frequency (RF) Control Area: The area within a facility where only KSC-approved transmitters/emitters are allowed to operate during an operational task which requires RF silence.

Radio Frequency (RF) Silence: A period of time where RF transmitters/emitters, either fixed-in-place or transient, are prohibited from emitting RF energy in a specified area.

Rated Load: The static weight the basic equipment can safely support or lift.

Real-Time Decision/Action: A real-time decision or action is one that affects personnel safety or NASA operational mission accomplishment by causing:

a. The potential to deviate from a normal or standard practice.

b. A minimum amount of time or no time to functionally verify the adequacy of the real-time decision or action and its effect to be performed.

Recall System: (PVS) A system which tracks selected components subject to periodic calibration, inspection, or test. Components included in recall systems are relief valves, pressure gages, and flex hoses.

Receptacle: (Electrical Extension Devices) A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

Recertification: (PVS) The procedure (appropriate tests, inspections, examinations, analyses, and documentation), which qualifies a previously certified vessel or system to continue or be returned to operation at a designated pressure. Also applies to GSE.

Recertification Interval: (PVS) The time between recertifications when a certified status is maintained through documented periodic examinations and inspections to determine acceptable vessel or system condition. This time period must be determined when the ISI plan is developed, and the length of this period will depend on the results of the initial and subsequent inspections, tests, and engineering analyses.

Reissue: A revised edition of an existing approved TOP that contains updated material, or has a different effectivity, to which the OMI or change applies.

Relocatable Power Tap: (Electrical Extension Devices) See **Power Strip**

Repair: (PVS) The work necessary to restore a pressure vessel or system to a safe and satisfactory operating condition, provided there is no deviation from the original design.

Rerated Vessel or System: (PVS) (1) A vessel or system judged to be unsafe, unsuitable, or unnecessary for continued operation at its original design pressure and/or temperature limits. (2) A vessel or system recertified to operate at a lesser or greater pressure and/or temperature limit relative to its original designs.

Residual Risk: The level of risk that remains after applicable safety-related requirements have been satisfied. In a risk-informed context, such requirements may include measures and provisions intended to reduce risk from above to below an acceptable level.

Revision: *(TOPs)* A modification of information contained in an approved existing TOP.

Risk: The combination of the likelihood (qualitative or quantitative) that an activity will experience an undesirable event and the consequence/severity of the undesired event were it to occur.

Risk (Safety) Assessment: Process of qualitative risk categorization or quantitative risk (safety) estimation, followed by the evaluation of risk significance.

Risk Assessment Code: A numerical expression of comparative risk determined by an evaluation of both the potential severity of a condition and the likelihood of its occurrence causing an expected consequence.

Safety Concurrence: The consent required from the safety organization, having operational jurisdiction, prior to start of procedures containing hazardous operations, prior to hazardous steps or sequences, prior to the alteration of hazardous steps/sequences, and prior to opening the control area for controlled work at the conclusion of hazardous activities.

Safety Coverage: The presence of a Safety professional, or designee, during operations as determined by an assessment as follows:

a. Full-time Coverage: The safety professional will be onsite to provide a go-to-proceed with the operation, monitor operations and controls to ensure compliance with safe performance and provide technical safety assistance as needed during the entire operation.

b. Part-time Coverage: The safety professional is present onsite to provide a go-to-proceed with the operation, periodically and at the end to reopen the area.

c. Optional Coverage: The safety professional is not required for onsite coverage.

Safety Critical: Anything (system, subsystem, equipment, component, operation, event, process, function, software, etc.) that could cause or lead to severe injury, major damage, or mission failure if performed or built improperly, or allowed to remain uncorrected (i.e., could result in a consequence severity Level 4 or 5 effect in the applicable risk matrix).

Safety Factor: Ratio of the design limit to the maximum operating conditions.

Safety Professional: Person meeting the Office of Personnel Management standards for such occupations defined in 29CFR 1960.2(s) (Definitions) for Government operations or equally qualified military, agency or nongovernment for contractor operations. NASA KSC Safety is responsible for determination of equally qualified personnel. Safety Specialists, Representatives, and Inspectors have sufficient experience within their discipline to recognize Safety and/or health hazards in the workplace.

Safety-Related Hardware Discrepancy: (PVS) Any hardware discrepancy that could increase the potential for injury or death to personnel or damage to hardware. The following are considered safety-related discrepancies:

a. Primary relief device set above the certified MAWP or design pressure.

b. Relief device with insufficient flow capacity.

c. Relief device past due for calibration.

d. Relief device with missing or illegible identification tag.

e. Pressure gage out of calibration or past due.

f. Obvious physical damage (e.g., crushed or kinked flexhose, dented or nicked piping/tubing/vessels, or heavy corrosion of vessels/piping).

g. Not labeling the vessel's MAWP/service fluid.

Safety-Relief Device Set Pressure: (PVS) The pressure at which a pressure relief device is set to operate. Set to operate means the set pressure of a relief valve or spring-loaded nonreclosing device, the bursting pressure of a rupture disk device or the breaking pressure of a breaking pin device. (Reference Paragraphs UG-125 and UG-134, ASME Code, Section VIII, Division 1, and Part AR, ASME Code, Section VIII, Division 2.)

Safety or Safety Representative: The term Safety is used without context to contractor or NASA personnel. The phrase "NASA S&MA" is used to mean a Government Safety representative only.

Scoop-proof: An electrical connector's shell design that prevents inadvertent cocking of the mating plug connector into the mating receptacle. Such cocking can occur in other connector designs, causing physical damage to the pins or inadvertent pin to pin contact which could result in electrical shorting. In a blind mating application, mating shells cannot "scoop" the pins and cause a shorting or bending of contacts.

Shall: A mandatory S&MA requirement. Noncompliance with a "shall" statement requires approval of a variance.

Should: An S&MA rule/requirement that is recommendation (guidance). The advisability of a "should" statement depends on the specific facts in a given situation. Implementation of a "should" statement is at the discretion of the responsible KSC program/project or directorate organization.

Software: Computer programs, procedures, rules, and associated documentation and data pertaining to the development and operation of a computer system. Software includes programs and operational data contained in hardware (e.g., firmware, programmable logic, and programmable gate arrays). This also includes COTS, GOTS, MOTS, reuse, legacy, and heritage software products and components.

Splash (KSC Vapor Suit): Two-piece garment consisting of a hooded pullover blouse and trousers with boots and lightweight, long gauntlet gloves.

Sub-task TOP: A procedure used to perform work when called up by another TOP (usually an integrated TOP).

Sub-task-only TOP: A procedure preplanned to be performed only as a subtask to a controlling procedure and may contain limited Safety controls.

System Certification Pressure: (PVS) The maximum pressure that has been applied to a system; however, no system element can have its MAWP exceeded when the certification pressure has been applied.

System Safety: Application of engineering and management principles, criteria, and techniques to optimize safety and reduce risks within the constraints of operational effectiveness, time, and cost throughout all phases of the system life cycle.

Tag: Lockout/tagout device that alerts workers regarding equipment/machinery status.

Tagout Device: A prominent warning means such as a tag and a means of attachment, which can be securely fastened to an energy isolating device and the equipment being controlled.

Task Leader: A person who has been trained and certified/stand boarded by his organization for a particular task.

Technical Operating Procedure (TOP): A written communication that identifies and directs work to be performed and provides the detailed instructions necessary to accomplish a task.

a. Category I TOP: Provides detailed procedures for the operation, maintenance, and verification of ground support systems and equipment. Instructions for assembly and disassembly, checkout, servicing, verification, handling, and transportation of the space vehicle and components including payload systems, subsystems, and experiments during prelaunch, launch, and postlaunch operations are also provided.

b. Category II TOP: Provides engineering instructions, authorizes work, establishes work control methods, in order to accommodate special tests or authorize temporary installations, removals, or replacements. Category II procedures cannot be used to change or replace Category I procedures.

Temporary Equipment (PVS) (PVS) Non-government owned equipment that is not required to meet the certification (or recertification) requirements of NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems or NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS). Temporary equipment is subject to all applicable laws, regulations, NASA safety requirements, OSHA requirements, and appropriate NCS. This typically includes contractor supplied rental equipment leased from an offsite location.

Temporary Power Taps: (Electrical Extension Devices) Connector switch assembly, surge suppressor power strip outlet. See Power Strip definition

Temporary Voltage Surge Suppressor Strip: (Electrical Extension Devices) A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions.

Test Article PVS: (PVS) A PVS object(s) being tested for the sole purpose of obtaining data (other than integrity data) on the object(s).

Test Specific PVS: (PVS) PVS used to perform testing of a specific test article. PVS used on a permanent or repeated basis, or built up of components used repeatedly for testing different hardware or configurations are not part of this category.

Threshold Limit Value-Time Weighted Average (TLV-TWA): The time weighted average concentration for a normal 8 hour workday and a 40 hour workweek, to which workers may be repeatedly exposed, day after day, without adverse effect.

Trained Inspector: (COPV) A person trained specifically in the detection of visual damage of COPVs and familiarized with the NDE methods and results that could be used to aid in the interpretation of visual damage. JSC White Sands Test Facility typically conducts this training.

Type A Mishap: A mishap causing death, permanent total disability, hospitalization (within a 30 day period from the mishap) of three or more persons for other than observation, and/or damage to equipment or property and/or mission failure resulting in loss equal to greater than $1 million. Mishaps resulting in damage to aircraft, space hardware, or GSE that meet these criteria are included, as are test failures in which the damage was unexpected or unplanned.

Type B Mishap: A mishap resulting in permanent partial disability to one or more persons, in-patient hospitalization of 2 or less personnel, damage to equipment or property and/or mission failure resulting in loss equal to or greater than $250,000, but less than $1 million. Mishaps resulting in damage to aircraft, space hardware, or GSE that meet these criteria are included, as are test failures in which the damage was unexpected or unplanned.

Type C Mishap: A mishap resulting in damage to equipment or property, or mission failure resulting in loss equal to or greater than $25,000, but less than $250,000, and/or causing occupational injury or illness that results in a case involving day(s) away from work or restricted duty. Mishaps resulting in damage to aircraft, space hardware, or GSE that meet these criteria are included, as are test failures in which the damage was unexpected or unplanned.

Type D Mishap: A mishap consisting of personal injury requiring medical treatment greater than first aid but without any lost time or restricted duty and/or property damage or mission failure resulting in loss equal to or greater than $1000, but less than $25,000. Permanent occupational.

Uninterruptible Power Supply: (Electrical Extension Devices) Designed for use with electronic computer/data supply processing equipment, and supplies uninterrupted power to said equipment during commercial power failures.

Unprotected Heights: Personnel exposure to within 6-feet of an unprotected-leading edge from which there is a drop of more than 4-feet.

Unsafe Vessels or Systems: (PVS) These are vessels or systems, which have been determined to be unsafe for service.

Vacuum System: (PVS) An assembly of components under vacuum (internal pressure less than that of the surrounding atmosphere) including vessels, piping, valves, relief devices, pumps, expansion joints, and gages.

Vacuum Vessel: (PVS) A vessel in which the internal pressure has been reduced to a level less than that of the surrounding atmosphere.

Variance: (Safety Variance) Documented and approved permission to perform some act or operation contrary to established requirements. The three types of safety variances are exceptions, deviations, and waivers. A variance may involve the approval of alternative means that provide an equivalent or lower level of risk or formal acceptance of increased risk due to the fact that the requirement is not satisfied.

Visible Damage: (COPV) 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 temporary relief from a specific requirement after the fact. Requested during the implementation of a project or operation to address situations that were unforeseen during design or advanced planning.

Warning: A notation which if not adhered to or observed could result in loss of life, personal injury, or exposure.

Watertight: (Electrical Extension Devices) So constructed that moisture will not enter the enclosure.

Weatherproof: (Electrical Extension Devices) So constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, rain tight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness are not a factor.

Wet Location: (Electrical Extension Devices) Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as vehicle-washing areas and locations unprotected and exposed to weather.

Workday: Any day a person reports to work, regardless of the amount of time spent on the job. The workday begins when a person reports to work and ends when he or she leaves.

Workweek: Any seven day period beginning on Sunday and ending on Saturday, or other seven day period, as specified and documented by an organization for accounting purposes.

APPENDIX B - ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACGIH	American Conference of Governmental Industrial Hygienists
AFGE	American Federation of Government Employees
AFMAN	Air Force Manual
AFMC	Air Force Material Command
AFSCF	Air Force Satellite Control Facility
AIAA	American Institute of Aeronautics and Astronautics
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
AP	Ammonium Perchlorate
API	American Petroleum Institute
APS	Aft Propulsion System
APU	Auxiliary Power Unit
ARCS	Aft Reaction Control System
ARF	Assembly and Refurbishment Facility
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
AWWA	American Water Works Association
B/L	baseline
BDA	Blast Danger Area
BEU	Breathing Escape Unit
BSM	Booster Separation Motor
C	Centigrade
c/o	Check-Out
C&W	Caution and Warning
CAP	Corrective Action Plan
CAPPS	Checkout Assembly & Payload Processing Services Contract
CCAFS	Cape Canaveral Air Force Station
CCB	Change Control Board
CCF	Converter Compressor Facility
CD	Center Director
CDE	Center Declared Emergency
CDDT	Countdown Demonstration Test
CDF	Confined Detonating Fuse
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CIL	Critical Items List
COPV	Composite Overwrapped Pressure Vessel
COTR	Contracting Officer Technical Representative
COTS	Commercial Off The Shelf
CPIA	Chemical Propulsion Information Agency (Johns Hopkins University)
CPS	Chemical Protection Suit
CT	Crawler Transporter
CTC	Chief Test Conductor
dB	Decibels
DBP	Design Burst Pressure

DC	Direct Current
DCR	Document Change Recommendation
DMES	Dimethylethoxsilane
DO	Duty Officer
DOD	Department of Defense
DOP	Detailed Operational Procedure
DOT	Department of Transportation
DRA	Document Release Authorization
ECS	Environmental Control System
ECU	Environment Control Unit
EDC	Engineering Documentation Center
EDO	Extended Duration Orbiter
EE&SE	Emergency Eyewash and Shower Equipment
EED	Electroexplosive Device
EEE	Electronic, Electrical, Electromechanical
ELSA	Emergency Life Support Apparatus
ELV	Expendable Launch Vehicle
EM	Electro-Mechanical
EMI	Electromagnetic Interference
EMS	Emergency Medical Services
EMU	Extravehicular Mobility Unit
EOM	End of Mission
EPD	Emergency Procedures Document
ERP	Emergency Response Plan
ESP	Engine Service Platform
ET	External Tank
ETA	Explosive Transfer Assembly
ETE	Explosives Test Equipment
ETI	Explosives Technologies International, Inc.
ETVAS	External Tank Vent Arm System
EWR	Eastern Western Range
FDS	Fluid Distribution System
FIV	Fuel Isolation Valve
FJAF	Field Joint Assembly Fixture
FM	Factory Mutual
FM	Frequency Modulation
FMEA	Failure Modes and Effects Analysis
FOD	Foreign Object Debris
FOS	Factor of Safety
FRCS	Forward Reactant Control System
FRF	Flight Readiness Firing
FRSI	Felt Reusable Surface Insulation
FSI	Factor of Safety
FSM	Fuel Supply Module
FSS	Fixed Service Structure
FTA	Fault Tree Analysis
GFCI	Ground Fault Circuit Interrupter
GHe	Gaseous Helium

GH_2	Gaseous Hydrogen
GO_2	Gaseous Oxygen
GOAL	Ground Operations Aerospace Language
GOX	Gaseous Oxygen
Gr/Ep	Graphite Epoxy
GSE	Ground Support Equipment
GSRP	Ground Safety Review Panel
GUCP	Ground Umbilical Carrier Plate
H_2	Hydrogen
HB	High Bay
HDP	Hold Down Post
HGDS	Hazardous Gas Detection System
HMF	Hypergol Maintenance Facility
HP	High Pressure
HPU	Hydraulic Power Unit
HPWF	High Pressure Wash Facility
HVAC	Heating, Ventilation, and Air Conditioning
HVDS	Hypergol Vapor Detection System
HVES	Hypergolic Vent Exhaust System
IA	Independent Assessment
ID	Identification
IDLH	Immediately Dangerous to Life or Health
IGSCC	Intergranular Stress Corrosion Cracking
IRIS	Incident Reporting and Investigation System
ISC	Institutional Services Contract/Contractor
ISEA	International Safety Equipment Association
ISI	Inservice Inspection
ISO	International Organization of Standardization
ISS	International Space Station
ISSP	International Space Station Program
IT	Intertank
IUS	Inertial Upper Stage
JSC	Johnson Space Center (NASA, Houston, Texas)
KCA	Kennedy Customer Agreement
KDP	Kennedy Documented Procedure
KEDS	KSC Electronic Documentation System
KHB	Kennedy Handbook
KNPD	Kennedy NASA Policy Directive
KNPG	Kennedy NASA Procedures and Guidelines
KNPR	Kennedy NASA Procedural Requirements
KPD	KSC Program Directive
KSC	Kennedy Space Center (NASA, KSC, Florida)
kV	Kilovolt
kW	Kilowatt
lb/in	Pound per square inch
LC	Launch Complex

LD	Launch Director
LDA	Launch Danger Area
LDEM	Lifting Devices and Equipment Manager
LEL	Lower Explosive Limit
LH	Left Hand
LH_2	Liquid Hydrogen
LLIS	Lessons Learned Information System
LO_2	Liquid Oxygen
LOTO	Lockout/Tagout
LOMS	Left OMS
LOX	Liquid Oxygen
LP	Liquefied Propane
LSC	Linear Shape Charge
LSP	Launch Support Program
LSSO	Launch Site Safety Office
LSSP	Launch Site Safety Plan
LSSR	Launch Site Safety Representative
LVP	Launch Vehicle Processing
M&P	Materials and Processes
MAWP	Maximum Allowable Working Pressure
MDCP	Mechanical Damage Control Plan
MDD	Mate/Demate Device
MDMT	Minimum Design Material Temperature
MDOP	Maximum Design Operating Pressure
MEC	Master Events Controller
MEOP	Maximum Expected Operating Pressure
MESC	Medical and Environmental Support Contractor
MIB	Mishap Investigation Board
MIL	Military
MLG	Main Landing Gear
MLP	Mobile Launch Platform
MMH	Monomethylhydrazine
MOP	Maximum Operating Pressure
MOU	Memorandum of Understanding
MPa	MegaPascal
MR	Material Review
MRB	Material Review Board
MSD	Musculoskeletal Disorder
MSDS	Material Safety Data Sheet
MTB	Materials Testing Branch
mV	Millivolt
MVAK	Module Vertical Access Kit
MWT	Maximum Work Time
N_2H_4	Hydrazine
N_2O_4	Nitrogen Tetroxide
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NBIC	National Board Inspection Code
NCC	NASA Convoy Commander

NCS	National Consensus Codes and Standards
NDE	Nondestructive Evaluation
NDI	Nondestructive Inspection
NEC	National Electrical Code
NEPO	NASA Emergency Preparedness Officer
NFC	National Fire Code
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NPD	NASA Policy Directive
NPG	NASA Procedures and Guidelines
NPS	Nominal Pipe Size
NS	Nonstock
NSI	NASA Standard Initiator
NSS	NASA Safety Standard
NSTS	National Space Transportation System
NTD	NASA Test Director
O_2	Oxygen
O&C	Operations and Checkout
O&M	Operations and Maintenance
O&SHA	Operating and Support Hazard Analysis
OAA	Orbiter Access Arm
ODS	Orbiter Docking System
ODMS	Oxygen Deficiency Monitoring System
OHF	Occupational Health Facility
OIC	Orbiter Integration Clerk
OIS	Operational Intercommunications System
OMBUU	Orbiter Midbody Umbilical Unit
OMD	Operations and Maintenance Documentation
OME	Orbiter Main Engine
OMI	Operations and Maintenance Instructions
OMRSD	Operational Maintenance Requirements and Specifications Document
OMS	Orbiter Maneuvering Subsystem
OPF	Orbiter Processing Facility
OPR	Office of Primary Responsibility
OSF	Ordnance Storage Facility
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OSMA	NASA Headquarters Office of Safety and Mission Assurance
OTC	Orbiter Test Conductor
OTV	Operational Television
PA	Public Affairs
PAWS	Paging and Area Warning System
PCR	Payload Changeout Room
PDE	Program Declared Emergency
PEL	Permissible Exposure Level
PFA	Plastic Films, Foams, and Adhesives
PGOC	Payloads Ground Operations Contract
PHA	Preliminary Hazard Analysis
PHE	Propellant Handlers Ensemble

PIC	Pyro Initiator Controller
PLB	Payload Bay
PM	Preventive Maintenance
PMN	Program Model Number
PNL	Panel
POC	Point-of-Contact
PPE	Personal Protective Equipment
ppm	Parts per million
PRA	Probabilistic Risk Assessment
PRD	Pressure Relief Device
PRSD	Power Reactant Supply and Distribution
psid	Pounds Per Square Inch Differential
psig	Pounds Per Square Inch Gage
PSM	Pressure Systems Manager
PTCR	Pad Terminal Connection Room
PV	Pressure Vessel
PVS	Pressure Vessel/Systems
PVT	Pressure Volume Temperature
QD	Quick Disconnect
R&D	Research and Development
R&M	Reliability and Maintainability
RAC	Risk Assessment Code
RBDA	Reliability Block Diagram Analysis
RCM	Reliability Centered Maintenance
RCS	Reaction Control System
RF	Radio Frequency
RH	Relative Humidity
rms	Root-Mean-Square
ROMS	Right OMS
RPSF	Rotation, Processing, and Surge Facility
RPT	Relocatable Power Tap
RRB	Risk Review Board
RSS	Rotating Service Structure
RTG	Radioisotope Thermoelectric Generator
RTLS	Return to Launch Site
S&A	Safe and Arm
S&MA	Safety and Mission Assurance
S/C	Spacecraft
S/N	Serial Number
SAE	Society of Automotive Engineers
SAR	Supplied Air Respirator
SCA	Shuttle Carrier Aircraft
SCAPE	Self Contained Atmospheric Protective Ensemble
SCBA	Self Contained Breathing Apparatus
SCC	Safety Control Center
SCFM	Standard Cubic Feet per Minute
SCO	Space Craft Operator
SPOC	Space Program Operations Contractor

SFP	Single Failure Point
SHA	System Hazard Analysis
SLF	Shuttle Landing Facility
SLOAA	Suspended Load Operation Analysis/Approval
SPF	Spray Paint Facility
SQ&MA	Safety, Quality, and Mission Assurance
SRB	Solid Rocket Booster
SRL	Self Retracting Lifeline/Lanyard
SRE	Safety and Reliability Engineering
SRM	Solid Rocket Motor
SRM&QA	Safety, Reliability, Maintainability, and Quality Assurance
SRSS	Shuttle Range Safety System
SS	Station Set
SSA	Software Safety Analysis
SSHA	Subsystem Hazard Analysis
SSME	Space Shuttle Main Engine
SSP	Space Shuttle Program
SSR	Safety Statistics Record
SSV	Space Shuttle Vehicle
STD	Standard
STE	Special Test Equipment
STS	Space Transportation System
SW	Switch
SW	Space Wing
TAL	Transatlantic Abort Landing
TC	Test Conductor
TCDT	Terminal Count-Down Test
TD	Test Director
TDC	Technical Documentation Center
TLV-TWA	Threshold Limit Value-Time Weighted Average
TOP	Technical Operating Procedure
TP	Test Procedure
TSM	Tail Service Mast
TTL	Task Team Leader
TVC	Toxic Vapor Check
TVSS	Transient Voltage Surge Suppression
UDS	Universal Documentation System
UFGS	Unified Facilities Guide Specifications
UHF	Ultra High Frequency
UL	Underwriters Laboratories
UPS	Uninterruptable Power Supply
USAF	United States Air Force
UT	Ultrasonic Thickness
UTPA	Universal Throat Plug Assembly
UT-THK	Ultrasonic Testing-Thickness
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VE	Visual Examination

VHF	Very High Frequency
VPF	Vertical Processing Facility
WAD	Work Authorization Document
WLAN	Wireless Local Area Network